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# Microstructure characterization of intermetallic (Ni-Ti)<sub>3</sub>C nanocarbide compound synthesized by mechanical alloying of elemental powders

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## ABSTRACT

In the present work, synthesis and microstructure characterization of nanocrystalline intermetallic carbide (Ni-Ti)<sub>3</sub>C synthesized by mechanical alloying under argon atmosphere has been investigated in detail. Microstructure characterization in terms of lattice imperfections of prepared ball-milled powders and quantitative estimation of different phases present in the powder samples have been carried out by analyzing X-ray diffraction data employing Rietveld's powder structure refinement method. Rietveld's analysis output reveals that the single phase stoichiometric nanocrystalline (Ni-Ti)<sub>3</sub>C has been formed after 7 h of ball-milling from Ni-Ti-C solid solution phase and extended milling up to 10 h confirms the phase stability of newly formed carbide phase. High resolution TEM images of 10 h ball-milled sample reveal the microstructure of prepared nano-carbide which is in good agreement as obtained from structural and microstructural evaluation by Rietveld method using XRD data. Finally, a comparative study between microstructural parameters of (Ni-Ti)<sub>3</sub>C with Ni<sub>3</sub>C helps to understand the effect of Ti doping on the phase formation of (Ni-Ti)<sub>3</sub>C.

## 1. Introduction

Metal carbides are typically expressed as “refractory” materials as a consequence of their incomparable properties like elevated melting temperatures, high Young's moduli at elevated temperatures, enormous hardness and superior thermal shock resistance. Consequently, it becomes a tradition to manufacture of high temperature appliances, cutting tools, surface layer coating and wear-resistance parts using metal carbides [1]. Moreover, metal carbides possess excellent electronic and thermal conductivity and few of them show evidence of superconductivity too [2–4]. Among these carbides, nickel carbide recently has found application to a great extent due to its excellent magnetic, mechanical and electro-catalytic properties [5,6]. Because of its excellent electrical conductivity as well as high degree of electro-catalytic activity, nickel carbide is recently being used in fuel cells as a potential material and can effectively be introduced as a modifier for new generation electro-chemical sensors [7]. At room temperature, nickel carbide (Ni<sub>3</sub>C) has a metastable phase resulting from the lack of ionic bonding and very low solubility of carbon into nickel lattice. Ni<sub>3</sub>C decomposes at temperature just above 430 °C and as a result nickel carbide based materials are very hard to be synthesized at room temperature [8,9]. In previous works, several literatures reported the

development of thin Ni<sub>3</sub>C film [10,11] but reports on pure Ni<sub>3</sub>C powder synthesis starting from elemental nickel and graphite powders are very few [12,13]. Portnoi et al. prepared nickel carbide by milling Ni-C powder mixture in argon atmosphere [12]. In our previous work, synthesis of stoichiometric nanocrystalline Ni<sub>3</sub>C powder was achieved by ball-milling the starting ingredients, metallic Ni and graphite powder mixture under argon atmosphere within a short duration [13]. Fan et al. [14] prepared uniform Fe doped Ni<sub>3</sub>C nano-dots dispersed in ultrathin N-doped carbon nanosheets through carburization of the two dimensional nickel cyanide coordination polymer precursors.

Conventional carbide preparation involving high temperature synthesis needs huge instrumentation. In contrast, mechanical alloying (MA) is a facile ultrafast solid state synthesis method of nanocrystalline metal carbide preparation in a single-step at room temperature, as reported in our previous works [15–19]. High localized pressures and temperatures developing in repetitive ball-powder-ball and ball-powder-wall collisions in the course of milling results in diffusion process of materials leading to the easy formation of new stoichiometric phases, which needs huge instrumentation by any other conventional synthesis method.

The purpose of the current research work is to synthesize nano-dimensional ternary Ni<sub>0.65</sub>Ti<sub>0.1</sub>C<sub>0.25</sub> metal carbide at room temperature

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# Solvent-Free Solid-State Synthesis of High Yield Mixed Halide Perovskites for Easily Tunable Composition and Band Gap

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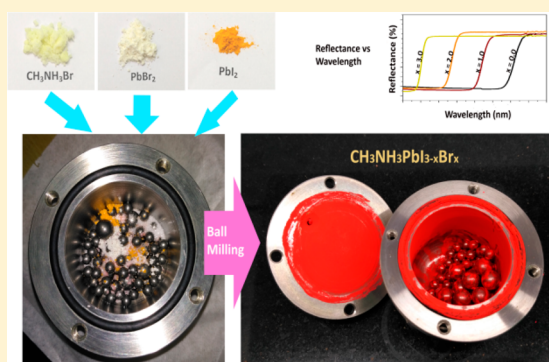
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## Supporting Information

**ABSTRACT:** We report the preparation of mixed halide hybrid perovskites ( $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$ ) using a solvent-less mechanochemical synthesis route. Compositional analysis using EDXRF microscopy has confirmed the production of the desired materials. As relative abundance of halogen ( $x$ ) increases, the tetragonal phase gradually transforms to cubic phase and the band gap tunability of the material is observed.



Organic–inorganic hybrid perovskites have recently attracted immense attention as the absorber layer in third-generation photovoltaic cells and for their promising optoelectronic applications such as in photodiode,<sup>1</sup> nanolaser,<sup>2</sup> X-ray photodetector,<sup>3</sup> and light-emitting diode.<sup>4</sup> These materials show unparalleled optoelectronic properties such as very low excitonic binding energy, easy band gap tunability covering most of the solar spectrum, excellent optical response (23–25%), sharp absorption edge, large extinction coefficient,<sup>5</sup> very long carrier diffusion length of more than tens of micrometers,<sup>6</sup> and high dielectric constant.<sup>7</sup> Utilizing all these favorable physical properties, the hybrid perovskite based solar cell has reached a competent power conversion efficiency of 22.1% within a few years of its discovery.<sup>8</sup> However, the mostly used hybrid perovskite methylammonium lead iodide ( $\text{CH}_3\text{NH}_3\text{PbI}_3$ ) is very unstable in the open environment as it degrades rapidly in a humid environment supported by ultraviolet light. In order to counter this problem, researchers are incorporating other halides (bromine, chlorine) in  $\text{CH}_3\text{NH}_3\text{PbI}_3$ .<sup>9,10</sup> Incorporation of bromine enhances the stability of the material, but it also increases the band gap, which is not suitable for solar cell application. Varying the bromide/iodide ratio to make mixed halide hybrid perovskite ( $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$ ) changes the physical properties very much, among which is the improved stability with reduced hysteresis in power conversion efficiency.<sup>10–12</sup>  $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$  can be prepared in various ways such as solution based chemical formulation. There is an inherent problem however with the wet chemical route for preparing mixed halide hybrid

perovskite ( $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$ ) due to the different solubility of the bromide and iodide precursors in the same solvent. It is difficult to find a solvent in which both mother reactants dissolve sufficiently. This restricts varying  $x$  continuously from 0.0 to 3.0. Very few studies has been reported where  $x$  is varied continuously using a wet chemical route. However, the method of preparation plays a crucial role in defining different physical and chemical properties like morphology, grain size, transport properties, crystallinity, and other structural parameters. Mechanochemical synthesis has gained huge popularity for its reduced environmental impact, low reaction energy consumption, and minimized reaction byproduct. This synthesis technique gives several advantages over the traditional solvothermal route. Hybrid perovskite materials have been prepared by different chemical routes<sup>13</sup> where precursors were mixed in some solvents and processed at different temperatures. In the solvent-less mechanochemical synthesis route, the precursors are ground together by means of colliding balls using a one-step process in a planetary ball mill. Very few reports have been published on this synthesis route for hybrid perovskite. Stoumpos et al. found an excessive amount of unreacted precursors along with  $\text{MAPbI}_3$  while trying to grind the precursor with just a mortar and pestle.<sup>14</sup> Prochowicks et al. first reported the production of methylammonium lead iodide ( $\text{CH}_3\text{NH}_3\text{PbI}_3$ ) with the help of ball milling which yielded

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# Dispersion Tailoring in Circular Photonic Crystal Fibers for Ultraflattened Dispersion

Kajal Mondal<sup>1</sup> and Partha Roy Chaudhuri

**Abstract**—In order to tailor the dispersion characteristics and to control the dispersion slope of index-guiding photonic crystal fibers (PCFs), a new controlling technique is reported. Moreover, this technique is applied to design PCF with both near zero and ultraflattened dispersion in a large wavelength range. The birefringence of the fiber is also addressed as the field profile becomes elliptical in the designed fiber. In addition, how the inevitable imprecision introduced during the fabrication process affects the final dispersion profile is investigated. A finite difference method is used to analyze the dispersion properties and the birefringence characteristics of the PCF. Simulation results reveal that ultraflattened dispersion of  $0 \pm 1.5$  ps/(nm.km) can be achieved over a bandwidth of 890 nm in the wavelength region of 1110–2000 nm along with polarization maintaining property.

**Index Terms**—Birefringence, chromatic dispersion, circular photonic crystal fiber, ultraflattened dispersion.

## I. INTRODUCTION

PHOTONIC crystal fibers (PCFs) or microstructured fibers are manufactured by single material component, usually un-doped silica, having a lattice of air holes running down their entire length [1], [2]. By manipulating the size and shape of air-holes or lattice geometry of the photonic crystal cladding, it is possible to control light-propagation characteristics of these fibers. The chromatic dispersion can also be controlled in order to amend the zero-dispersion wavelength [3] or to engineer the dispersion slope and make the dispersion curve to be ultraflattened [4]–[6].

There are mainly three techniques by which flattened dispersion over a wide range can be obtained namely, selectively reduced hole size [7], selectively liquid filled holes [8], and creation of a defect at the core [9]. However, realization of these kinds of PCFs is extremely challenging. In this letter, in order to control dispersion and dispersion slope, a *new dispersion controlling technique* is reported. Here, the dispersion properties of PCFs have been tailored by changing the number of holes belonging to the first, the second, or the third ring in order to obtain desired dispersion characteristics. By means of this technique, similar results have been obtained as reported in [7]. However, differently from [7] where *air-hole diameters have been modified* to tailor dispersion, in the

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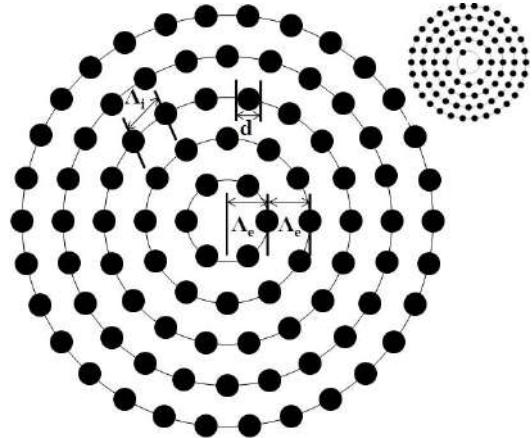


Fig. 1. Transverse cross section of a PCF with circularly distributed holes. Inset shows cross section of same PCF with three holes in the first ring.

present method the number of holes in the rings have been changed. Results have shown that the dispersion parameter can be considerably increased by dropping the air-holes in the first ring, or through adding in the second or in the third rings. Optimizing the number of holes in the rings, PCFs with zero-dispersion wavelength around 1500 nm, and the dispersion parameter value between  $\pm 1.5$  ps/nm.km in a wavelength range of 890 nm have been thus designed. The *birefringence characteristic* of the fiber is also studied as the field profile becomes elliptical in the final design. In fact, the technique can also be utilized to design a fiber which can successfully compensate positive dispersion and the positive dispersion slope [10], [11].

## II. FIBER DESIGN

Fig. 1 depicts cross section of a 5-ring PCF, where air-hole arrangement of the considered structure is shown. For illustration, in the inset of Fig. 1, another PCF cross section is shown, where number of holes in the first ring is reduced to 3 instead of 6. The key feature of the structure is a *ring shaped distribution* of air-holes [12]–[14]. The background material is considered as silica and its refractive index is calculated by the Sellmeier equation. Significant parameters of the circular PCF (C-PCF) structure are the diameter of the holes,  $d$  and the separation between any two neighboring rings,  $\Lambda_e$  (external pitch, is also the radius of first ring). The center-to-center spacing between any two nearest holes in a ring (internal pitch  $\Lambda_i$ ) then depends on the total number of holes present in that ring. The internal pitch is related to

# Probing Spin-State Switching in $\text{Fe}(\text{phen})_2(\text{NCS})_2$ Thin Film Nanocrystals on Different Substrates by Electrical Conductivity Measurements

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Spin-state switching mechanism is investigated by measuring the temperature of the electrical conductivity of spin crossover (SCO) material  $\text{Fe}(\text{phen})_2(\text{NCS})_2$  thin films grown on glass, quartz and silicon substrates. The morphology characterized by scanning electron microscopy, clearly reveals the growth of thin films of thickness  $\sim 300$  nm comprising of nanocrystals, size and distribution of which is dependent on the nature of substrates. The film on quartz is found to have the most uniform growth of nanocrystals of size  $\sim 22$  nm with a homogeneous distribution. All the films retain the orthorhombic crystal structure as that of bulk with slight distortions in lattice plausibly arising out of the strain. Spin state switching between LS and HS is clearly revealed by the hysteresis loop observed in the temperature dependence of the electrical conductivity in its heating and cooling cycle. The critical temperature of transition between HS and LS states is found to be 162 K, 193 K and 217 K for film on glass, quartz and Si respectively. Film on quartz is found to exhibit a wide hysteresis loop of width  $\sim 60$  K while that of on silicon exhibits higher transition temperature with narrow hysteresis loop  $\sim 14$  K. The results are found to be quite inspiring to tune the SCO characteristics to develop molecular switch and memory devices close to room temperature.

**Keywords:**  $\text{Fe}(\text{phen})_2(\text{NCS})_2$  nanocrystals, Thin Films, Electrical Transport, Spin-State Switching.

## 1. INTRODUCTION

The spin cross over (SCO) phenomena, which is a singular research topic in the development of the coordination chemistry, is a thermal transition in a transition-metal compound between electronic states with different numbers of unpaired electrons. SCO materials are formed by 3 d transition metal ions in an octahedral coordination displaying a spin transition from a low spin (LS) state, usually the ground state to high spin (HS) state, usually a metastable one.<sup>1</sup> Such a LS-HS transition can be induced in a controllable and reversible manner by the application of external stimuli such as temperature,<sup>2</sup> pressure,<sup>3-4</sup> light irradiation,<sup>5-7</sup> magnetic field<sup>8</sup> leading to distinctive changes in magnetism, color, structure, dielectric constant.<sup>9-14</sup> The switching process is due to the change in

splitting of *d*-level of the transition metal that induces the electron redistribution. SCO compounds are proposed for many applications, such as molecular memories, sensors, displays,<sup>15-17</sup> hybrid electronics<sup>18</sup> and optoelectronics.<sup>19</sup> Recently, a great effort has been made towards the growth of the thin films and the fabrication of nanostructures.<sup>20-25</sup> The synthesis of stable compounds and the development of new specifically dedicated procedures have permitted immense progress opening a new technological prospective of SCO compounds.

Substantial efforts are now being made to investigate SCO compounds in thin film form on suitable substrate at the nanoscopic level for possible applications.<sup>26-29</sup> The task is therefore to obtain a robust technique to grow SCO thin films/nanocrystals and to understand the phenomena in SCO nanocrystals. Recently, we have shown that the spin transition can also be triggered by the electric field when applied to SCO nanocrystals fabricated on

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## Analytical Chemistry

# Multifunctional Logic Applications of a Single Molecule: A Molecular Photo-Switch Performing as Simple and Complex Gates, Memory Element, and a Molecular Keypad Lock

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Carbazole (CZ) can act as a photo-switch leading to a multifunctional logic system when triggered by fluoride (F<sup>-</sup>) ions, H<sub>2</sub>O and light, through efficient interaction of the pyrrole unit with the anions. Here we are reporting a unimolecular platform of CZ (and case specific CZ-F<sup>-</sup>) that can be configured as NOT, YES, complimentary IMPLICATION and INHIBIT, a new complex logic gate performing IF-THEN and NOT operations and a memory element with cyclic "Erase-Read-Write-Read"

ability with feedback loop mechanism. The fluorescence responses of the CZ system also have been exploited to design a potential highly secured molecular keypad lock operating with a purely opto-chemical password composed with optical and chemical input keys. The system displays the applications of light responsive molecules as multifunctional, reconfigurable molecular logic devices that may lead towards true molecular information processing units.

## Introduction

Information processing and designing of Boolean type logic gates at molecular-level was found to have great attention using optical switches.<sup>[1–3]</sup> Aviram (1988) proposed that small molecules might be applied in molecular electronic devices for memory, logic and amplification.<sup>[1]</sup> Thereafter, De Silva et al. (1993) historically pioneered the molecular photoionic logic device.<sup>[2]</sup> The reported system with two chemical inputs and one optical output perfectly mimicked the operations of an AND gate. The work was trailed further with AND logic operations by De Silva and his group.<sup>[5,6]</sup>

Later, serious researches were endeavoured to employ molecular systems in binary operations and logic systems<sup>[7–19]</sup> such as YES,<sup>[7–10]</sup> NOT,<sup>[8,11]</sup> AND,<sup>[8,11–14]</sup> OR,<sup>[7,8,11–13,15,16]</sup> NAND,<sup>[11]</sup> NOR,<sup>[2,7,11,15,16]</sup> XOR,<sup>[11,12,14]</sup> XNOR,<sup>[11,13,15]</sup> IMPLICATION<sup>[11,17,18]</sup> and INHIBIT<sup>[7,12–17,19]</sup> etc. Now the present dilemma is to physically integrate multiple logic gates on a single molecular system in order to achieve the functional complexity of integrated circuits beyond basic logic gates e.g. YES, NOR, XOR etc. Extremely efficient molecular wiring between basic individual molecular logic devices with ultimate precision can only open the door to

a world of 'Molecular Integrated Circuits' (MIC). The semiconductor logic devices embedded on silicon chips and microprocessors, executing binary arithmetic and logical operations<sup>[20]</sup> are the functional base of modern computers. Therefore, advances in Molecular Logic Devices and Molecular Integrated Circuits may open the doors of molecular computational technologies or molecular computing.

However, the efficient and precise molecular wiring of simple logic switches may turn out to be extremely difficult presently. One bypass approach to avoid this complex situation may be functional integration. To get out of this complex situation, one possible way out lies on performing the functions of multiple logic gates on a single molecular platform. Then the complex logic circuit, composed of various simple logic gates, might operate on same molecule without the necessity of inter-connecting individual logic gates. Actually, co-existence of multifunctional logic gates on a unimolecular platform is going to be much more advantageous in creating functional integrated circuits in a clear-cut fashion as a substitute to the time consuming and tricky bodily connections between different molecular devices.

Two major aspects of the information technology are the data storage and protection. We are in search of molecules that can be employed for the data storage and protection functions as an alternate resource of semiconductor based devices and systems. To fulfil the storage demand high density storage devices with high "write-read-erase-read" speed are the need of future. To keep up with the pace, HDDs with high storage capacities and high-speed flash drives have evolved with modern technology and became available in the market. However, the need for storage capacities and data transfer rate are ever escalating. Therefore, researchers are in search of molecular storage devices to replace the semiconductor devices. Recently, in this context, Kumar et al. reported new

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## Research paper

# Electrochemical and UV–Vis spectroscopic studies on the interaction of sodium 1,4-dihydroxy-9,10-anthraquinone-2-sulphonate with cetyltrimethylammonium bromide micelles

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## ABSTRACT

The energy optimized structure of sodium 1,4-dihydroxy-9,10-anthraquinone-2-sulphonate (QS) was determined using computational methods. The interaction of it with cationic surfactant cetyltrimethylammonium bromide was investigated in aqueous solution at pH 7.4. The aspect of the affinity of such molecule to cationic surfactant micelle is important in determining its biological action. The binding constant, partition coefficient and the stoichiometry were determined for molecule-CTAB interaction. The study showed that the hydrophobic interaction plays a major role in binding of QS to CTAB micelles. Gibbs free energy for the binding and distribution of QS between the bulk aqueous medium and surfactant micelles were calculated.

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## 1. Introduction

Nowadays cancer is the most dangerous threat to humanity which has been increasing enormously over the last so many years. Although considerable progress has been made to enhance our knowledge on cancer, yet a lot remains to be done. Till date, the most important approach in treating cancer is chemotherapy and radiotherapy in conjunction with surgery. However, most of these approaches barring surgery have many serious side effects. It has been observed that the affected patient dies not of the disease itself but more because of a variety of side effects during treatment. This is alarming for us and there is a growing need to think of new ways of treating cancer that takes care of the aspect of side effects during treatment.

Anthracycline drugs such as adriamycin, daunorubicin, carminomycin, idarubicin, etc., have received a significant interest due to their effectiveness and extensive clinical utilization in various forms of human cancer [1–3]. However, high cost in obtaining these compounds from natural sources [3] makes a limitation on the use of these drugs to the cancer suffering people residing particularly in the third world countries. This opens an important way

of research for generating the doable alternatives of these drugs which would be inexpensive as well as efficient. Since the chemistry of this class of molecules is governed by the planar hydroxy anthraquinone unit, therefore, many simple and cheap hydroxy anthraquinones have been tried and compared with the established drugs [4–16].

Though several mechanisms of drug action of these molecules have been proposed, the intercalation of such molecules into DNA backbone has been established as the dominating mode of their drug action [1–3]. In addition the mechanism of drug action is related to the interaction of a drug molecule with biological tissues by means of its binding to membranes at the molecular level [17–19]. Many biological processes occur at the ionizable surface of the membranes or along their hydrophobic region which makes a comparative study on the interaction of the drug with cationic, zwitterionic, anionic and neutral surfactants to be imperative [20,21]. This provides useful information on the nature of drug–membrane interaction. The studies on the drug–surfactant interactions have been done by several workers using various techniques as it has widespread applications in pharmaceutical field. Micellar systems possess the ability to solubilize hydrophobic drugs [22–24] thereby increasing their bioavailability and thus it can be used as a model system for biomembrane, as well as drug carriers in numerous drug delivery and drug targeting systems [25–27]. The physicochemical interactions of drugs with surfactant micelles can be visualized as an approximation for their interactions with

Abbreviations: QS, Sodium 1,4-dihydroxy-9,10-anthraquinone-2-sulphonate; ct DNA, Calf thymus DNA; CTAB, Cetyltrimethylammonium bromide.

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## Synthesis, spectroscopic characterization with computational modeling and epoxidation activity of two iron(III)-Schiff base complexes

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Two non-heme mononuclear iron(III) complexes, [Fe(L)Cl] (1) and [Fe(L)Br] (2) containing a (N,O)-donor Schiff base ligand, (H<sub>2</sub>L = 2-((5-((2-hydroxyphenylimino)methyl)furan-2-yl)methyleneamino)phenol), have been synthesized and isolated in pure state. The structural formulation for iron complexes have been determined by different physico-chemical methods. Room temperature magnetic measurement for both 1 and 2 indicates the existence of high spin iron(III) species in their solid state. The structural consolidation for the iron complexes (1 and 2) has been performed through theoretical modeling with B3LYP density functional theory (DFT) using 6-31g(d) basis set. The optimized structures agree very well with the experimental proposed structures. The iron(III)-Schiff base complexes have been evaluated as effective catalytic systems towards alkene epoxidation using (*E*)-stilbene as a convenient in presence of *tert*-butylhydrogenperoxide (TBHP). It is revealed that 2 has better catalytic efficacy than 1 in terms of the yield of the reaction for both the iron complexes.

**Keywords:** Iron(III), Schiff base, spectroscopic methods, epoxidation activity, DFT study.

### Introduction

Transition metal complexes containing oxygen and nitrogen based polydentate ligands are of great interest for having their diverse geometric configurations, structural lability, and electronic reactivity<sup>1-3</sup>. Iron is the most prevalent transition metal in nature. Among the transition metal complexes, iron complexes have significant contribution in developing utility materials of industrial and biological significance<sup>4-6</sup>. Synthetic ligands have an influencing effect on the design of metal catalysts in order to bring high order of reactivity and selectivity for different organic transformations. Sterically and electronically tuned ligands in association with iron metal ions may therefore result in development of efficient and low cost catalysts for enantioselective synthesis<sup>7</sup>. Further efforts in tuning iron catalysts concerning handling, stability, activity and selectivity have to be made to bring the catalytic systems closer to large scale industrial

application. Thus, finding of effective catalytic systems that use clean, inexpensive terminal oxidants, such as molecular oxygen or hydrogen peroxide, are highly desired from both environmental and economic point of views.

Epoxidation of olefins and arenes<sup>8,9</sup> is a marvelous transformation in synthetic organic chemistry<sup>8</sup> since the epoxy compounds are widely used in the preparation of wide range of commodity chemicals<sup>10</sup>. In relation to epoxidation, hydrogen peroxide is treated possibly the best terminal oxidant after molecular oxygen from environmental and industrial perspective<sup>10,11</sup>. Among the transition metal complexes, iron, cobalt and manganese-Schiff base complexes have drawn special interest for their significant contribution in catalytic epoxidation reactions<sup>10,12a,b</sup>. But the real breakthrough in transition-metal catalyzed asymmetric epoxidation of unfunctionalized alkenes was made in 1990 when two research groups, Jacobsen

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## Computational and Docking Studies of 5,6-dihydroxy-7,8,4'-trimethoxyflavone: A $\alpha$ -Glucosidase Inhibitory Constituent from *Limnophila indica*

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### ABSTRACT

The natural flavonoid, 5,6-dihydroxy-7,8,4'-trimethoxyflavone (DHF) has been isolated from the aerial parts and roots of small aquatic herb *Limnophila indica* and characterized by experimental and computational methods. Optimized geometry of DHF shows a strong hydrogen bond as confirmed by Wiberg indices. The FTIR spectra of DHF were studied by vibrational energy distribution analysis (VEDA) using potential energy distribution (PED) analysis. The electronic spectra were carried out by TD-DFT procedure and compared with experimental results. The experimental and theoretical results corroborates very nicely with the present compound. To understand the biological efficacy of DHF to act as a therapeutic agent (antiviral), binding with protein  $\alpha$ -Glucosidase residues has been studied. The nature of binding between DHF and  $\alpha$ -Glucosidase residues is hydrophobic in nature. The study suggests further investigation on DHF for their pharmacological importance.

**Keywords:** Flavonoid, Wiberg bond indices, TD-DFT, Docking, Hydrophobic.

# FT-IR, UV-visible, and NMR Spectral Analyses, Molecular Structure, and Properties of Nevadensin Revealed by Density Functional Theory and Molecular Docking

Abhishek Kumar<sup>a</sup>, Ambrish Kumar Srivastava<sup>b,c</sup>, Shashi Kumar Gangwar<sup>d</sup>, Neeraj Misra<sup>d</sup>, Goutam Brahmachari<sup>b,c</sup>, Avijit Mondal<sup>b,c</sup>, and Sadan Mondal<sup>b,c</sup>

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## ABSTRACT

Nevadensin [2-(4-methoxyphenyl)-5,7-dihydroxy-6,8-dimethoxy-4H-1-benzopyran-4-one] is a natural bioactive flavonoid compound that has the potential to become a novel "natural lead" in the field of drug discovery program. The molecular structure, vibrational frequencies, and corresponding vibrational assignment of nevadensin have been investigated experimentally and theoretically by employing the B3PW91/6-311++G(d,p) method. The fundamental vibrational wave numbers as well as their intensities were calculated, and a good correlation between experimental and scaled calculated wave numbers had been accomplished. The ultraviolet spectrum of the studied molecule was recorded in the region 200–500 nm, and the electronic properties were predicted by the time-dependent density functional theory approach. <sup>1</sup>H and <sup>13</sup>C NMR spectra have been calculated by employing the gauge-independent atomic orbital method. Nevadensin has been reported to exhibit antimicrobial activities against both Gram-positive and Gram-negative bacteria and also against the fungal pathogens, highlighting the pharmacological importance of the molecule.

## ARTICLE HISTORY



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Density functional theory;  
molecular docking;  
nevadensin; spectral analysis;  
UV-vis analysis

## Introduction

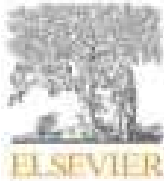
Flavonoids are a class of physiologically and ecologically essential compounds found ubiquitously in higher plants in response to a wide range of environmental stimuli.<sup>1</sup> These compounds are much effective and useful due to their multidirectional therapeutic and "lead molecules" in drug development.<sup>2–4</sup> These naturally occurring polyphenolics exhibit a wide range of biological properties including antioxidant, antitumor, enzyme inhibitory, cytotoxic, insecticidal, antimicrobial, and also used in the treatment of diabetes and cancer.<sup>5–7</sup> Nevadensin [2-(4-methoxyphenyl)-5,7-dihydroxy-6,8-dimethoxy-4H-1-benzopyran-4-one] is a natural bioactive flavonoid, first isolated from *Iva species* by Farkas et al.,<sup>8</sup> and other natural new sources for the compound have also been reported later on.<sup>9–13</sup> Nevadensin is a penta-oxygenated flavone possessing a number of pharmacological activities; hence, it plays an important role in drug development and discovery. As the number of therapeutic agents synthesized with the help of flavonoids is increasing day by day, a complete investigation of this class of compounds is, thus, essential to have a deeper insight into the structural and biological properties of this class.

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## Long wave instability of thin film flowing down an inclined plane with linear variation of thermophysical properties for very small Biot number



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### ARTICLE INFO

#### Keywords

Thin film  
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### ABSTRACT

We investigated interfacial instability of a thin liquid film flowing down an inclined plane, considering the linear variation of fluid properties such as density, dynamical viscosity, surface tension and thermal diffusivity, for the small variation of temperature. Using long wave expansion method and considering order analysis specially for very small Biot number ( $B$ ) we obtained a single surface equation in terms of the free surface  $h(x, t)$ . Considering sinusoidal perturbation method we carried out linear stability analysis and obtained the critical Reynolds number ( $Re_c$ ) and linear phase speed ( $c_r$ ), both of which depend on  $K_\rho$ ,  $K_\eta$  but independent of  $K_\sigma$ ,  $K_\kappa$ . Using the method of multiple scales, weakly nonlinear stability analysis is carried out. We demarcated subcritical, supercritical, unconditional and explosive zones and their variations for the variation of  $K_\rho$ ,  $K_\eta$  and  $K_\sigma$ . Also we discussed the variations of threshold amplitude in the subcritical as well as in the supercritical zones for the variation of  $K_\rho$ ,  $K_\eta$  and  $K_\sigma$ . Finally we discussed the variation of nonlinear wave speed  $N_w$  for the variation of  $K_\rho$ ,  $K_\eta$  and  $K_\sigma$ .

### 1. Introduction

Searching the study of instability mechanism on the thin film we found that most of the authors studied the effect of isothermal/nonisothermal cases and very few of them considered the variation of different physical properties due to variation of temperature. Although certain physical properties such as viscosity, density, thermal conductivity and surface tension highly depend on the variation of temperature, so these physical quantities could not be considered as constant in real situation. Gossais and Kelly [1] studied the effects of variable viscosity on the surface wave mode of instability of a liquid film flowing down heated or cooled inclined surface by means of long wavelength analysis. They found that cooling stabilizes the flow, while heating destabilizes it. For the case of cooling they derived a cutoff Prandtl number above which the flow is always stable. The effects of variable viscosity on the surface wave mode of instability of a liquid film flowing down heated or cooled inclined surfaces, studied again by Gossais and Kelly [2], using two models of viscosity variation with temperature. Both the models confirmed that heating destabilizes the flow, while cooling stabilizes it. They also found that the critical wave number is always zero in case of heating, while for the case of cooling critical wave number can be non zero. Reisfeld and Bankoff [3] studied the stability of a heated volatile liquid film subjected to surface tension and Vander Waals forces, assuming the linear variation of viscosity with

temperature. They found that effect of variable viscosity reduce the rupture time of the film relative to the constant viscosity. Pascal et al. [4] first studied the long-wave instability of flow down an inclined plane considering the linear variation of different thermophysical properties such as density, conductivity, surface tension, viscosity and specific heat. Linear stability analysis is carried out by long wave perturbation method. They found the critical Reynolds number considering the cases when Biot number  $B = 0$  or  $B \rightarrow \infty$  or as  $A = \lambda = 0$ , where  $A$  and  $\lambda$  are the scaled gradients with respect to temperature of the thermal conductivity and viscosity respectively. For the general case they obtained an analytical expression of the critical Reynold's number by implementing asymptotic expansions as  $B = 0$  or as  $A = \lambda = 0$ . Recently D'Alesio et al. [5] studied the effects of variable fluid properties on thin film instability, where the fluid properties are allowed to vary linearly with temperature except the specific heat  $C_p$ , which is taken as constant. Linear stability analysis is carried out using the long wave perturbation method. They showed how the critical Reynolds number and perturbation phase speed depend on the various dimensionless parameters and thermophysical properties. The approach developed by Pascal et al. [4] and S.J.D. D'Alesio et al. [5] although are pioneering work, restrict themselves to discuss only linear stability analysis, due to lengthy process of algebraic computation. But our proposed analysis helps to construct a single surface equation in terms of free surface

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## State-Wise Analysis of Supply Side Factors of Financial Inclusion in India

Subhendu Bag

Department of Economics, Vivekananda Mahavidyalaya, Burdwan, West Bengal

**Abstract :** Accessibility to financial resources of all sections particularly the vast weaker section of the society is argued to be the key parameter of Inclusive Growth. Hence, financial inclusion helps in promoting sustainable

development in a country. The problems in achieving desired goal may be explored from both demand and supply sides. In our study I mainly focus on the supply side factors i.e., bank branch penetration. I have computed the availability index of financial outlets based on UNDP Goal Post (similar to HDI) Method for every state and union territory of India for the period 2006- 2013. I have again used Herfindahl – Hirschman Index (HHI) for estimating the level of concentration in the financial availability index. I also have compared the pattern of concentration among the different categories of banking institutions in setting up of their financial outlets. I have found that there is utter discrepancy in the index values achieved by different states. All most 50 % of the states and UTs could not reach at the minimum level of development in setting up of financial outlets. On an average, only 10 % of them reach at a significant achievement in infrastructural development over the whole study period. Again, a clear increasing tendency of concentration in availability index among the major states as well as in different categories of bank are also found. The concentration is found to be related indirectly with the controlled supervision and management in view of public welfare.

**Keywords :** Bank Branch Penetration, Concentration Measure, Financial Availability Index, Financial Inclusion, Herfindahl – Hirschman Index (HHI), Principal Component Analysis,

### Introduction

Inclusive development is an important target of millennium development goal. But without financial inclusion of most of the people, the target will remain unattainable. However, accessibility to financial resources is considered to be the key parameter of actual empowerment of the vast weaker section of a society. "A well developed financial system brings poor people into the mainstream of the economy and allows them to contribute more actively to economic development both individually and collectively" (Semaio et al 272). On the other hand, financial exclusion eventually leads to some crucial problems, such as widespread poverty, concerns of healthy life, lack of education and literacy, unemployment, low productivity etc. and hence hampering the sustainable development.

Consequently, financial inclusion has emerged as a significant strategy of inclusive growth in any emerging economy, like India. Realizing the gravity of the problem the Reserve Bank of India set up Khan Commission in 2004 to look into the state of Financial Inclusion and strategically Financial Inclusion first featured in 2005. Thereafter, the Reserve Bank of India and NABARD had been initiated a multi-pronged strategy comprising all types of banking and nonbank financial institutions for enforcing the outreach of financial services to all sections of the population in the country. Besides these, Self-Help Groups (SHGs)

## Evaluation of Online Learning Repositories: A Comparative Study

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### ABSTRACT

Many online learning repositories available around the world. This paper provides a comparative analysis among selected online learning repositories (eGyankosh, ePG pathshala, MIT resources and Sodhganga) for learning resources. The comparative study is based on some analytical parameters, like generic, content related, retrieval related, post processing, interface related, etc. The collected data have been analysed on the basis of parameters. The results have been displayed through different types of diagrams like multiple bar diagrams, pie diagram, etc. It was found that none of the selected online learning repositories achieved the full score. And also found that Sodhganga ranked the highest position among them.

**Keywords:** Online learning repositories; Electronic information; Digital reference sources; Information explosion

### 1. INTRODUCTION

There are various types of online learning resources available on the Internet. Use of electronic information has increased with the rapid advancement of internet and its related technologies. Now internet is an effective communication medium enabling collaboration and interaction between individuals and their computers regardless of their geographical barrier. The development of the world wide web has led to tremendous growth in the quantity of all types of publications. Presently the web is a reliable and effective mechanism for dissemination of information. The web has surrounded a variety of information resources, such as, electronic journals (e-journals), educational materials, technical reports, library catalogues (OPAC), databases, career sources, information on organisations, associations and many more<sup>1</sup>.

To keep pace with the rapid growth of information, libraries are re-innovating themselves. They must provide well equipped environment for information seekers with many options, time saving by use of different types of Information and communication technology. While most of the libraries are trying to publish their digital resources on web very fast, they are also taking steps to make their online learning repositories and reference services available digitally. Few digital reference services incorporate e-mails, instant messaging (online chat), and telephone have been in use for decades, while other services such as text messaging and video conferencing are emerged in the last decade<sup>2</sup>.

Digital reference service is considered as an online reference service for library patrons to query reference information on library's website. Unlike traditional reference,

digital reference service allows patrons to submit questions and receive answer via the internet or other electronic means<sup>3</sup>. Therefore, the digital reference sources should be strong in nature to render services to the tech-savvy users.

Online learning repositories are one of the method of digital reference sources for learning resources. Some of major online learning repositories studied here are eGyankosh, JISC resources, MIT resources, CEC UGC resources ePG Pathshala, Sodhganga<sup>4</sup>.

### 2. LITERATURE REVIEW

Singh<sup>5</sup> studied the comparative digital reference services of north Indian academic libraries. The various models of providing digital reference services such as email, "Ask questions", video conferencing, digital robots, online chat reference and collaborative digital reference were discussed in his research. He also discussed the strength and weakness of existing reference service being provided by the university libraries. To complete the research he used the observation method of study to explore the websites of the above universities. An evaluation criteria was used to collect the relevant data and the collected data were tabulated, analysed and interpreted to compare the present digital reference service of the above selected universities.

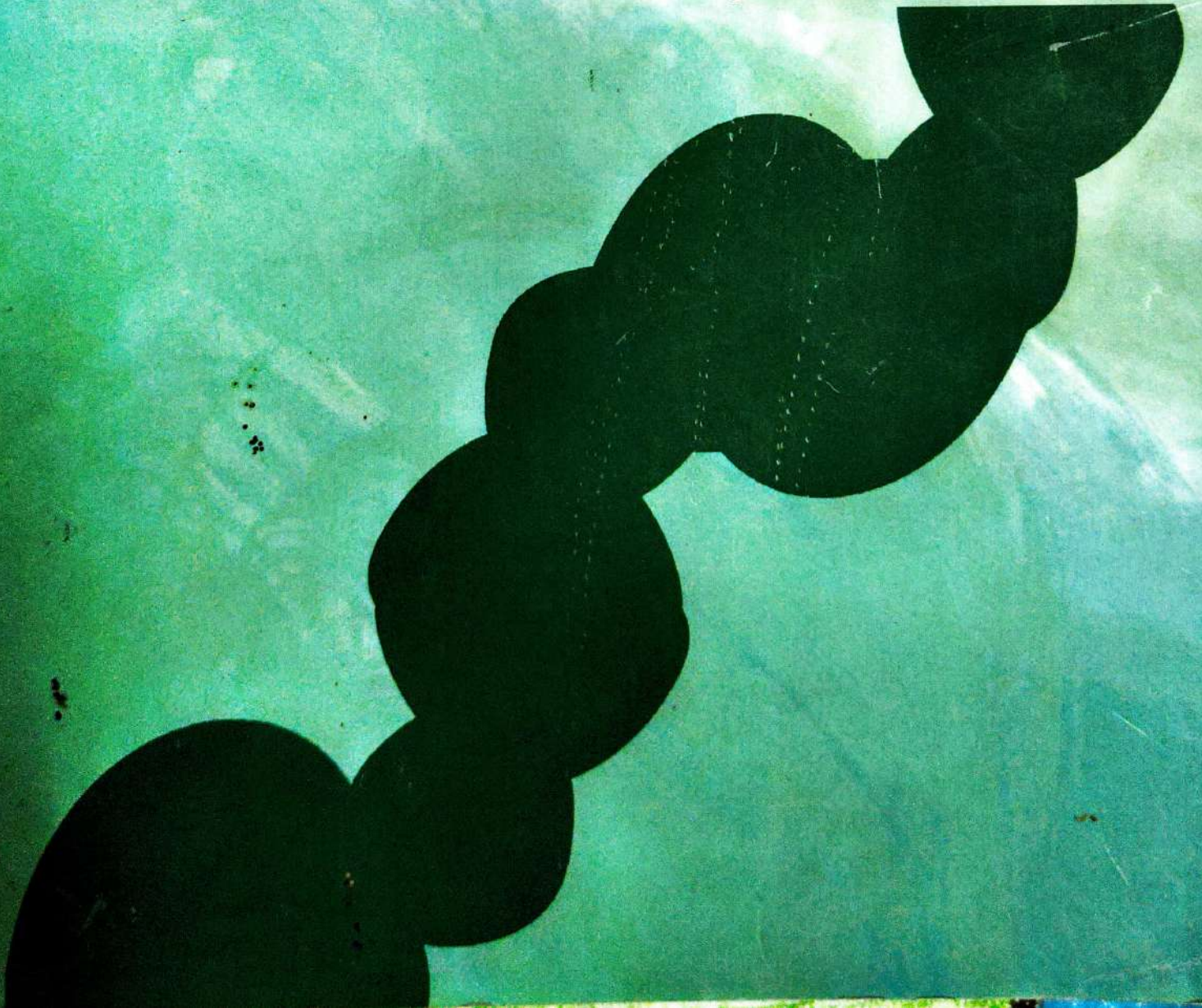
Kumah<sup>6</sup> compared the use of Internet and library of graduate students in the University of Ghana. A convenient sampling technique was used to select the sample for the study. 93.3 per cent of the respondents answered positive regarding their use of library; 98.8 per cent of the respondents use Internet; and lastly Other source of information used by the graduate students which includes media, interaction with experts, etc. It was found in his study that 72 per cent of the

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# Decentralized Administration in Disguise of Centralized Finance: A hindrance for Integrated Rural Development

Amit Kumar Ash

**Abstract :** Despite the voluminous research works by the scholars on Panchayat and rural development, little is known about the financial autonomy of the grass roots democratic bodies, which are the central concern in the process of rural development. After the enactment of 73<sup>rd</sup> constitutional Amendment Act, PRIs bodies has been established almost all parts of the country, but endeavor of decentralization for the socioeconomic upliftment of the poorest of the poor has been hindered in the context of the centralized financial system in these bodies. The present paper is a modest attempt to review the current role performance of these infantile decentralized democratic bodies in perspective of the centralized financial system, and to suggest measures for regalanising the existing financial structure for strengthening their financial stability so that PRIs would be established as a unique unit of integrated rural development.

**Keywords :** Panchayat Finance, Panchayat Autonomy.

**Introduction :** In the recent years, the process of decentralization has taken an important role in matters of governance in developing countries. Decentralization now reflects in most of the developing countries

as a broader process of Political economic reforms. Though there was a legacy of local government in pre-independence India, India has constitutionally adopted decentralized governance in 1992. After enactment of 73<sup>rd</sup> Amendment Act, 1992 now the Panchayat Raj Institutions (PRIs) are regarded as the third layer of government in rural India after Union and States. 73<sup>rd</sup> constitutional amendment brings a tectonic shift in the process of decentralization in rural India. As a result of this amendment lots of positive things happen such as- setting up of State Finance Commission, regular elections of PRIs by State Election Commission, representation of the weaker section, constitutional status of PRIs, etc. All these things have given special dignity to rural local governance in India (Chottopadhyay, 2013).

At present Panchayat has taken an indispensable part of rural development in all over the India. Huge money taken from Central as well as State Government is spent by the hand of Panchayat for rural development. But problem is that Panchayat is facing challenges for integrated rural development due to lack of Own Source Revenue (OSR). The notion of local government- local development in accordance with local needs and local resources- has not been

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*Measuring CSR based on Fuzzy ANP based BSC Model*

**MEASURING CORPORATE SOCIAL RESPONSIBILITY - BASED ON FUZZY  
ANALYTIC NETWORKING PROCESS BASED BALANCE SCORECARD  
MODEL**

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Over the last few decades Corporate Social Responsibility (CSR) disclosures becomes a powerful driver of overall stakeholders' development while the relationship between CSR and its performance have provided conflicting results due to the most used intersecting circles representation of assessment of CSR. This study fills in an important gap by analyzing the framework of CSR assessment practices on identification of five criteria and seventeen indicators encompassing the strategies of accountability, transparency and compliance of CSR. To achieve the goal of CSR the strategies have been defined in connection with different literatures and quaternary survey for criteria selection while the criteria expressed in a fuzzy horizon. This MCDM model has been solved using a fuzzy analytical networking process and balanced scorecard method to develop selection strategy and criteria for CSR impost. The paper's outcomes help administrators of corporate sectors, particularly in developing countries, to follow sustainable actions as CSR providers effectively and to expertise a significant reasonable advantage. The findings exposed the CSR assessment structure and interrelationships among BSC perspectives/criteria and indicators on which managers are needed to emphasize to get optimum CSR performance. In this study the most important strategy and criteria to perform optimum CSR level are 'accountability of CSR project' as best strategy and "Project team work, incentives, Environmental resources, Communication for motivation, Reporting initiative of Stockholders, CSR project with stockholder capital, Strategic governance, Mission sustainability, political role, Human resources", respectively are criteria.

*Keywords:* Corporate Social Responsibility (CSR); Criteria; Strategy; Fuzzy Analytical Networking Process (F-ANP); Balanced Scorecard (BSC).

JEL Classification: C44, C61, D81



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# Game theory based multi criteria decision making problem under uncertainty: a case study on Indian Tea Industry

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## GAME THEORY BASED MULTI CRITERIA DECISION MAKING PROBLEM UNDER UNCERTAINTY: A CASE STUDY ON INDIAN TEA INDUSTRY

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**Abstract.** The long-term evolution of multi agent multi criteria decision making (MCDM) and to obtain sustainable decision a novel methodology is proposed based on evolutionary game theory. In this paper multi agent MCDM is represented as an evolutionary game and the evolutionary strategies are defined as sustainable decisions. Here we consider the problem of decision making in Indian Tea Industry. The agents in this game are essentially Indian Tea Estate owner and Indian Tea board. The replicator dynamics of the evolutionary game are studied to obtain evolutionary strategies which could be defined as sustainable strategies. The multi agent MCDM in Indian Tea Industry is considered under different socio-political and Corporate Social Responsibility scenario and groups of Indian Tea Industry. Again, the impacts of imprecision and market volatility on the outcome of some strategies (decisions) are studied. In this paper the imprecision on the impact of the strategies are modelled as fuzzy numbers whereas the market volatility is taken into account as white noise. Hence the MCDM problem for Indian Tea Industry is modelled as a hybrid evolutionary game. The probabilities of strategies are obtained by solving hybrid evolutionary game and could be represented as a Dempster-Shafer belief structure. The simulation results facilitate the Decision Makers to choose the strategies (decisions) under different type of uncertainty.

**Keywords:** MCDM in Indian Tea Industry, Evolutionary Game, Evolutionary stable strategies, Sustainable solution to MCDM, Uncertain Evolutionary game, Strategies under uncertainty, Sustainable development with CSR.

**JEL Classification:** C72, C73, D81, G34.

### Introduction

Any multi agent MCDM problem involves simultaneous decision making which could be set-up as a game problem where the criteria and alternatives can be considered as strategies of the agents (players). MCDM is a method to select most convenient alternative among

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## Desmids Diversity of Bankura District, West Bengal

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**Abstract :** Present study was carried out to explore the diversity of desmid taxa in Bankura district. During the study, 21 taxa of desmids belonging to different groups namely saccoderm desmids and pacoderm desmids were recorded.

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**Keywords :** Desmid diversity, Pacoderm desmids, Saccoderm desmids.

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Desmids have cosmopolitan distribution which ranges from Tropical to Alpine region. Single cell desmids plays a crucial role in every aquatic ecosystem and contributing to the food supply involving nutrient cycling. Desmids are usually single cell, although some are multicellular. It's micro-morphology and existence gives us a clue in respective niche[1]. The report on desmid flora of Bankura district are scanty[2,3]. Present study was carried out to explore the diversity of this particular algae in Bankura.

Total 21 taxa have been recorded in the present study. These are *Gonatozygonpilosum* Wolle, *Closteriumsetaceum* Ehrenberg, *Haplotaenium minutum* (Ralfs.) Bando, *Desmodium bengalicum* Turner, *Micrasteriaslaticeps* Nordstedt, *Micrasteriasfoliacea* Bailey, *Cosmariumpseudotaxichondrum* Nordstedt, *Euastrum spinulosum* West & West, *Micrasteriaspinnatifida* (Kutz.) Ralfs, *Pleurotaeniumehrenbergii* (Bréb.) De Bary, *Teilingiagranulata* (Roy et Biss.) Bourrelly, *Micrasteriastropica* Nordstedt, *Xanthidiumhastiferum* Turner, *Arthrodesmusquiriferus* West et West, *Hyalothecadissiliens* (Smith) Brébisson ex Ralfs, *Groenbladiaundulata* (Nordstedt) Forster, *Spondylosiumjavanicum* (Gutw.) Grönblad, *Onychonemalaeve* Nordstedt, *Mesotaeniumchlamydosporum* de Bary, *Triplastrum spinulosum* (Kisselev) Gauth-liév and *Netriumdigitus* (Ehrenberg) Itzigson et Rothe (Plate -1). Study of such significant algal group is not yet done in this particular area. Desmids are not only the primary producer of the ecosystem, moreover it indicates some environmental issues which is more helpful for restoring the ecosystem. So, more emphasis is necessary for the study of such algal group for long term environmental restoration.

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### PLATE - I

(Legend to the plate)

Fig. 1. *Gonatozygonpilosum* Wolle

Fig. 2. *Closteriumsetaceum* Ehrenberg

Fig. 6. *Micrasteriasfoliacea* Bailey

Fig. 3. *Haplotaenium minutum* (Ralfs.) Bando

Fig. 4. *Desmodium bengalicum* Turner

Fig. 5. *Micrasteriaslaticeps* Nordstedt

Fig. 14. *Arthrodesmusquiriferus* West et West

## Habitat Diversity of the Genus *Physolinum* Printz, Burdwan, West Bengal (India)

Prasanta Mallick \*

### Abstract

Habitat is the very important aspect of all living creatures, starts from animals to plants and from cryptogams to phanerogams. Algae are the very promising biological organism in all ecosystem especially in marine or fresh water habitat but also even in terrestrial -sub aerial habitat. Terrestrial habitat is basically depend upon some basic component like minerals nutrients, organic matter, water and air by different composition and sub aerial habitats depend upon the existing substratum. The present communication deals with four different form of genus *Physolinum* Printz. Taxa has great diversity in their habitats and also their morphological character, pigment composition and growth pattern. Habitat diversity is not yet reported from this area.

**Key words :** *Physolinum*, Habitat Diversity, Burdwan

### Introduction

Habitat diversity and its ecological significance starts from the nineteenth century Hariot (1889), Printz (1920) Brook (1981). Great contribution had been done by the sub aerial and others divers habitats by Thompson and Wujek (1997), Neustupa (2005) and Rindi et al (2006). Significant effort were carried out in subtropical and temperate forest by Handa and Nakano (1998), Mikhailyuk (1999), Kharkongor and Ramanujam (2014). In Indian context very little bit work have been done by few workers in different states Bruhl and Biswas (1923), Panikkar and Sindhu (1993), Chandra and Krishnamurthy (2000) and Saharia (2005). The district Bardhaman is a transitional zone between the Bihar plateau, which constitutes a portion of peninsular shield in the west and the Ganga-Brahmaputra alluvial plain in the north and east Towards south, the alluvial plain merges with the Kasi-Subarnarekha-Baitarani deltaic plains. This district lies mainly between the Ajoy, the Bhagirathi and the Damodar rivers. It is bounded on the north by the districts of Santal Pargonas, Birbhum and Murshidabad, on the east by Nadia. on the south by Hooghly, Bankura and Purulia an on the west by Dhanbad (Bihar) Geographically the district is located between north latitude 22°56' to 23° 53' and east longitude 86° 48' to 88° 25'. The present area of the district is 7001.4 sq km. Climate condition of the district is warm and humid. The genus *Physolinum* is the most common sub-aerial alga in both tropical and temperate climate., I have been collected this taxa from cementing rock and bark of the tree. Both habitats having different colour composition in different time of the season, In early winter the colour of the alga is green but in mid winter the colour would change into orange red. Cellular composition and size variants is also good observation in this study.

### Material and Method

The specimens were collected from different sub aerial habitats of Burdwan district of west Bengal. Specimens were preserved in 4% formalin; pH, temperature and details ecological notes were recorded simultaneously. Photography were made using GWF (Bando 1988) as mountant from both preserved and live specimens. Microphotograph were taken by Leica DM 1000 with EC 4 camera. Standard literature are consulted for this purpose, Fritsch (1935), Smith (1950), and Wehr and Sheath (2003).

### Results and Discussion

Tree bark and cementing wall is the very common place for the growth of the subaerial plant. Tree

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# FACILE PRODUCTION OF CRYSTALLINE SILVER NANOEMULSION USING AQUEOUS EXTRACTS OF PUTRANJIVA (*DRYPETES ROXBURGII*): SYNTHETIC PROTOCOL OPTIMIZATION THROUGH PRECURSOR, EXTRACT CONCENTRATION AND TEMPERATURE VARIATION STUDY

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**Abstract :** Emulsions of Silver nanoparticles (Ag NPs) were synthesized using a facile, single step, and completely green biosynthetic method employing aqueous leaf and fruit extracts of Putranjiva (*Drypetes roxburgii*) as both the reducing as well as capping agent. The kinetics of nanoparticle formation was also monitored by Ultraviolet–Visible (UV–Vis) spectrophotometric study. Aqueous leaf extract of Putranjiva can reduce silver ions more rapidly than aqueous fruit extract, leading to the formation of highly crystalline nanoemulsion of silver. With varying synthetic conditions like extract concentrations or precursor concentrations, the shape and sizes of the Ag NPs varies. The morphology and crystalline phase of the NPs were determined from High Resolution Transmission Electron Microscopy (HR-TEM), Energy Dispersive X-ray (EDX) analysis, X-ray Diffraction (XRD) analyses. The various phytochemicals present within the Putranjiva plant parts result in effective reduction of silver precursor to nanocrystal. In addition to that, the chemical frameworks of these biogenic molecules are also effective at wrapping around the NPs to provide excellent robustness against agglomeration. Fourier Transform Infra-Red spectroscopic (FTIR) analysis was performed to gather information about the chemical framework. A rigorous study has been performed for procedure optimization by varying different parameters to get most effective stable nanoparticle synthetic protocol.

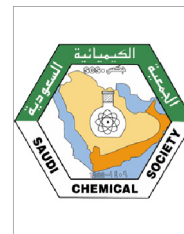
**Index Terms :** Silver nanoemulsion, Biogenic synthesis, Putranjiva, Protocol optimization

## I. INTRODUCTION

A variety of devices and structures generally ranging from 1 to 100 nm are designated as nanomaterials, those have offered exceptional chemical, optical, magnetic, photoelectrochemical and electronic properties distinctly different from bulk structures (Campbell et.al. 2002, Jain et. al. 2007). The nanoparticles (NP) of noble metals are found to have potential applications in various fields like sensor technology (Nouailhat 2008, Ren et.al. 2005), optical devices (Kamat 2002), catalysis (Liu and Croma 2018), biological labeling (Agasti et.al. 2010), drug delivery system [Liu et.al 2016], and treatment of some cancers (Aslan et. al. 2013, Benelli 2016). Hence, noble metal nanomaterials are at the leading edge of the rapidly developing field of nanotechnology. The sizes, crystal structures, controlled monodispersity and stabilization are the critical factors for specific properties of nanoparticles [Rao et.al. 2002]. Numerous chemical and physical methodologies have been formulated in the recent past, to synthesize noble metal and several other nanostructured materials [Cushing et. al. 2004, Sun et. al. 2002].

An enormously grown interest on this area has led to considerable concern about some of those established synthetic methods. With the development of newer chemical methods, the concern for environmental contaminations is also heightened besides the laborious and expensive chemical procedures those also generate a large amount of hazardous byproducts. This in turn can cause contamination of the nanoparticle surface, leading to adverse effects in medical applications [Shankar et. al. 2004]. On the other hand, physical synthetic methods are problematic due to the enormous consumption of energy required to maintain the high temperature and pressure conditions needed, that restrict the usefulness of these methods too. Thus, a steady need for effective green synthetic protocol has been generated for a clean, environmentally benign but facile method of nanoparticle synthesis.

For green synthesis, the principles include the use of less toxic precursors to prepare nanomaterials; the use of water as a solvent where possible; using the least number of reagents and as few synthetic steps as possible; reducing the amount of by-products and waste; and using a reaction temperature close to room temperature. As a fruitful alternative to the conventional methods, biological methods using sources ranging from unicellular organisms to higher plants fulfill almost all the requisite conditions and are considered safe and ecologically sound for the nanomaterial fabrication [Murphy, 2008]. The contemporary challenge is to find out desired ingredients from efficient biogenic sources and the suitable conditions for tailored nanomaterial synthesis.



## ORIGINAL ARTICLE

# Water soluble gold-polyaniline nanocomposite: A substrate for surface enhanced Raman scattering and catalyst for dye degradation



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## KEYWORDS

Gold nanoparticle-polyaniline nanocomposite; Cetyltrimethylammonium bromide; Surface enhanced Raman scattering; Catalytic activity; Organic dye

**Abstract** In this work, a water-soluble gold nanoparticle-encapsulated polyaniline nanocomposite (AuNP-PANI) was prepared in the presence of an ionic surfactant such as cetyltrimethylammonium bromide (CTAB) using versatile two steps method. The prepared nanoparticles (AuNPs) were characterized by UV–Visible spectroscopy, Transmission Electron Microscope (TEM) and Dynamic Light Scattering (DLS). The nanocomposite (AuNP-PANI) were initially characterized using UV–Visible spectroscopy, Transmission Electron Microscope (TEM), Scanning Transmission Electron Microscope (STEM) and DLS. The structure and composition of AuNP-PANI further characterized using Fourier Transmission Infrared Spectroscopy (FTIR), X-ray diffraction study (XRD), Energy Dispersive X-ray Spectroscopy (EDS) and Thermogravimetric analysis (TGA). Electrochemical properties of AuNP-PANI were studied using Cyclic Voltammetry (CV). The prepared nanocomposite exhibited good surface enhanced Raman scattering (SERS) of 4-amino thiophenol (4-ATP) and 4- (dimethyl amino) pyridine (4-DMAP) for which the enhancement factor (EF) were found to be  $1.95 \times 10^5$  and  $2.016 \times 10^5$ , respectively. The nanocomposite also showed excellent catalytic activity for the chemical degradation of Congo red (CR) and methylene blue (MB) as evidenced from the calculated rate constants which were determined to be  $0.30 \text{ s}^{-1}$  and  $0.33 \text{ s}^{-1}$ , respectively.

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## 1. Introduction

Multifunctional metal nanoparticles such as gold (Bogdanović et al., 2014; Cui et al., 2012), copper (Bogdanović et al., 2015), silver (Blinova et al., 2009), palladium (Mullane et al., 2004), platinum (Islam et al., 2011) and nickel (Zhang et al., 2015) as well as graphene oxide (Zeng et al., 2018) have been recently reported to combined with polyaniline (PANI) to obtain new



# Hansuli Banker Upakatha in the context of literary geographic study

Ananta Gope

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**Abstract** Bengali regional novelist Tarashankar Bandopadhyay is known as the artist of rural Bengal. In almost all the novels, he wanted to depict the spirit of place, the nature of landscape, the conflict between traditional and modern way of life and livelihood processes of people in the *Rarh* region. His works form an excellent resource base to provide an authentic and indispensable source of human experience of place for reconstructing the region in a specific time frame. The novel *Hansuli Banker Upakatha* not only provides the source of knowledge of a particular place and community to the geographers, but also reflects the underlying social structure, individual experience of the members of the community, cultural values, social stigma, ethnic identity crisis, landscape of a community based society genuinely and scientifically from the perspective of a writer. This article examines *Hansuli Banker Upakatha*—the river-based Bengali novel in order to explain a servile community's sense of place, territorial consciousness and ethno-cultural particularities, the causes and ultimate consequences of radical change and perils of their community culture through the lens of a novelist. Besides, I have argued that it is essential for the geographers to explore further links between texts and geography to assess the real image of place, people, culture and landscape.

**Keywords** Community · Environment · Literary geography · River-based novel · Sense of place

## Introduction

Geographers use written texts to analyze complex nature of human–environment inter-relationship in a subjective way. These have gained considerable attention in the last 50 years. Humanistic approach in geography established a new insight for the development of geographical studies of literature. In this approach, texts are considered as data source for subjective analysis of place, people and landscape. Within the broad realm of geographical studies of literature, the writings of the novelists are of particular interest to the geographers in pursuit of exploring the subjective dimensions of place. The author's heightened gifts of perception explored the artistic descriptions of landscape, personalities of place and the relation of society with nature to achieve a regional synthesis in a more realistic way. *Hansuli Banker Upakatha* is a river-based<sup>1</sup> regional novel of

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<sup>1</sup> *River-based Novel* A river is essential in the theme of a river-based novel but it may not be essential in the livelihood of people. A river leaves her impact in entire life of people which is elegant, sacred and virtuous to sustain lifeline in hereditary way. This life line is a universal one but it may be a community life or not.



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# An Assessment of Educational Resources through ERIC, CORE, PDFdrive and Project Gutenberg

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# An Assessment of Educational Resources through ERIC, CORE, PDFdrive and Project Gutenberg

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## Abstract

There are so many databases in the world for retrieval of information from e-resources. This research paper analyses ERIC, CORE, PDF Drive and Project Gutenberg for retrieval of e-resources. Here everything was analyzed on the basis of some observation and collected data were tabulated for analysis. This paper includes brief description about ERIC, CORE, PDF Drive and Project Gutenberg and screenshots of normal search, advanced search and use of fuzzy logic. This research reflects that none of the databases under study achieved full score found that ERIC ranked the first position.

Keywords: Educational resources; ERIC; CORE; PDFdrive; Project Gutenberg

## **1. Introduction**

We are living in the information age now. The 21<sup>st</sup> Century is the time of information explosion and our life is very fast. Each and everyone wants to get anything he requires without sparing time or in some cases by spending a little time. At present most of the work can be done through online. Searching and retrieval of document (Information) is not the exception.

Any type of document may be treated as information source as the document gives the information. It is a record of human knowledge, observation and thoughts available in many forms and formats. It has two components, such as conduit and content. Conduit is the physical facilities used for gathering, storing, processing and disseminating information where as Content is the information sources and elements (Mukhopadhyay, 2013).

With the advent of Information Communication Technology (ICT) and also the World Wide Web (www), maximum of the information are available by a single click, i.e. by online search (In which process interactive searching and retrieval of requested information is available via computer from online database, is called Online Search) (Wiki, 2018).

My study based on the following four online databases which provides electronic resources freely to the users:



# Stability of thin liquid film flowing down a rotating horizontal or inclined plane by momentum-integral method



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## HIGHLIGHTS

- Coriolis force stabilizes the flow field.
- Linear unstable zone depends on the angle of propagation.
- Linear unstable zone depends on the inclination angle.
- Centrifugal force stabilize/destabilize the flow field.
- Unstable zone depends on the Reynolds number.

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Momentum-integral method

## ABSTRACT

In this study we investigate the linear as well as the weakly nonlinear stability of a thin liquid film flowing down a rotating horizontal or inclined plane. The analysis is carried out using the momentum-integral method, which is valid for small as well as large Reynolds number ( $Re$ ). A single free surface equation is obtained considering self-similar velocity profiles for specific ranges of flow parameters. Considering sinusoidal perturbation of the free surface and taking into consideration the linear terms from the free surface equation we obtain the linear phase speed along  $x$ -direction ( $c_x$ ) and the critical wave number ( $k_c$ ). It is found that the linear phase speed decreases with the increasing value of the parameter  $G$  which is directly proportional to the square root of the Coriolis force, the angle of propagation of the wave ( $\phi$ ) and the angle of inclination ( $\theta$ ) of the inclined plane but it increases with the increasing value of Taylor number ( $Ta$ ). The study also points out the variation of the region of instability with the variation of  $G$ ,  $\phi$ ,  $\theta$ ,  $Re$  and  $Ta$ . It is found that as  $G$  increases, the region of instability decreases, which reflects the stabilizing role of Coriolis force. It is observed that as the angle of propagation of the wave  $\phi$  increases from 0 to 0.6725, the unstable region decreases but increases if  $\phi$  varies from 0.6725 to 2.2, thereafter again decreases up to  $\phi = \pi$ . Also it is shown that for  $\phi = 0$ , the region of instability decreases as  $\theta$  increases but the situation becomes reverse if  $\phi = \frac{\pi}{4}$ . The Taylor number  $Ta$  plays a double role. For  $\phi = 0$ ,  $\frac{\pi}{4}$ , the linear unstable zone increases as  $Ta$  increases but for  $\phi = \frac{\pi}{4}$ , the situation reverses. Also it is found that the region of instability always decreases for the variation of small as well as moderate Reynolds number, up to a critical value of the propagation angle ( $\phi_c$ ). But for small values of  $Re$  when  $\phi > \phi_c$ , the unstable region first decreases up to a critical value of  $Re$ , then again increases up to another critical value of  $Re$  and ultimately decreases for moderate values of  $Re$ . Weakly nonlinear stability analysis reveals the dependence of  $J_2$  in the Landau's equation and imaginary part of the complex frequency  $\omega_i$  on the variation of the Coriolis and centrifugal forces. Both the forces ensure the existence of supercritical and unconditional stable zones. The nonlinear study confirms the stabilizing role of the Coriolis force and the destabilizing role of the centrifugal force as obtained in the linear stability analysis. We also obtained that in the supercritical stable zone the threshold amplitude decreases (increases) as the Coriolis force (centrifugal force) increases. Finally we find that the nonlinear phase speed decreases with the increase of the Coriolis force but increases with the small increment of the centrifugal force.

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## 1. Introduction

Instability of thin liquid film down a rotating inclined plane is one of the most important instability phenomena both from the

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## Stabilization of ZrO<sub>2</sub> matrix: Revisiting the ‘archaic’ issue with a peculiar example

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### ABSTRACT

Theories/mechanisms involving stabilization pathways for zirconia systems involve conflicting arguments. The present work explains why the oxygen vacancy factor should not be treated as the ‘universal’ mechanism always; the role of the dopant metal cation also needs a renewed attention. Our studies on Zn<sup>2+</sup>-doped ZrO<sub>2</sub> system finds that an easy (and fast) transformation to monoclinic phase is noted due to the instabilities of O–O bond lengths (2.67 Å and 2.59 Å) in the horizontal and vertical planes of the ZrO<sub>6</sub> octahedra, thereby, triggering a prompt conversion of an otherwise stable (cubic/tetragonal) ZrO<sub>2</sub> to monoclinic within a narrow temperature window (500–750 °C).

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Zirconia, one of the most studied engineering materials for last few decades, earned the name of “ceramic steel” [1,2] due to the similarity of Young’s modulus values (~200 GPa; between ZrO<sub>2</sub> and steel); thus making it an extremely popular material in materials community. The potential applicability of ZrO<sub>2</sub> for structural and functional applications makes the system relevant in various fields like fuel cells, tribological, dental applications etc. [2–4]. The cubic and tetragonal forms of ZrO<sub>2</sub> have been made stable at room temperature by doping with some other oxides, e.g., CaO, MgO, Y<sub>2</sub>O<sub>3</sub>, CeO<sub>2</sub>, Gd<sub>2</sub>O<sub>3</sub> etc. [5,6]. It has been reported that in the monoclinic phase ‘Zr’ atoms favors a seven fold coordination while eight fold coordination is preferred for the cases of dopant-stabilized tetragonal and cubic phase [7]. Although a variety of dopants have been tried for stabilizing the zirconia system, Zn<sup>2+</sup> does not find much attention as of now. Also, the ionic radii for Zr<sup>4+</sup> (0.84 Å) and Zn<sup>2+</sup> (0.9 Å) ions are close to each other for eight-fold coordination. So, the incorporation of Zn<sup>2+</sup> ions into ZrO<sub>2</sub> lattice, in principle, should also lead to a stable system and may possess some special property/features.

Most of the reports published on ZnO doped ZrO<sub>2</sub> systems have focused mainly in the field of catalysis and have shown heterogeneous phase mixture [8,9]; i.e., the respective unary members (i.e., ZnO and ZrO<sub>2</sub>) retained individual identity. Our approach of present work aims at explaining such phenomena, i.e., the importance of the role of the

dopant metal cation in stabilizing a zirconia matrix. In the present work, ZnO doped ZrO<sub>2</sub> systems (ZZO) varying Zn/Zr molar ratios via co-precipitation route have been prepared to study the role of Zn<sup>2+</sup> in stabilizing the zirconia matrix. The observations in our previous work [10] were unique in this context; no other dopant/s (e.g., Y<sub>2</sub>O<sub>3</sub>, MgO, CaO etc.) used for stabilizing ZrO<sub>2</sub> structure has depicted similar behavior before. A ZnO-stabilized ZrO<sub>2</sub> matrix that crystallizes at 500 °C (in a pseudo-cubic form) and becomes unstable beyond 700 °C (formation of significant monoclinic zirconia) raises the question on the role played by a dopant metal ion, itself. Through this work, we intend to address such issues and explain the underlying mechanism behind the stabilization/destabilization of the ZrO<sub>2</sub> phase in ZZO system.

Co-precipitation method was used to synthesize various compositions of the Zn<sub>x</sub>Zr<sub>1-x</sub>O<sub>8</sub> system (x = 0.1, 0.15 and 0.2); the samples are coded as ZZ10 (Zn<sub>0.1</sub>Zr<sub>0.9</sub>O<sub>8</sub>), ZZ15 (Zn<sub>0.15</sub>Zr<sub>0.85</sub>O<sub>8</sub>) and ZZ20 (Zn<sub>0.2</sub>Zr<sub>0.8</sub>O<sub>8</sub>) throughout this paper. The experimental process has been outlined elsewhere [10]. The obtained precipitates were dried and calcined at various temperatures for 2 h. The samples have been designated as ‘ZZO or ZZ (10, 15 and 20)-Calcination temperature (in °C)’ (e.g., ZZO-500, ZZO-750, ZZ10-500) throughout this paper.

An X-ray powder diffractometer (Bruker; Model D8 Advance with DaVinci) operated at 40 kV and 40 mA generating CuK<sub>α</sub> radiation was used to obtain XRD data of all prepared samples. The diffracted intensities were collected in step-scan mode (step size 2θ = 0.02°; counting time 30s per step) in the angular range 2θ = 20–80°. Raman spectra were collected using Raman spectrophotometer (Seki Technotron Corporation, STR 750, Japan). Inductively coupled plasma optical emission spectroscopy (ICP-OES, Varian 720-ES) was used for the elemental

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# Microstructure characterization of mechanosynthesized CeO<sub>2</sub> stabilized nanocrystalline ZrO<sub>2</sub>

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**Abstract-** In this research work, nanocrystalline cubic (c) zirconia was synthesized by mechanical alloying monoclinic (m) ZrO<sub>2</sub>-CeO<sub>2</sub> powder mixture (0.9: 0.1molar ratio) using high-energy planetary ball mill. X-ray powder diffraction (XRD) patterns of ball-milled powders reveal that the mechanical alloying technology was effective to synthesize stable cubic (c) zirconia phase within a short milling time. Structural and microstructural changes of different phases and relative phase abundances have been estimated by adopting Rietveld analysis of XRD data. Output results of Rietveld analysis are used to explain the formation mechanism. The average crystallite sizes of cubic zirconia are between 5 to 8 nm. After 8h of ball milling, c- ZrO<sub>2</sub> becomes the major phase with some minor contribution of m-ZrO<sub>2</sub> phase so that the final ball-milled product is recognized as nano-dimensional partially stabilized zirconia (PSZ) ceramic. Finally, HRTEM study of 8h ball-milled powder mixture corroborates with the results as obtained by the Rietveld analysis of XRD data.

**Index Terms-** Ball milling; Rietveld analysis; cubic ZrO<sub>2</sub>; Nanoparticles.

## 1. INTRODUCTION

In recent years, the high-energy ball milling method has received considerable attention basically for (i) producing nanoparticles with enhanced surface reactivity (ii) amorphization of powder sample (iii) polymorphic and other types of phase transitions, (iv) producing metal-metal, metal-ceramic or ceramic-ceramic nanocomposites [1-5]. The materials transfer by diffusion of components during ball milling provides the way to new phase formation. This solid-state technique is especially useful for synthesizing those compounds that are difficult to prepare in the conventional process due to the requirement of high pressure or temperature. In the present study, the ball-milling method has been employed for stabilization of Zirconia phase by CeO<sub>2</sub> doping. Rietveld's whole profile fitting method is adopted for microstructure characterization of the prepared nanocrystalline PSZ powders. Rietveld refinement method based on pseudo-Voigt analytical function can successfully be applied for phase quantification as well as microstructure characterization of a multiphase material.

Pure, undoped zirconia exists in three polymorphs: monoclinic (space group: P2<sub>1</sub>/c) from room temperature to 1440K, tetragonal (space group: P4<sub>2</sub>/nmc) between 1440 and 2650K and cubic (space group: Fm $\bar{3}$ m) up to the melting point of 2950K. Being stabilized in the cubic phase, zirconia has a wide range of technological applications as structural ceramics [6, 7]. These materials exhibit a high ionic conductivity at high temperatures allowing their use in fuel cells, oxygen sensors, oxygen pumps etc [8].

The purpose of the present research work is (i) to prepare nanocrystalline PSZ at room temperature by high energy ball milling, adding CeO<sub>2</sub> as a dopant and (ii) to characterize prepared materials in terms of several microstructural defect parameters by analyzing X-ray diffraction profiles with Rietveld's powder structure refinement method. (iii) to find out direct supportive evidence of XRD pattern analysis method by HRTEM study.

## 2. EXPERIMENTAL

Mechanical alloying was executed by a high-energy planetary ball mill (Model-P5, M/s FRITZSCH, GmbH, Germany). Monoclinic ZrO<sub>2</sub> and CeO<sub>2</sub> powders were mixed in a required molar ratio (0.9:0.1) and the starting ingredients were sealed in a chrome steel vial containing chrome steel balls. The ball-to-powder weight ratio (BPWR) was kept at 40:1. Milled powder was collected from the vial after a selected milling time interval varying from 1h to 8h. Step-scan XRD data (step size 0.02° 2 $\theta$ ) of unmilled and all ball milled powders were recorded from an X-ray powder diffractometer (Panalytical; Model PW1830) with Ni-filtered CuK $\alpha$  radiation. The 8h ball milled powder was finely dispersed in alcohol and a tiny drop of the solution then taken on a carbon-coated Cu-grid of TEM. The TEM was operated at 200KV (Model HR-TEM, JEOL JEM 2100) for obtaining well-resolved TEM micrographs of nanocrystalline ZrO<sub>2</sub> particles.

## 3. EVOLUTION OF MICROSTRUCTURE BY X-RAY POWDER DIFFRACTION

In the present study, Rietveld's whole profile fitting method has been successfully adopted employing

Research Article

## Dose-dependent Pupical, Adulticidal and Ovicidal activities of leaf extracts of *Tiliacora acuminata* on Japanese encephalitis vector *Culex vishnui* group

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**Abstract:** Vector of Japanese encephalitis is *Culex vishnui* group of mosquito and control of that mosquito is facing threat due to emergence of resistance to synthetic insecticides. Insecticides of plant origin now act as suitable alternate for control of JE vector. To investigate dose-dependent pupical, adulticidal and ovicidal activities, crude and acetone extracts of leaf of *Tiliacora acuminata* were used against *Cx. vishnui* group of mosquito. In case of dose-dependent pupical activity, highest mortality observed at 1.5% concentration of crude extract and 75 ppm of acetone extract with 45.67% and 67.67% mortality respectively after 36 h of exposure followed by 24h and 12h. In case of adulticidal activity, highest mortality in crude extract was observed at 2.5% concentration with 73% of adult mosquitoes were dead, but in acetone extract at 120 ppm concentration shows nearly about 67% mortality of adult mosquitoes after 24 h of exposure. While in ovicidal activity at 0.5% crude extract have 11.67% egg hatching so nearly about 88.33% ovicidal activity takes place at this concentration. In acetone extract, there was nearly about 93.33% ovicidal activities at 55 ppm concentration. So leaf extracts of *T. acuminata* may be used as better pupical, adulticidal and ovicidal plant origin insecticide for control of *Cx. vishnui* group of mosquito. Further research is required to isolate and characterize the active principle of *T. acuminata* plant leaf extract.

**Keywords:** *Tiliacora acuminata*, *Culex vishnui* group, Pupical, Adulticidal and Ovicidal activity.

### 1. Introduction

Mosquito, the term derived from the Sanskrit word "Masak", is a notorious creature because they pierce the host's skin for consumption of blood.

According to NVBDCP (National Vector Borne Disease Control Programme) under The Ministry of Health and Family Welfare, Government of India, *Culex vishnui* group (*Culex tritaeniorhynchus*, *Culex vishnui* and *Culex pseudovishnui*) is the chief vectors of JE in different parts of India. *Cx. vishnui* breeds preferably in the stagnant water of rice fields.

Japanese encephalitis which is previously known as Japanese B encephalitis caused by the mosquito-borne Japanese encephalitis virus.<sup>1</sup>

Symptoms of most JE virus infections are moderate fever and headache but in some instances without any significant symptoms. The extreme symptoms of the disease are characterized by quick start of high fever, headache, neck stiffness, coma, seizures, spastic paralysis and death. Spreading of JE in new area has been associated with extensive rice cultivation especially by irrigation schedule.<sup>2</sup>

A multitude of prevention and control strategies have been developed against Japanese encephalitis such as proper treatment of affected person, vaccination and control of vector population to inhibit the transmission of JE virus. We must take special emphasis on the third strategy to eradicate the spreading of JE.

From very ancient period's practice of using different synthetic insecticides to control mosquito population is a common phenomenon in Cosmo tropical areas. But in the recent year, their use declines drastically in many countries due to the appearance of insect resistance, biomagnification through food chain and non-biodegradable properties.

In the recent past, natural product of plant origin is experimentally used to control varieties of insect pest or vectors.

The extract which bears the active components of plants is applied for mosquito control programming. Repellent, ovipositional attractants, deterrent and insect growth hormone regulator activity of different plant extracts have been reported from the work of different authors.<sup>3,4,5</sup> Some phytochemicals act as growth, development inhibitor, chemosterilant and repellent or



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## **রোহিঙ্গা আত্মপরিচয় সংকট ও রোহিঙ্গা সমস্যা নিরসনে ভারতের ভূমিকা সেখ আসিফ ইকবাল**

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**স্বপ্নী নন্দ**

*In the south-east Asia Rohingya issue has given seminal importance in the social, political as well as religion perspective. Due to being deported from previously known as Burma or modern-day Myanmar, Rohingyas are taking shelter in neighboring countries. They are one of the oldest inhabitants of Myanmar, but according to Myanmar, they are 'Bengalee' and they have migrated from Bangladesh and illegally settled in Myanmar. By showing this reason, the citizenship of Rohingyas was canceled according to the Myanmar Citizenship Act of 1982. However historians say that the Rohingya lived in the Arakan region since the eighth century. Rohingya Muslims also participated in Burmese's independence movement evenly with the Burmese. By the principle of 'Divide and Rule', under the rule of imperialism, the English sowed the seeds of divisions among the people living in Burma. On January 4, 1948 Burma gained independence. Rohingya or Arakanese Muslims were not included in the Constitution of Myanmar, 1947 though one hundred forty tribes of Burma were included in the Constitution. Displaced from their origin a large number of Rohingya enter India, apart from taking shelter in different neighboring countries. India has to make decisions regarding Rohingya, keeping in mind the importance of India's internal security and friendly relations with Myanmar. In the international stage India is taking decision to keep the balance in respect of international relationship. India is trying to solve the problem by social development of the Rakhine region.*

**Keywords: Rohingya, Refugee, Rakhine, Myanmar Citizenship Act of 1982, Kaladan Multi-Modal Transit Transport Project, United Nations, Kofi Annan Commission.**

বর্তমান বিশ্বে বিশেষ করে পূর্ব এশিয়ার অন্যতম আলোচ্য বিষয় হল রোহিঙ্গা উদ্বাস্ত সমস্যা। রোহিঙ্গারা পশ্চিম রাখাইন প্রদেশের উত্তরাংশে বসবাসকারী একটি জাতিগোষ্ঠী। ধর্মের বিশ্বাসে এরা অধিকাংশই মুসলমান। আজকের রাখাইন রাজ্য ছিল ইতিহাসের আরকান রাজ্য, যার অংশে ছিল বৃহত্তর চট্টগ্রামের একাংশ এবং ফেনী ও নোয়াখালী অংশ।<sup>১</sup> ধারণা করা হয় রোহিঙ্গা নামটি এসেছে আরাকানের রাজধানী স্রোহং থেকে, স্রোহং > রোয়াং > রোয়াইঙ্গিয়া > রোহিঙ্গা।<sup>২</sup> আরাকান রোসাঙ্গ নামেও পরিচিত। তখনকার কবি-সাহিত্যিকেরা আরাকানকে রোসাঙ্গ রাজ বলে অভিহিত করেছেন। বিশেষ করে আলাওল, মগন ঠাকুর, দৌলত কাজি প্রমুখের লেখায় রোসাঙ্গ শব্দের উল্লেখ আছে।<sup>৩</sup> ১৬ শতকের কবি দৌলত কাজীর 'সতী ময়না লোর চন্দ্রানী' কাব্যে রোসাঙ্গ রাজ বা আরাকানের পরিচয়



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## **বর্ধমান জেলার কোলিয়ারি শ্রমিক সংগ্রাম : একটি পর্যালোচনা**

**সঞ্জীবন মহলদার**

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### **Abstract**

*The extensive area of Asansol and Durgapur is often considered as the coal mining regions of Burdwan district. In the Colonial regime of India, these evolved a particular social class who were known as the working class. This working class which mostly comprised of Bauris, Nunias, Chamars, Koris, Bhiyas, Ghatwals, Turi, Teli, Jolaha, Kahar, Kalwar, Dosadhs were the most important. All miners started working in these mines in lieu of very low wages. Right from the beginning, both the local and the migrated workers were constantly and consistently exploited and this gradually gave rise to defiance and rebellions amongst them. This rebellions activities of the working classes were very much discernible even during the non-cooperation movement. Names like Bankim Mukherjee and then Bijoy Paul became pioneering landmarks in the history of Trade Union Movements in Asansol. Deben Sen was yet another reactionary whose able leadership was instrumental in moulding the coal miners rebellion afresh and contributed largely to its proper growth. The anger and discontent of the coal miners was greatly invigorated and instigated by the fact that despite constant protests. The Coal-miners were still under the brunt of exploitation even after independence. This anger and contempt of the workers was shaped responsibly by the trade union—AITUN, INTUC, CITU, Hind Mazdoor Sabha. The present researcher intends to investigate the various hues and aspects of this organized movement under the responsible direction of the Trade Union; viz., the origin of the movement, its causes, the owner-labourer relationship, the socio-economic and political consciousness of the workers, the spirit and fervour of the rebellion, the relation between the Govt. and the owners of Coal mines, and the analysis of the role of the trade unions in organizing these movements.*

**Keywords: Coal mines, working class, oppression, protest, trade union.**

ব্রিটিশ ঔপনিবেশিক শাসনে ভারতবর্ষে ঊনবিংশ শতকের দ্বিতীয়ার্ধ থেকে আধুনিক শিল্পায়নের সূত্রপাত। তার ফলে নতুন একটি সামাজিক শ্রেণির উদ্ভব ঘটে, যারা শ্রম বিক্রি করে মজুরির বিনিময়ে, তারা শ্রমিক শ্রেণি হিসাবে পরিচিত। ঔপনিবেশিক অর্থনীতির ফলে ভারতবর্ষের সর্বস্তরের মানুষ শোষিত ও অত্যাচারিত হচ্ছিল। শ্রমিকশ্রেণিও তার বাইরে ছিল না। বিভিন্ন পরিস্থিতি ও ঘটনার ঘাত-প্রতিঘাতে এদেশের মানুষের মধ্যে সাত্ত্বাজ্যবাদ বিরোধী চেতনা গড়ে উঠেছিল। তার ফলে প্রতিবাদ ও প্রতিরোধ আন্দোলনও শুরু হয়ে যায়। শ্রমিকশ্রেণি এই সংগ্রামে





# Microstructure and Electrical Characterization of Thermoelectric Nanocrystalline Bi<sub>2</sub>Te<sub>3</sub> Synthesized by Mechanical Alloying

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Nanocrystalline bismuth telluride, Bi<sub>2</sub>Te<sub>3</sub> has been synthesized by mechanical alloying (MA) the powder mixture composed of Bi and Te in the inert gas atmosphere within a short duration of 15 min. Microstructure characterization of the prepared powder has been investigated adopting the Rietveld's method using X-Ray diffraction (XRD) data and analyzing high-resolution transmission electron microscopy (HRTEM) images. The XRD pattern of 15 min milled powder is composed of reflections of major Bi<sub>2</sub>Te<sub>3</sub> phase with other two minor phases. Detailed structural information of these minor phases has been reported here which was not explored in any previous works. XRD analysis reveals that the stoichiometric Bi<sub>2</sub>Te<sub>3</sub> phase has been formed after 1h of milling and there is no phase transition up to 10h of milling. HRTEM study also reveals the formation of single phase nanostructured Bi<sub>2</sub>Te<sub>3</sub> phase. The DC (direct current) conductivities of 15min, 30min and 10h milled powders are measured within the temperature range of 359 to 633K. The electrical conductivity ( $\sigma$ ) of Bi<sub>2</sub>Te<sub>3</sub> indicates the semiconducting nature of the sample. There is no significant change of electrical conductivity of Bi<sub>2</sub>Te<sub>3</sub> phase since its formation after 15min to 10h of milling, as there is no noticeable change in crystallite size.

**Keywords:** Nanostructured materials, mechanical alloying, microstructure, X-ray diffraction, HRTEM.

## 1. Introduction

As fossil fuel resources are becoming exhausted, thermoelectric (TE) devices, as alternative power resources have found their applications in power generators or cooling devices<sup>1,2</sup>. Currently, due to relatively low efficiency and high cost, TE materials have limited applications. TE materials can play a vital role in energy conservation if efficient and stable novel materials can be prepared in a cost-effective way. Bismuth telluride based alloys are well known potential TE materials for near room temperature applications due to their low thermal conductivity and large Seebeck coefficient<sup>3-5</sup>. Reducing the crystallite size of polycrystalline TE materials to the nano-scale has resulted in a significant reduction of the lattice thermal conductivity and improvement in the figure of merit<sup>6,7</sup>. Most of these advances are related to the use of nanostructures due to thermal conductivity reduction<sup>8,9</sup>. Alternatively, composite TE materials containing several phases may have higher efficiency introducing more interfaces leading to a decrease in the thermal conductivity. The aim of the present research work is the production of nanostructured bismuth telluride thermoelectric material in a low-cost method. For this purpose, we have employed the MA method to prepare nanocrystalline bismuth telluride alloy starting from an elemental powder mixture of Bi and Te at room temperature.

This simple and cost-effective preparation route has the advantage to produce nano-dimensional Bi<sub>2</sub>Te<sub>3</sub> powder in large quantities in a very short duration of time. Although several reports on mechanosynthesis of single/composite TE materials have been published<sup>10-14</sup>, the growth mechanism of bismuth telluride TE material synthesized by mechanical alloying (which may lead to the formation of nanocomposites including several constituent phases of the same family), has not been reported yet. Earlier review shows that during growth process Bi<sub>2</sub>Te<sub>3</sub> may co-exist with different high-pressure phases, which are still remained unidentified so far the structure report is concerned<sup>15,16</sup>. In another work, synthesis of Bi<sub>2</sub>Te<sub>3</sub> was prepared by mechanical milling in a short time but the appearance of other phases in the XRD pattern was ignored and so the growth mechanism of stoichiometric Bi<sub>2</sub>Te<sub>3</sub> phase remains unexplored<sup>17</sup>. In the present work, XRD pattern analysis reveals that at relatively lower time milling (15min and 30 min) major rhombohedral Bi<sub>2</sub>Te<sub>3</sub> phase has been formed along with a trace amount of two minor phases. Formations of such intermediate metastable high-pressure phases during mechanical alloying were already reported by ourselves<sup>18,19</sup>. However, higher time of milling after 1h produces single phase nanocrystalline Bi<sub>2</sub>Te<sub>3</sub>, which remains stable up to 10h of milling. Detailed structural information of the hitherto unidentified phases evolved in the way of formation Bi<sub>2</sub>Te<sub>3</sub> has been reported in the present work.

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## Dual macro-cyclic component based logic diversity

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### Highlights

The paper highlights the designing of special logic circuits based on dual macrocyclic component inputs.

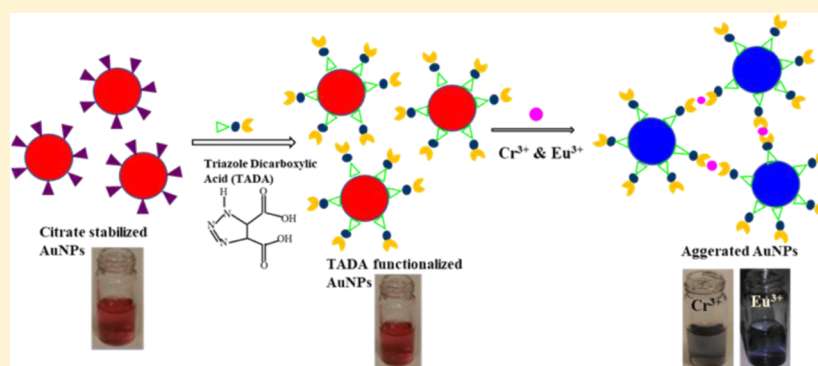
The systems could be easily tuned to integrate multiple functionalities through direct modulation of the optical signals.

For the first time, a memory device and a keypad lock as well have been designed operating through macrocyclic components.

### Abstract

In continuation of our recent studies on the photophysics of a photodynamic therapeutic agent, harmine (HM) in model membrane, the present contribution highlights a new model to design multiple logic circuits, a memory device and a molecular lock regulated by dual macrocyclic components as chemical inputs. The unique reversible photoswitching regulated by macrocyclic components plays decisive role in the manifestation of the final outputs for the logic functions. Inspired by this phenomenon, herein, we are reporting the use of a photosensitizer molecule for designing of various logic circuits at molecular level with the intention to escalate the next generation molecular logic arena. For these desired outcomes, fluorescence spectroscopic changes of HM upon addition of macrocyclic components (CTAB and  $\beta$ -CD) were utilised. Beyond the simple single input single output logic gates (NOT, YES, PASS 0 and PASS 1), we were also able to design IMPLICATION and INHIBIT gates. In addition to different logic functions, the modulations of the optical responses of HM driven by the macrocyclic components were employed to design “Erase-Read-Write-Read” and “Write-Read-Erase-Read” type memory units. Moreover, considering the optical responses of HM we proposed a supramolecular keypad lock operated through unique sequential entry of opto-chemical passwords.

# Colorimetric Dual Sensors of Metal Ions Based on 1,2,3-Triazole-4,5-Dicarboxylic Acid-Functionalized Gold Nanoparticles

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**ABSTRACT:** A simple, rapid, selective, and cost-effective colorimetric assay for  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  ion detection has been developed using functionalized gold nanoparticles. Gold nanoparticles (AuNPs) were prepared using  $\text{HAuCl}_4$ , where sodium citrate is a reducing agent as well as a capping agent, and then functionalized with 1,2,3-triazole-4,5-dicarboxylic acid (TADA). Fourier transform infrared (FTIR) and Raman spectroscopies suggested that TADA was functionalized on the surface of AuNPs through the N atom of triazole. The TADA-functionalized gold nanoparticles (TADA@AuNPs) simultaneously detect  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  ions from aqueous solution and showed different responses to the two metal ions ( $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$ ) based on an aggregation-induced color change of AuNPs. They showed a color change from wine red to blue, which was easily detected by the naked eye, as well as by UV–visible and FTIR spectroscopies. The surface plasmon resonance absorbances of  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  are 633 and 671 nm, respectively, when  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  react with TADA@AuNPs and showed good linearity with  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  concentrations with detection limits 5.89 nM and 4.30  $\mu\text{M}$ , respectively ( $S/N = 3$ ). The TADA@AuNPs showed excellent selectivity toward  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  compared to those of the 16 different metal ions. We had also tested the selectivity of TADA@AuNPs toward  $\text{Eu}^{3+}$  compared to that of the other 10 lanthanide systems. Optimal detection was achieved toward  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  ions in the pH range 4–10. In addition, TADA@AuNPs were applied to detect  $\text{Cr}^{3+}$  and  $\text{Eu}^{3+}$  ions from lake water showing low interference.

## 1. INTRODUCTION

Trivalent chromium ion,  $\text{Cr}^{3+}$ , is one of the fundamental trace transition metals that regulates the insulin on the control of blood sugar in human beings.<sup>1–3</sup> Insulin resistance or glucose intolerance largely depends on the deficiency of chromium in human blood. However, excessive accumulation of chromium ion would induce the oxidative damage of some cellular components, such as lipid, protein, and DNA.<sup>4,5</sup> As stipulated by the World Health Organization (WHO), the U.S. Environmental Protection Agency (EPA) standard, and European Community (EC), the maximum tolerable limits of  $\text{Cr}^{3+}$  ion in drinking water are 50, 100, and 50  $\mu\text{g/L}$ , respectively.<sup>6</sup>  $\text{Cr}^{3+}$  is the environmental pollutant as it is extensively used in electroplating, alloying, and paint pigments. To detect chromium ions in biological and environmental samples, the development of highly selective and sensitive

chromium sensors is an important area of research. On the other hand, among all, lanthanides, especially europium, is very essential in industry, where it is used as a material for catalyst, semiconductor, and energy. Europium phosphors are used in television tubes to give a bright red color and as an activator for yttrium-based phosphors. Due to the specific physical properties<sup>7,8</sup> of europium, it is also used for improving crop quality in agriculture. Thus, the increasing consumption of europium in both industry and agriculture endangers environment as well as human health.<sup>9,10</sup> Therefore, development of methods for detection of europium is very important. Currently, common techniques are employed for the detection

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## A predator-prey model with Crowley-Martin response for predation

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### Abstract

*The present investigation accounts for the influence of intra-specific competition among predator populations in a prey dependent predator-prey model of interacting populations. In this model we considered Qiwu's growth rate for prey, Crowley-Martin response function for predation and intra-specific competition among predator populations. We offer a detailed mathematical analysis of the proposed model to illustrate some of the significant results that has arisen from the interplay of deterministic ecological phenomena and processes. In particular, stability (local and global) and bifurcation (Hopf-Andronov) analysis of this model are conducted for biologically feasible parameters. We attained sufficient conditions to ensure the global stability of the unique positive equilibrium, by using appropriate Lyapunov functions and Lasalle invariance principle. Finally, numerical simulations through computer illustrate the dynamics of the ecological system.*

**Keywords:** Predator-prey model, Intraspecific competition, Stability, Bifurcation, Lyapunov function, Crowle-Martin functional response.

MSC(2010) : 34A34, 34D20, 37B25, 37G15, 92D25.

### 1. Introduction

Ecological systems are characterized by the interactions of different species within their natural environment. Studies of mathematical models are informative in understanding predator-prey interactions in these systems; as a result, predator-prey models have been important in ecological science since the early days of this discipline after the pioneering works of Lotka and Volterra. We start with the modified Lotka-Voltera type predator-prey system

$$\frac{dX}{dT} = RX \left(1 - \frac{X}{K}\right) - CMXY, \quad (1.1a)$$

$$\frac{dY}{dT} = MXY - DY, \quad (1.1b)$$

$$X(0) \geq 0, Y(0) \geq 0, \quad (1.1c)$$

---

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## Ratio-dependent predator-prey model with Qiwu's growth for prey

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### Abstract

*Modelling of predation process of an eco-system becomes closer to the existent situation when response of both the species is believed in the modelling process. Ratio-dependent functional response is one of them. In this article, a prey-predator model is thought with Qiwu's growth for prey and ratio-dependent Holling type II functional response predation development. The crucial mathematical features of the proposed model are analyzed with the help of equilibria, stability analysis, and bifurcation theory. The parametric space under which the system enters into a Hopf-bifurcation has been investigated. Explicit formula for determining the stability of bifurcating periodic solutions is driven by using normal form and central manifold theory. Our analytical findings are performed by numerical experiments. Biological implications of the analytical findings are talked about in the conclusion section.*

**Keywords:** Prey-predator model; Ratio-dependent response; Stability; Hopf-bifurcation.

MSC(2010) : 92Bxx, 92D40, 37B25, 34D23, 34D35

### 1. Introduction

Behaviour of ecological system is characterized by the interaction of species with the wide range of spatial and temporal scales natural environment. From the early beginning of this discipline, one of the most key interactions that influence the dynamics of all species is predation. Studies of mathematical models are informative in understanding prey-predator interactions in these systems; as a result, predator-prey dynamics have been significant in mathematical ecology since the early days of this discipline after the pioneer work of Lotka and Volterra. We begin with the modified Lotka-Volterra type prey-predator system which is known as Wangersky-Cunningham model

$$\frac{dX}{dt} = RX\left(1 - \frac{X}{K}\right) - MXY, \quad (1.1a)$$

$$\frac{dY}{dt} = EMXY - DY, \quad (1.1b)$$

$$X(0) \geq 0, Y(0) \geq 0, \quad (1.1c)$$

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# A Review on Hydrodynamical Stability of Thin Film Flowing Along an Inclined Plane

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## Article Info

**Keywords:** Hydrodynamical stability, Inclined plane, Thin film.

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## Abstract

The dynamics and stability of thin liquid films have fascinated scientists over many decades. Thin film flows occur over a wide range of length scales and are central to numerous areas of engineering, geophysics and biophysics. These include nanofluidics and microfluidics, lava flows, coating flows, tear-film rupture, dynamics of continental ice sheets and surfactant replacement therapy. Study of falling film instability has its wide applications in the practical field of industry and engineering. Practical applications in industrial processing motivate the recent research to investigate the factors which may affect the formation of waves on the surface of the coating layers and/or to determine the ways to overcome or to minimize the unwanted factors within the desired limit of tolerance. The dynamics of a liquid film flowing down a plane under the action of gravity is a problem which appears in many technological and natural systems, namely large scale geophysical environments such as lava flows or spillways, daily life scenarios such as water flowing down a window pane or a slippery road on a rainy day, chemical engineering processes such as evaporators, heat exchanges and falling film reactors or surface coating. The aim of this paper is to throw light on the studies conducted on hydrodynamical stability.

## 1. Introduction

Hydrodynamical stability is an important branch of the fluid mechanics both from application and theoretical points of view. Stability is the measure of the ability of a system to resist the changes or in other words how a system reverts to its original state after suffering all possible modes of perturbation. An important criterion for a flow state to be physically stable is the ability of the system to withstand small disturbances which are present or may be transmitted from the surroundings to the flow. The theory of small oscillations is a useful tool for investigating the stability problems in hydrodynamics. If small disturbances superimposed on initial laminar flow, decay in time or with distance downstream, then the laminar flow is stable. If they increase, that is if the growth of the perturbation is unbounded, or if the real outcome is just another different state, or if it is a bounded but turbulent or chaotic state or accompanies the collapse of physical assumptions underlying the governing equations then the outcome is a different physical system. A very common example of instability is the formation of waves on surfaces of water owing to the action of wind. The "Taylor-Couette flow instability" is a well known instability, which arises due to centrifugal force, and Rayleigh-Benard convection, which arises due to difference of density are important instability phenomena occurring in laboratories and nature. A detailed description of the entire field is given by Schlichting [1], Lin [2], Hsieh and Ho [3] and Drazin and Reid [4]. It is very interesting that despite the effort of generations of applied mathematicians, beginning with Rayleigh, Kelvin and Reynolds, many simple understanding of phenomena related to hydrodynamic stability remain incomplete. Therefore it is an important task for the applied mathematics community to highlight different aspects of flow instability.

The instability of a thin film was first investigated in 1949 when Kapitza and Kapitza [5] took some elegant photographs with the help of some simple kitchen apparatus. After the publication of these photographs, the research community felt that these photographs represent a simple hydrodynamical instability phenomenon on a thin film flowing along an inclined plane. The beauty and simplicity of this phenomenon

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## e-Learning Platform in SAARC Countries

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## **e-Learning Platform in SAARC Countries**

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### **Abstract**

*The present paper deals with the e-Learning platform in SAARC countries. There are eight SAARC countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Srilanka) but among them only 5 countries (Afghanistan, Bangladesh, India, Pakistan and Srilanka) have their own e-learning platform for their citizens.*

***Purpose:*** *To acquire information about each and every e-learning platform which includes name, year of origin, sponsoring authority, aims, subject area covered, learning path, learning quadrant and type of the courses offered by each e-learning platform.*

***Methodology:*** *e-Learning platforms of each SAARC countries have been studied and filled a questionnaire. The collected data are tabulated in three different tables and analyzed in a significant manner.*

***Findings:*** *India and Bangladesh have started education through e-learning platform in the year 2016) where as Afghanistan and Pakistan have started in the year 2018 and Srilanka has the oldest e-learning platform. edX covers the maximum subject areas.*

**Keywords:** SAARC, e-Learning, MOOC, SWAYAM, DigiSkill, edX, Muktopaath, FOOE

**Introduction:** The present valuable right of all human being should be the “Right to education” and the slogan should be the “Education for all”. Now the free education made a remarkable impact in the modern society as whole. Learners from the different areas of the world mainly from SAARC Countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Srilanka) face several problems in time of accessing educational services including learning materials. This is a critical issue in the field of education and this critical situation may be dissolved with the integration of ICT and Education. In this situation many Governments and agencies have implemented such type of e-learning platform so that education barriers are





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# Enhanced photocatalysis performance of mechano-synthesized $V_2O_5$ - $TiO_2$ nanocomposite for wastewater treatment: Correlation of structure with photocatalytic performance

M. Mondal<sup>a</sup>, H. Dutta<sup>b</sup>, S.K. Pradhan<sup>a,\*</sup>

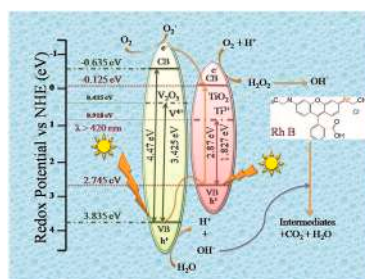
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## HIGHLIGHTS

- Photocatalytic  $V_2O_5$ - $TiO_2$  nanocomposites are synthesized by mechanical alloying.
- 3h ball-milled nanocomposite shows ~94% degradation of RhB under visible light much higher than our previous work.
- Microstructure study of  $V_2O_5$ - $TiO_2$  is done by Rietveld method of XRD data analysis.
- Pineapple flower-like morphology of 3h milled composite favours photodegradation.
- Leaf ( $V_2O_5$ )/flower ( $TiO_2$ ) heterojunctions excel the photocatalytic performance.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

### Keywords:

$V_2O_5$ - $TiO_2$  nanocomposites  
Mechanical alloying  
Rietveld  
FESEM  
Photocatalysis

## ABSTRACT

The harmful chemical organic dyes used in textile industries and wastewater poses a great threat to human beings due to huge toxicity and enormous health hazards. Consequently, the conversion of these harmful chemicals into harmless substances becomes utmost essential for sustainable development in wastewater research. High-energy ball-milling of orthorhombic  $V_2O_5$ -anatase (a)  $TiO_2$  mixture (1:1 M ratio) at room temperature results in the formation of nanocrystalline  $V_2O_5$ - $TiO_2$  solid solution phase. A series of  $V_2O_5$ - $TiO_2$  solid solution is synthesized by varying the milling time from 5min to 20h. The Rietveld X-ray powder structure refinement methodology has been adopted for microstructure characterization of unmilled and all ball-milled nanocomposite samples, in terms of lattice imperfections. From Rietveld analysis, lattice parameters, relative phase abundance of individual phases, crystallite size and r.m.s. lattice strain values are estimated. At the early stage of milling of 30min, a- $TiO_2$  transforms to polymorphic rutile (r)- $TiO_2$  due to high energy impact of mechanical alloying. The final ball-milled powder mixture is composed of  $V_2O_5$ - $TiO_2$  solid solution with a trace amount of r- $TiO_2$  phase. Photocatalytic study through the degradation of Rhodamine B (RhB) in presence of visible light reveals enhanced degradation (~94%) of RhB with 3h ball-milled  $V_2O_5$ - $TiO_2$  nanocomposite, compared to ~74% with 15h milled nanocomposite reported earlier. Optical bandgaps of ball-milled  $V_2O_5$ - $TiO_2$  nanocomposites are within the semiconducting range. FESEM study of ball-milled powder mixture reveals the pineapple flower-like morphology of nanoparticles of  $V_2O_5$ - $TiO_2$  nanocomposites. An enormous number of the

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## Dielectric response of ZrO<sub>2</sub>–CeO<sub>2</sub> nanocrystalline solid solution above room temperature

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### ARTICLE INFO

#### Keywords:

Nanocrystal  
Ball milling  
Dielectric properties  
Current-voltage characteristics

### ABSTRACT

Here we report the dielectric response of partially stabilized zirconia above room temperature. The conductivity increases with rise in temperature and frequency, obeying a power law type nature. The frequency exponent study shows that the Correlated Barrier Hopping model governs the conductivity process. The value of dielectric permittivity increases with increase in milling hour. It is observed that both free charge and space charge conductivities increase as the temperature increases. The complex dielectric permittivity is found to be increased with increase in temperature and decrease with frequency. Complex impedance study shows the grain boundary resistance is higher than the grain resistance. The current density-electric field characteristics show that the Poole Frenkel Emission model is the best suited model for the prepared samples and the trap height varies non-linearly with temperature.

### 1. Introduction

Recently zirconia has developed interest not only in fields of pure research but also in industrial applications. Four different chemical properties like basic, acidic, reducing and oxidizing properties have been observed in zirconia [1]. Also it shows three different temperature dependent polymorphs, namely monoclinic with space group P2<sub>1/c</sub> (Room temperature - 1440 K), tetragonal having space group P4<sub>2/nmc</sub> (1440 K–2650 K) and cubic phase having space group Fm $\bar{3}$ m (2650 K to melting point). Numbers of technical applications concern the cubic form of zirconia which is however not easily available. This engineered material is hard, wear resistant, show high fracture toughness and find applications in structural ceramic industries [2–4]. Apart from these, zirconia is characterized by high temperature ionic conductivity which enables to use this material in oxygen sensor, oxygen pumps and solid oxide fuel cells [5]. The partially stabilized zirconia (PSZ) is the mixture of cubic and tetragonal (or monoclinic) phases, and different methods have been extensively employed to develop PSZ at room temperature. Generally this is achieved by adding different dopants which act as stabilizer. The sol-gel method has been extensively

used to obtain nanocrystalline doped zirconia powders [6–8], but the main drawback of this process is high production cost, which makes it commercially unsuitable. In this study, we have developed nanocrystalline PSZ by ball milling method which is a very cost effective process [9,10]. The precursor passes through different mechanochemical phase transitions before reaching the desired state [11,12]. The key feature of this process is that the final product shows low temperature ductility and enhanced hardness. Earlier works suggest that room temperature stabilized cubic zirconia can be synthesized successfully by means of high energy planetary ball milling method either by adding dopant or even without adding dopant [13,14]. Structural and microstructural changes in different prepared samples have been evaluated by analyzing XRD patterns of different samples using Rietveld refinement method.

Further, grain and grain boundary play important role in determining the physical properties of the nanomaterials. So, we have studied the ac complex impedance spectroscopy to have an insight of the grain and grain boundary contribution. The electric modulus study provides information regarding the relaxation dynamics of the prepared samples. The ac and dc conductivity studies and I–V behaviour contain valuable information regarding the sample character. The electrical behaviour of

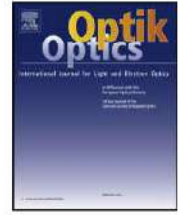
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Original research article

# A comparative study of birefringence in photonic crystal fiber employing various lattice geometries with all-circular air holes

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## ABSTRACT

This article presents a detail theoretical investigation on birefringence characteristics for various highly birefringent photonic crystal fiber designs based on triangular, square, and circular-lattice geometry. In order to compare the results, a systematic comparative study is then performed. It is shown that the birefringence of any particular lattice geometry can be modulated by modifying the structural anisotropy (asymmetry) of that geometry. The variations of birefringence with normalized wavelength have been evaluated for various asymmetric designs of a lattice geometry and variation for other lattice geometries have thereby been determined and compared. These photonic crystal fibers are composed of a solid silica core surrounded by cladding of circular air-holes. The birefringence is due to large axial anisotropy introduced into the fiber by a prefer arrangement of air-holes in the fiber cladding. A finite difference mode-convergence analysis is implemented to determine the required modal indices of the photonic crystal fiber, which is then used to calculate the birefringence of the fiber. Based on the results, the birefringence is found to be largely dependent on the lattice geometry associated as well as the degree of asymmetry. Numerical results show that for a particular type of asymmetric design triangular-lattice geometry is the best choice in terms of high birefringence. One of the considered designs based on triangular-lattice geometry, formed by omitting three adjacent air-holes at the centre, can considerably enhance the birefringence as high as  $12.6 \times 10^{-3}$  at normalized frequency 0.48.

## 1. Introduction

Photonic crystal fibers (PCFs) or microstructured fibers have attracted a lot of research attention due to many possibilities and promising applications in the field of photonics [1–3]. PCFs are new kinds of optical fiber where cladding is constructed by a lattice of air-holes running down their entire length. By manipulating the arrangement of air-holes, *i.e.*, the lattice geometry of the photonic crystal cladding or size and shape of the holes, it is possible to control the light propagation characteristics of these fibers [4–6]. The polarization properties can also be controlled in order to design polarization maintaining fiber or to design single polarized single mode fiber [7–11]. When control over the polarization of light is crucial, high birefringence ( $\sim 10^{-3}$ ) is introduced into the fiber which reduces the coupling between the fundamental degenerate modes. There are mainly two ways by which an optical fiber can be made birefringent *e.g.*, by applying mechanical stress (stress birefringence) into the fiber and by introducing axial anisotropy into the core or cladding (form birefringence). Huge design flexibility in PCFs offers enormous scope to introduce anisotropy, leading to significant opportunities in birefringence enhancement. Various approaches have been proposed to introduce asymmetry in a PCF structure. Numerous asymmetric structures have been reported which use elliptical air-holes embedded either in the cladding or in the core [12–19]. Besides, several structures employ a cladding with squeezed lattice configuration [20–22]. In addition, hybrid

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## Research article

Kajal Mondal\*

# Structural dependence of transmission characteristics for photonic crystal fiber with circularly distributed air-holes

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**Abstract:** In this study, design and transmission characteristics of a special type of photonic crystal fiber (PCF) geometry namely, circular-lattice photonic crystal fiber (C-PCF) structure are presented. The cladding of the structure consists by a cylindrically symmetrical distribution of air-holes in the silica background and the core is created by omitting one air-hole at the center. The structure provides high degree of flexibility in the fiber design and hence tailorable modal properties. Structural dependence of transmission characteristics of the geometry is numerically investigated by using finite difference mode convergence algorithm. The wavelength responses of fiber parameters, such as effective refractive index, chromatic dispersion, mode-effective area, and nonlinear coefficient of the structure are systematically investigated. Besides, effective V-parameter and single-mode operation of the fiber are also evaluated and discussed. The simulation results show the possibility of large negative dispersion and dispersion flattened nature of the geometry.

**Keywords:** chromatic dispersion; fiber nonlinearity; modal properties; mode-effective area; photonic crystal fiber.

## 1 Introduction

Recently, photonic crystal fibers or holey optical fibers [1] have received a great deal of research attention owing to their exciting features, such as single material component, huge design flexibility, and endlessly single-mode operation. The modal properties of PCF *e. g.*, effective refractive index of the fundamental guided mode ( $n_{\text{eff}}$ ), group-velocity dispersion [2], birefringence ( $B$ ) [3], mode-effective

area ( $A_{\text{eff}}$ ) [4], and nonlinear parameter ( $\gamma$ ) [5] are eminently tailorable and controllable that distinguishes PCFs from simple conventional fibers. These novel characteristics of PCF offer huge potential for applications in the field of optical communication [6], polarization management [7], high power delivery [8], nonlinear and advanced photonic devices [9]. PCFs are consisted by an array of microscopic air holes along their entire length that makes a low index cladding around the undoped silica core. The two valuable features of PCF are huge design-flexibility in the microstructure cladding and high index-contrast between air and silica. These two attributes support designing innumerable transverse geometry that primarily governs the fiber's light-propagation characteristics. Furthermore, the wavelength-dependent nature of average cladding index directs to design endlessly single-mode fiber. Thus, PCFs have become one of the most exciting platforms for the design of electromagnetic waveguide structure during the past few years [10, 11].

Different types of PCF structures have been studied and reported in literature till date. However, most reported studies of PCFs are based on a hexagonal distribution (triangular-lattice PCF) of holes around the central core [1–6, 12, 13]. In addition, few other structures, such as square-lattice [14], octagonal-lattice [15], decagonal-lattice [16], and honeycomb structure [17] have also been proposed as PCF design. In recent times, PCFs with a circular distribution of air holes have been proposed [18–20] and, indeed, realized with polymer [21]. However, detail theoretical analysis and structural dependence of the modal properties have not been thoroughly addressed in order to explore new features and applications. Therefore, for further enhancement the performance, it is required to investigate the benefits offered by this type of structure as propagating medium. Keeping these in mind, in this article, we present a detail study on this new kind of PCF structure whose cladding consists of a cylindrical distribution of air-holes in the silica background material. The prime objective is to provide a general outlook to PCF designers regarding structural dependence of transmission characteristics for

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# Frequency Dependent Charge Transport and Spin State Switching Characteristics of $\text{Fe}(\text{phen})_2(\text{NCS})_2$ in Polymer

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We report on the bistability in spin states of spin crossover (SCO) compound  $\text{Fe}(\text{phen})_2(\text{NCS})_2$  in polymer (polypyrrole) by frequency (1–100 kHz) and temperature dependent (305–457 K) electrical conductivity measurements. The structure and growth of SCO compounds in conducting polymer are obtained by scanning electron microscopy, X-ray diffraction and optical absorption measurements. The thermal dependence of ac conductivity  $\sigma(\omega)$  shows the clear formation of a hysteresis loop in its cooling and heating cycle due to the difference in conductivity in high spin and low spin state. The size, shape and width of the hysteresis loops are found to be critically dependent on the applied frequency and/or the ratio between SCO and polymer. The ac conductivity is found to exhibit a dispersive behavior following Jonscher's law:  $\sigma(\omega) \propto \omega^n$  below a critical frequency  $\omega_c$ , above which it is found to monotonically decrease with increasing frequency. The thermal dependence of the exponent  $n$  and  $\omega_c$  is also explored. The charge transport phenomena are explained in the framework of hopping of charge carriers. The data reveals that addition of polymer can play an important role to tune the conductivity of SCO compounds and its spin state dependence characteristics which may be quite helpful for fabricating future spin-based devices. Temperature dependent magnetic susceptibility measurement also confirms the spin transition behavior of the SCO/ppy composite samples. These SCO/ppy composite samples can be taken as the reliable nanomaterials fabricated with the concept of future spin based nanoarchitectonics.

**Keywords:** Spin-Crossover, AC Conductivity, Hysteresis, Polymer, Nanoarchitectonics.

## 1. INTRODUCTION

Synthesis and development of functional materials has become a new trend in recent years in the area of nanoscience research. Nanoarchitectonics is the new concept of combining the science of the nanotechnology along with the other science disciplines for creating the nanomaterials or nanosystems or in other words the useful functional materials [1–14]. In recent years, molecular systems and molecular nanomaterials are playing crucial role in developing the field of nanoarchitectonics. Switchable molecular materials have been in the research spotlight for last several decades due to their potential use in many advanced technologies such as memory storage and molecular sensing devices [15–18]. Spin-crossover (SCO) complexes of  $3d^4$ – $3d^7$  transition metal ions are paradigmatic examples of molecular materials showing bi-stability

in magnetic, optical and electrical properties [19]. The low spin state (LS) to high spin state (HS) transition (or vice versa) can be triggered by various external stimuli e.g., temperature, light illumination, pressure, magnetic field, X-ray irradiation or electric field. The changes in their physical properties associated with the spin transition can propagate in a cooperative way [20] which can produce hysteresis phenomena even at room temperature. SCO materials with wide thermal hysteresis at and above room temperature have been useful for the applications in optical displays or magnetic devices [15–16]. Of late, great focus has been made towards the development of electric field induced spin-state switching devices [21–22]. Recently, we have shown the fabrication of 300 nm thick SCO films and spin-state switching under the application of electric field [23]. The advantage of electrical stimuli for changing the states of the crossover materials to others external stimuli is due to its better compatibility in

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# Stability of thin film flowing down the outer surface of a rotating non-uniformly heated vertical cylinder

Anandamoy Mukhopadhyay · Souradip Chattopadhyay · Amlan K. Barua

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**Abstract** We investigated an incompressible viscous liquid film flow over a rotating vertical cylinder of radius  $R$  and of infinite length rotating with a uniform angular velocity  $\Omega$  about its axis. The surface of the vertical cylinder is non-uniformly heated where the temperature varies linearly in the downstream direction. The flow is assumed to be axisymmetric, and the component of the velocity along the azimuthal direction is assumed to be constant. The surface tension of the liquid is assumed to vary linearly with temperature such that as the temperature increases, the surface tension decreases. This gives rise to Marangoni stress over the free surface of the thin film. Using the long-wave approximation method, we derived a free surface evolution equation. For linear stability analysis, we used a normal mode approach and found that the Marangoni

number plays a double role. There exists a critical Marangoni number ( $Mn^*$ ) such that for  $Mn < Mn^*$ , it plays a stabilizing role and for  $Mn > Mn^*$  it plays a destabilizing role. We also found that as the rotation number  $Ro$  increases, the destabilizing zone increases but it decreases with the increment of the radius  $R$  of the cylinder. We further performed a weakly nonlinear analysis of the flow using the method of multiple scales. The study reveals that the Marangoni number  $Mn$ , the radius  $R$  and the rotation number  $Ro$  have substantial effects on different stability zones. The study also reveals that in the supercritical stable (subcritical unstable) zone, the threshold amplitude of the nonlinear disturbance increases (decreases) with the increment of  $Mn$  and  $Ro$  but decreases (increases) with the increment of  $R$ . The nonlinear wave speed in the supercritical stable zone decreases with the increment of  $Mn$  and  $Ro$ , whereas it increases with the increment of  $R$ . We also examined the effect of thermocapillarity and rotation on the profile of the steady travelling wave solutions of the leading order part of the evolution equation.

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**Keywords** Thin films · Rotating vertical cylinder · Instability · Thermocapillarity · Travelling wave solutions

## List of symbols

$R$  Radius of the vertical cylinder  
 $Ro$  Rotation number

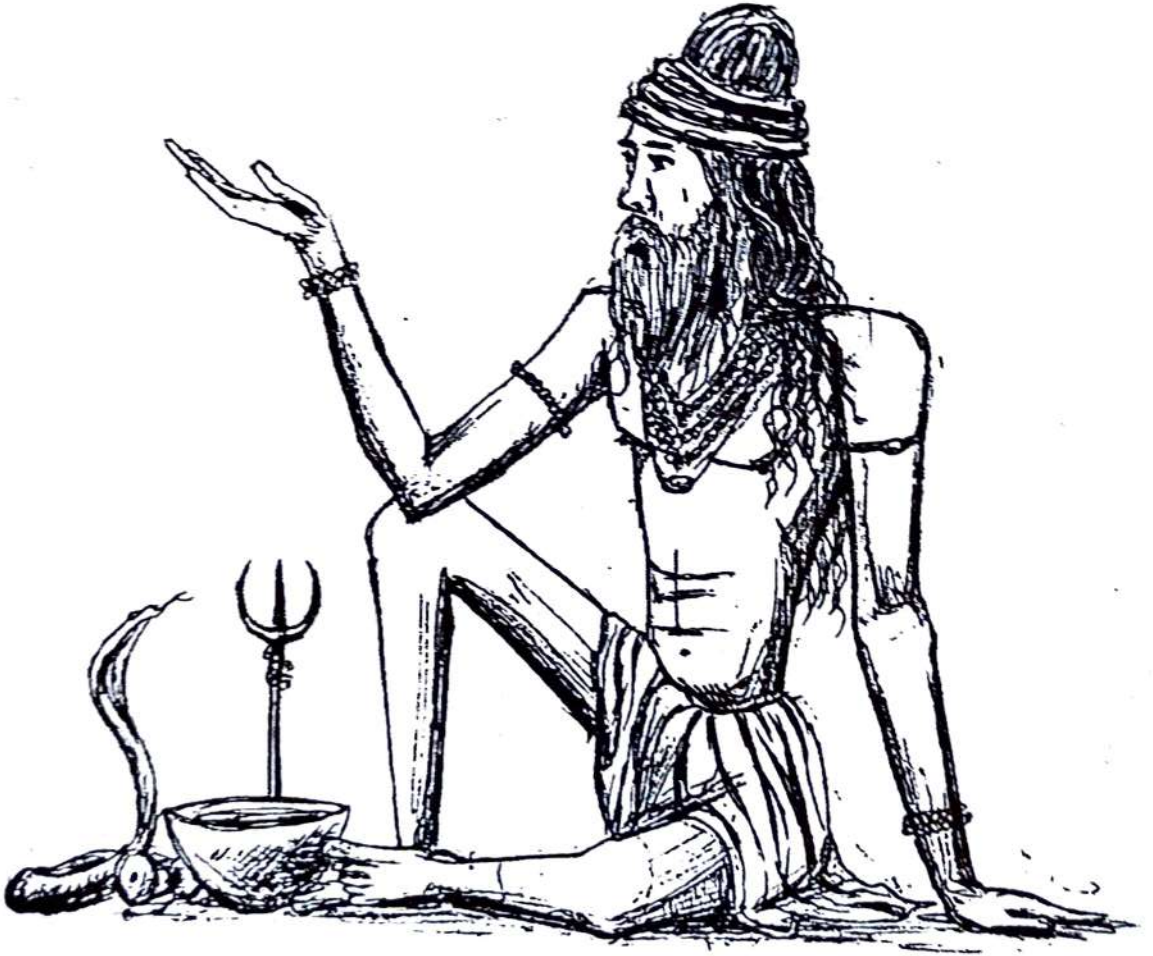
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# আন্তর্মুখ

বাংলা গবেষণা-পত্রিকা

পর্ব-৯, সংখ্যা-৪

ত্রৈমাসিক



বাংলা সাহিত্যে পৌরাণিক চরিত্র : নির্মাণ ও বিনির্মাণ



# আন্তর্গৃহ

বাংলা গবেষণা-পত্রিকা

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# একালের নির্বাচিত মহিলা কবিদের কলমে পৌরাণিক চরিত্রের বিনির্মাণ

শান্তনু সাহা

আধুনিক বাংলা কবিতা বাংলা সাহিত্যের এক গুরুত্বপূর্ণ পর্যায়ে আধিকার করে গলে একদিক শতাব্দীর প্রথম দশক থেকে রচিত কবিতা, বিশেষত যেগুলো মহিলা কবিদের রচনা এক অদৃশ্য মেধাচর্চার দলিল হিসেবে পরিগণিত হতে পারে। তাঁদের রচনা নির্ভর করে কবিদের বেছে নেওয়া বিষয়ের ওপর ও অন্তর্গত দর্শনের ওপর সবচেয়ে এই কবিতাগুলোর ভেতরে একটি অদৃশ্য যোগসূত্র পরিলক্ষিত হয়। যেমন প্রবন্ধকারী কবির বক্তব্য নারীদের এই সমাজ ব্যবস্থায় অবস্থান টিকে তুলে দেবে। নির্বাহিত নারীদের প্রতিফলন প্রকাশিত হয়ে থাকে কবিতার ভিতর। তারা কে অতীতের নারী সত্তার প্রতিভূ হয়ে ওঠে। মল্লিকা সেনগুপ্ত 'নারীর নিজেস্বত্ব' বইতে লিখেছেন: "মেয়েদের কবিতার বেশিটাই ব্রজ গানের মতো: যন্ত্রণার কথা বা কল্পিতদের বা লাস্যের লিরিক। আর এখন, মেয়েদের কবিতার বেশিটাই, গানেরও অংশ শির টানটান করা রাগ।"<sup>১</sup> আলোচ্য প্রবন্ধে যে সময়কালকে ধরার উদ্দেশ্যে করা হয়েছে, একবিংশ শতাব্দীর প্রথমার্ধ, তার ভেতরে এই ধরনের কবির সংখ্যা গুরু। এবং তাঁদের লিখন ভঙ্গিমা যথেষ্ট সাবলীল। তাঁরা তাঁদের কবিতার ভিতর নিজেদের কঠোর তৈরি করতে পেরেছেন। কিছু কবিতা পড়লেই বুঝতে পারা যায় সেই লেখা অমুক কবির। আরও একটি লক্ষণীয় বিষয় হল কবিতাগুলোয় উপস্থিত বিষয় বৈচিত্র্য। আধুনিক বিশ্বে গ্লোবালাইজেশনের ফলে যেমন ভিন্ন দিক ফলে গেল জ্ঞানার্জনে ও চিন্তনচর্চায়, একইরকম ভাবে সাহিত্যের গণ্ডিতে ছাপিয়ে যেতে শুরু করেছে প্রচলিত বিষয় বৈচিত্র্যকে। নারীদের লেখা কবিতাগুলো এক সংস্কৃত চেতনার কথা বলে। যদিও সাহিত্যের আঙ্গিনাকে লিঙ্গভেদে বিভাজিত করে দেওয়া যায় না, তবু বিষয় স্থিত ভিন্নতা আসলে এক অন্য কণ্ঠস্বর: "এতে লিঙ্গ-সাম্প্রদায়িক নেই বরং রয়েছে পুরুষতান্ত্রিক আধিপত্য থেকে মেয়েদের মাথা তুলে দাঁড়ানোর সাংগ্ৰামকে সম্মানিত করার প্রচেষ্টা।"<sup>২</sup> তাই মল্লিকা সেনগুপ্ত, মন্দাক্রান্তা সেন, পৌলোমী সেনগুপ্ত প্রমুখ কবিরা বিশেষভাবে স্বতন্ত্র। তাঁদের কবিতায় বিভিন্ন বিষয়ের ভিতর একটিদিয়ে হল পৌরাণিক বিষয় ও চরিত্রের উপস্থাপন। আলোচ্য প্রবন্ধের ভিতর এই বিশেষ দিকটির বিনির্মািত রূপটিকে তুলে ধরার চেষ্টা করা হয়েছে এবং এই পৌরাণিক চরিত্র ও বিষয়ের উপস্থাপন তাঁদের কবিতার ভিতর একইরকম ভাবে 'পুরুষবাদের প্রাপ্তে এক নতুন মহাকাশ' গড়ার স্বপ্ন দেখায়। এমন একটি

এপ্রিল-জুন, ২০২০

# একালের নির্বাচিত মহিলা কবিদের কলমে পৌরাণিক চরিত্রের বিনির্মাণ ১৯০

ড্রিসকর্সের প্রস্তুতি শুরু হয় যার ভিতর দিয়ে এই পুরুষতান্ত্রিক সমাজ ব্যবস্থায় অস্তিত্ব অর্জনের প্রকল্প শুরু হয়। মল্লিকা ব্যাখ্যা করেছেন এই চেতনার প্রয়োজনীয়তা—

"আমার মনে হয় এই রাগের মধ্য দিয়ে যাওয়া দরকার আমাদের, যদি আমরা দূরত্ব থেকে দেখার চেষ্টা করি, অবজেক্টিভিটি আনতে চাই, নিজেদের বাস্তব অবস্থার সঙ্গেই বিশ্বাসঘাতকতা হবে, যা ভার্জিনিয়া উলফ করেছিলেন, যাতে আমাদের কথা জেনে আসনে বা সেন্সাপিয়ারের মতো শোনাবে।"<sup>৩</sup>

তাই অবশ্যজ্ঞাবী ভাবেই, প্রায় প্রত্যেক কবি পুরাণ চরিত্রগুলিকে ছুঁয়ে গেছেন, অভিনয় করে গেছেন এবং ওই চরিত্রদের তাঁদের লেখার ভিতর আস্থান করেছেন যেন তাঁদের মাধ্যমে নিজেরা নিজেদের বর্তমান অবস্থাকে বিশ্লেষণ করতে পারে। অসাম্যের ব্যবস্থায় সাম্য আনার চেষ্টা করা যেতে পারে।

বাংলা সাহিত্যে পুরাণের ব্যবহার অথবা পুরাণধর্মী রচনা কেই সাহিত্যের রূপ দেওয়া সাহিত্যের এক বিশেষ অঙ্গ। পুরাণ কোনো বিচ্ছিন্ন আলোচনা নয়, বরং বাংলা সাহিত্যের ভিতর তার উপস্থিতি প্রয়োজনীয় বা সমান্তরাল টেক্সট হিসেবে পৌরাণিক চরিত্র বা গল্প সাহিত্যস্থিত সাধারণ চরিত্র বা গল্পগুলোর অনেক সমর্থন পরিপূরক। তাই মঙ্গলকাব্যের ভিতর চণ্ডী বা মনসা বা শিব শুধুমাত্র দেবী বা দেবতা হিসেবে নয়, বরং মানবিক দৃষ্টিকোণ থেকে, দোষ-গুণ সমন্বিত মানুষ চরিত্রের সমান্তরালে তাঁদের উপস্থিতি লক্ষ করা যায়। ভারতবর্ষের বহুটা বিস্তৃত ও বহু চর্চিত পৌরাণিক পরিমণ্ডল এক বৃহৎ উৎস হিসেবে পরিগণিত হয় বাংলা সাহিত্যের ক্ষেত্রে।

সৃষ্টির পরে মানুষ তার মেধা ও মনন দিয়ে গড়েছে এই মানব সংস্কৃতি। এই পরিক্রমা বহু দিনের ও সযত্নালিত। এই সংস্কৃতির অন্তর্গত এই পুরাণ। এই সম্পর্ক সুদীর্ঘ যা ছিন্ন করার কোনো অবকাশ নেই। সেই প্রাচীন কাল থেকে কল্পনার ডানায় ভর দিয়ে বাস্তবতায় এসে বসাই হল পুরাণের কাজ। পুরাণ এক কথায় সৃষ্টির গল্প। সুধীরচন্দ্র সরকার তার অভিধানে পুরাণের ব্যাখ্যা দিয়েছেন—

"যে গ্রন্থে স্বাভাব, জন্ম, দেবতা, অসুর, গন্ধর্ব, যক্ষ, মনুষ্যাদির বৃজ্ঞাত্ত এবং সৃষ্টি, বিবরণ, ব্রহ্মানুসন্ধান, ব্রহ্মের সাকার ও নিরাকার বর্ণন অন্তর্ভুক্ত নির্ণয়, জ্যোতির্বিজ্ঞান, পূর্বতন রাজন্যবর্গের বংশাবলী প্রভৃতি নানা বিষয়ে সর্বিশেষ লিখিত আছে, এবং যদ্বারা ভূত, ভবিষ্যৎ ও বর্তমান অবস্থার পরিজ্ঞান, জ্ঞানের নির্মলতা ও বুদ্ধির প্রার্থ্য জন্মে, তার নাম পুরাণ।"<sup>৪</sup>

ভারতবর্ষের ইতিহাসে ধর্মের ওপর ভিত্তি করে পুরাণ চরিত্র নির্মিত হয়েছে। প্রাচীন রামায়ণ, মহাভারতের সময়কাল থেকেই হিন্দু, বৌদ্ধ, জৈন ইত্যাদি ধর্মের অনুপ্রেরণায় রচিত হয়েছে যে সমস্ত আখ্যান তাঁদের বর্তমান বিশ্লেষণে সেই সময়কাল

অন্তর্ভুক্ত: পর্ব ৯, সংখ্যা ৪

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## Retrieving the Ethnic World of the Adis: An Ecocritical Reading of Mamang Dai's *The Legends of Pensam*

Santosh Kumar Malik

### Abstract

Northeast India is the home to different ethnic groups with a variety of cultures, languages, religions and is regarded as the melting pot of diverse races, castes, and cultures. It is one of the most under-represented regions of India. The troubled political atmosphere, the scenic landscape, and the confluence of various ethnic groups in the region perhaps have given rise to a body of literary writings that is entirely different from the rest of India. Like the region itself, literature in English from the Northeastern part of India has also been stereotyped. But if we make a critical study at the literary writings of this region, we will find that most of the authors such as Mamang Dai, Temsula Aao, Aruni Kashyap, Easterine Kire are consciously incorporating the geopolitical and environmental issues like the ecological degradation of the region, the exploitation of resources, radical climate change of the land, deforestation, encroachment, poaching, etc. in their writings. For instance, Mamang Dai's *The Legends of Pensam* is a novel that has a strong ecological concern. History, myth, tradition, memory, and fiction merge together in this novel, which showcases the unique ecology of Arunachal Pradesh. The clash between tradition and modernity and the degeneration of traditional values during the colonial period as well as the ecological degradation of the land can well be studied from an ecological viewpoint. The novel advocates the restoration of the age-old bond between man and the nature as a way of retaining the identity of the tribal communities in the contemporary world of globalization and modernization.

**Keywords:** Literature in English from Northeast India, tribal community, ethnic groups, environmental degradation, ecology, environment, ecocriticism.

The Northeast region of India is often viewed by most of the Indians as a conflict-ridden zone with problems related to identity, violence, ethnic strife, infiltrations, militancy, and so on. This stereotyped view of the region is also reflected in the literature in English from Northeast India. However, these issues are not the ultimate defining themes of the writings from this region. The rich cultural heritage of various ethnic groups, the beautiful natural landscape, and the troubled political atmosphere of the region have collectively contributed

# Identification of Water Resource Potential Zones of Karu River Basin Using Remote Sensing and GIS techniques in Purulia District, West Bengal [India]

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**Abstract** - Remote Sensing and GIS tools have broadly help hydrologists to delineate the water resource potential zones for watershed development and management. Water is a valuable natural resource in our daily life. It is used as domestic as well as agricultural purposes. It's amount varies from season to season. It is plenty during rainy season but in dry season, it is scarce. Assessment of the potential zones of water resource is extremely important for the protection of water quality and the management of surface/ground water systems. Water resource potential zones are demarcated with the help of Remote Sensing and geographical Information System (GIS) techniques. In this study, standard methodology is used to determine potential of water resource using integration of RS & GIS techniques. Different parameters that can be considered for identifying water resource potential zones such as slope, drainage frequency, drainage density, geology, groundwater level, soil, surface water bodies and land use/land cover are generated using satellite data and survey of India (SoI) toposheets of scale 1:50000. Suitable ranks are assigned of each category of these parameters. Different thematic map of each parameter is prepared using ordered weighted averaging technique in Qgis. Finally composite map is prepared by assigning all parameters to identify water resource potential zone. These are classified into five categories like very poor, poor, moderate, good and excellent. This suggested methodology has been applied for achieve the goal of the selected study area in Purulia district, West Bengal. Water resource potential zones will be useful for identification of suitable location for agriculture and domestic use of surface and underground water.



**Keyword** - River basin, RS & GIS, Overlay analysis, Thematic, Potential zones, Water resource

## I. INTRODUCTION

Water resource both ground and surface are useful to human in agriculture, industrial, household, recreational and environmental activities. Main source of water on the earth's surface is precipitation. After precipitation rain water is drained out through surface run-off in the drainage basin. All part of the earth's surface is under any drainage basin. Some portion of rain water is stored as underground water. It depends on voids within geological stratum and bearing formation of the earth's crust which act as conduits for transmission and as reservoirs for storing water. Some portion of water is stagnant on the earth's surface. Surface water bodies like streams, ponds etc., can act as recharge zones [1].

Over the years the growing importance of water based on an increasing population and unscientific exploitation of water is creating a water stress condition. In present scenario, rainfall is gradually decreasing, uncertain and uneven spatially. This alarming situation is cost and time effective technique for proper evaluation of water resources and management planning. Identification of various parameters is important for generating a water resource model of a study area. Karu river basin is a tributary river basin of Subarnarekha river which is originated in the Ajodhya hill of Purulia district. The term basin, catchment and watershed etc. are widely used to denote hydrological units [2]. Watershed is a natural hydrological entity that covers a specific areal space on the earth's surface from which the rainfall run-off flows through drain, channel, gully and stream or river at any particular



**Waves and instabilities of viscoelastic fluid film flowing down an inclined wavy bottom**Sanghasri Mukhopadhyay <sup>1,\*</sup> and Asim Mukhopadhyay <sup>2</sup><sup>1</sup>*Laboratoire LOCIE, Université Savoie Mont Blanc, Chambéry 73000, France*<sup>2</sup>*Vivekananda Mahavidyalaya, Burdwan 713103, West Bengal, India*

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Evolution of waves and hydrodynamic instabilities of a thin viscoelastic fluid film flowing down an inclined wavy bottom of moderate steepness have been analyzed analytically and numerically. The classical long-wave expansion method has been used to formulate a nonlinear evolution equation for the development of the free surface. A normal-mode approach has been adopted to discuss the linear stability analysis from the viewpoint of the spatial and temporal study. The method of multiple scales is used to derive a Ginzburg-Landau-type nonlinear equation for studying the weakly nonlinear stability solutions. Two significant wave families, *viz.*,  $\gamma_1$  and  $\gamma_2$ , are found and discussed in detail along with the traveling wave solution of the evolution system. A time-dependent numerical study is performed with Scikit-FDif. The entire investigation is conducted primarily for a general periodic bottom, and the detailed results of a particular case study of sinusoidal topography are then discussed. The case study reveals that the bottom steepness  $\zeta$  plays a dual role in the linear regime. Increasing  $\zeta$  has a stabilizing effect in the uphill region, and the opposite occurs in the downhill region. While the viscoelastic parameter  $\Gamma$  has a destabilizing effect throughout the domain in both the linear and the nonlinear regime. Both supercritical and subcritical solutions are possible through a weakly nonlinear analysis. It is interesting to note that the unconditional zone decreases and the explosive zone increases in the downhill region rather than the uphill region for a fixed  $\Gamma$  and  $\zeta$ . The same phenomena occur in a particular region if we increase  $\Gamma$  and keep  $\zeta$  fixed. The traveling wave solution reveals the fact that to get the  $\gamma_1$  family of waves we need to increase the Reynolds number a bit more than the value at which the  $\gamma_2$  family of waves is found. The spatiotemporal evolution of the nonlinear surface equation indicates that different kinds of finite-amplitude permanent waves exist.

DOI: [10.1103/PhysRevE.102.023117](https://doi.org/10.1103/PhysRevE.102.023117)**I. INTRODUCTION**

Investigations of thin liquid films are one of the most important hydrodynamic problems, as they are ubiquitous in nature and technology; this has attracted much attention from a number of researchers over the last six decades. A simple and obvious example is the flow of rainwater down a windowpane under the action of gravity. It has extensive use in various industrial and technological applications such as evaporators, condensers, heat exchangers [1,2], canisters for nuclear waste disposal, nuclear reactor cooling systems, material processing, food and chemical industries, biomedical engineering, and geothermal reservoirs. A typical thin-film flow consists of an expanse of a liquid partially bounded by solid substrates with an interface where the liquid is exposed to another fluid, usually gas and most often air in applications. The solid substrates may be planar or undulated. It is well known that the waves on the surface of a thin film enhance the transport of heat mass and momentum across the liquid-gas and liquid-solid interface. In some applications, the presence of surface waves may be a desirable feature, as in the case of cooling films, where they enhance heat and mass transfer [3,4]. On the other hand, it is undesirable in the coating films

to increase the glossy texture of the finished product [5]. So to model improved devices, it is desirable to know details about the film flow and its finite-amplitude behavior.

Wave evolution on falling liquid film has been extensively studied over the last few decades, starting from the pioneering work by Kapitza [6] and Kapitza and Kapitza [7], in which a vast variety of wavy regimes, like a rolling wave with a capillary hill and a series of nearly solitary waves or almost-harmonic waves of falling liquid films, was observed. In this situation, we need to understand the stability and its criteria for falling films. In 1957 Benjamin [8] and in 1963 Yih [9] were reportedly the first to investigate theoretically the long-wave instability of falling film over an inclined plane. They determined the phase velocity of the waves and critical Reynolds number for the transition, respectively. In 1966 Benney [10] derived a wave evolution equation governing the flow by regular perturbation technique in terms of flow depth, by expanding the variables in powers of the long-wave parameter. Extensive reviews of the literature for the film flow over flat inclined or vertical substrates with various effects are reported by Fulford [11], Hanratty [12], Chang and Demekhin [12], Lin and Wang [13], and Chang [14].

The corresponding problem of falling film for non-Newtonian fluid has also been studied extensively, since the simple model of considering the linear law of viscous fluids is not a reasonable approximation to the real physical

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# Hydrodynamics and instabilities of falling liquid film over a non-uniformly heated inclined wavy bottom

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# Hydrodynamics and instabilities of falling liquid film over a non-uniformly heated inclined wavy bottom

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## ABSTRACT

Hydrodynamics and instabilities of a thin viscous liquid film flowing down an undulated inclined plate with linear temperature variation have been investigated. Using the long-wave expansion method, a non-linear evolution equation for the development of the free surface is derived under the assumption that the bottom undulations are of moderate steepness. A normal mode approach has been considered to take into account the linear stability of the film to investigate both the spatial and temporal instabilities, while the method of multiple scales is used to obtain the Ginzburg–Landau-type worldly equation for studying the weakly non-linear stability solutions. The numerical study has been carried out in python with a newly developed library Scikit–FDif. The entire investigation is done for a general bottom profile followed by a case study with a sinusoidal topography. The case study reveals that the Marangoni effect destabilizes the film flow throughout the domain, whereas the bottom steepness  $\zeta$  gives a dual effect for the linear stability. In the “uphill” portion, an increase in  $\zeta$  stabilizes the flow, and in the “downhill” portion, an increase in  $\zeta$  gives a destabilizing effect. Furthermore, a weakly non-linear study shows that both supercritical and subcritical solutions are possible for the system. It is noted that the unconditional stable region decreases and all the other region increases in the “downhill” portion in comparison with the “uphill” portion for a fixed set of parameters. The stability analysis of a truncated bimodal system is investigated. The spatial uniform solution of the complex Ginzburg–Landau equation for sideband disturbances has also been discussed. Numerical simulation indicates that a different kind of finite-amplitude permanent wave exists. The amplitudes and the phase speeds of the wave are dependent on thermocapillary as well as the bottom steepness.

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## I. INTRODUCTION

The primary aspiration for research is to develop technology that makes human life easier and convenient. Application of falling liquid films’ flow over a substrate can be found everywhere in our daily life from nature to the industry. A few common industrial examples are found in coating applications,<sup>1</sup> heat exchangers,<sup>2</sup> evaporators, condensers, absorbers, and rectification columns.<sup>3</sup> Numerous commercial, medical, biological, and natural examples can be found where the gravity-driven film flows over undulated or rough substrates.

In some applications, the presence of surface waves may be a desirable feature as in the case of cooling films, where they enhance

heat and mass transfer.<sup>4,5</sup> On the other hand, it is undesirable in the coating films to increase the glossy texture of the finished product.<sup>6</sup>

The hydrodynamics of thin viscous fluid film has been extensively studied over the past few decades starting from the pioneering work by Kapitza and Kapitza and Kapitza.<sup>7,8</sup> They reported a vast variety of wavy regimes, such as a rolling wave with a capillary hill, and a series of nearly solitary waves or almost harmonic waves of falling liquid films. In this situation, we need to understand the stability and its criteria for falling films. In 1957, Benjamin<sup>9</sup> and, in 1963, Yih<sup>10</sup> were reportedly the first to investigate theoretically the long-wave instability of the falling film over an inclined plane. An extensive review of the literature for the film flow over flat inclined/vertical substrates with various effects can be found in

# New records and new taxa of genus *Xanthidium* Ehrenberg (Desmidiaceae, Desmidiales, Conjugatophyceae) from India

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## Abstract

The present communication deals with four taxa of *Xanthidium* Ehrenberg. Two taxa viz. *Xanthidium aculeatum* Ehrenberg and *X. antilopaeum* (Bréb) Kützing f. *javanicum* Nordstedt are new records from India while another two viz. *X. turneri* sp. nov. and *X. freemanii* West and West var. *minor* var. nov. are proposed as new to science.

**Key words:** *Xanthidium*; new records; *X. turneri* sp. nov.; *X. freemanii* West and West var. *minor* var. nov.

## Introduction

Several works have appeared on Indian desmids in recent times apart from the classical work of Turner (1892) when the taxa of *Xanthidium* have been described. Among the recent workers the name may be mentioned of Bharati (1963, 1965, 1966), Suxena and Venkateswarlu (1970), Bharati and Pai (1972), Freitas and Kamat (1979), Pandey and Pandey (1980), Hegde and Bharati (1980, 1983, 1984), Gurudeva *et al.* (1983), Hegde (1986, 1987, 1988), Hegde and Isaacs (1989), Habib *et al.* (1990), Mukherjee and Srivastava (1993).

During the systematic investigation on the desmid flora of Bankura and Purulia districts of West Bengal, and recent field survey on Burdwan district (MRP) the authors have recorded several taxa of *Xanthidium*. In the present communication besides recording two for the first time from

India, two new taxa have also been proposed.

## Materials and methods

Specimens were collected from different aquatic habitats of Bankura, Burdwan and Purulia districts of West Bengal. Specimens were preserved in 4% formalin; pH, temperature and ecological notes were recorded simultaneously. Camera Lucida drawing and photomicrography (Leica DM 1000) were made using GWF (Bando, 1988) as mountant from both preserved and live specimens.

## Results and discussion

### *X. aculeatum* Ehrenberg

Prescott *et al.*, 1982, p. 45, pl. 311, fig. 1; Dillard 1991, p. 171, pl. 52, fig. 3.

Plate 1, Fig. 3; Plate 2, fig. 7

Cell as broad as long excluding spines; semi cells elliptic, reniform, apex

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# The Impact of Buddhist Philosophy in Sanskrit Literature

Satyaprasad Mishra

## Abstract

Sanskrit is a language always kept in high esteem and used mostly for religious and scientific discourses in Hinduism, Buddhism and Jainism. The philosophical thoughts of those religions were written in Sanskrit language and Pali language. The most of treatises of Hinduism were written in Sanskrit language. We know, The Buddhist Philosophy Tripitaka literature were written in Pali Language, with some in Sanskrit as well as other local Asian languages. Basically, the Philosophers of Buddhism gave more stress to teach their thoughts in Pali language. After Buddhist era, We found the impact of Buddhist philosophy in Sanskrit epics. Both Buddhist literature and Sanskrit literature are very rich and large. I could not examine the each and every word of both literatures. I just try to present some instance where the poets were influenced in Buddhist literature. In this work, I just take only 'Jatakamala' of Buddhist literature and try to find the similarities with popular epics of Sanskrit literature.

## Keywords

Buddhism, Jainism, Pali, Sanskrit, Tripitaka, Jatakamala, Sanskrit epics.

## Introduction

The Literature is the medium of communication between the thinker and reader. A philosopher can spread his thoughts easily in this society through the epics, poems and dramas of any languages. A grammarian can easily express the uses of grammar rules through the epics like 'Bhatti Mahākāvya'. The wiseman can spread the use full thoughts for the art of living through the epics like 'Māhābhārat'. So, literature is not only the way of sharing the views and thoughts in our country but also in the whole world.

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There are so many epics, poems and dramas were written in Sanskrit language. The views of Aryan peoples were written in *Vedas*, *Brahmans*, *Aranyakas* and *Upanishads*. After the Vedic age, the views and philosophical thoughts of Lord Buddha's were written in Tripitaka, Agamas, Sutras, Stotras, Shastras, Tantras and Jatakas etc. We see, the most of Sanskrit poets were influenced in Buddhist Philosophy.

## The Philosophy of Buddhism

Lord Buddha tried to teach the truths of life in simple way. In Buddhist literature, we see the stories deals on philosophical thoughts and views of Lord Buddha on Enlightenment, Peace, Free of Suffering, Meditation and Nirvana. The authors of Buddhism have composed treatise and literary works in Sanskrit and Pali languages dealing with Buddhist Philosophy, logic etc. Arya Sura written 'Jatakamāla' where 34 Jatakas stories are found. The *Jatakamala* is a Buddhist Literature one of those where the previous births of Gautama Buddha in both human and animal form.

श्रीमन्ति सद्गुणपरिग्रहमङ्गलानि कीर्त्यास्पदान्यनवगीतमनोहाराणि ।

पूर्वप्रजन्मसु मुनेश्वरीताङ्गतानी भक्त्या स्वकाव्यकुसुमाञ्जलिना रचयिष्ये ॥(Jatakamala / 1)

## The impact of Buddhist philosophy in Sanskrit literature

Sanskrit is a classical Indian language. The name Sanskrit means sacred. Sanskrit was not thought of as a specific language but as a refined or perfect sacred tongue. It is a language always kept in high esteem and used mostly for religious and scientific discourses in Hinduism, Buddhism and Jainism. The Sanskrit language is supposed to have



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**TALES AND SOCIETY:  
IN THE CONTEXT OF SANSKRIT LITERATURE.**

Dr Satyaprasad Mishra

**Abstract :**

The tales and stories reflect the culture of a society. The knowledge of morality is developed through the listening of tales and stories of human beings. We never say that we did not listen any tales and stories from our family which are useful for developing our moral sense. The interest of tale listening is generated naturally in human mind. There are so many tales and stories were written in Sanskrit language. Some of those are taught in schools and colleges. Those stories and tales reflect the culture and history of our society, civilization and community. So, There is a good impact of tales and stories in our society. I could not analyze the whole Sanskrit fable literature which were written from Vedic age to 19<sup>th</sup> century. So, I have analyzed few tales and present some aspects of tales which are related directly with our society.

**Keywords:**

*Āgveda, Brāhmana, Aranyaka, Upanishad, Rāmāyan, Mahābhārat, Purānas, Akhyān, Upakhyān, Avadāna, Jātakmālā, Brhatkathā, Brhatkathāmanjari, Kathāsaritsāgar, Pancatantra, Hitopadesha, Simhāsandwatrīnshikā, Vetālpāncbīmshati, Purushaparīksha, Sukasaptati, Prabandhakosha, Prabandhacintamani, Kathākoutuka, & Bhojaprabandha, & Society.*



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## REVIEW PAPER

## Colorimetric Sensors of Hg<sup>2+</sup> Ion Based on Functionalized Gold and Silver Nanoparticles

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### ABSTRACT

Monitoring the levels of toxic Hg<sup>2+</sup> metal ions in an aquatic environment is an important issue because this ion can have an adverse effect on human health and the environment. Therefore, the detection of Hg<sup>2+</sup> ions in water is a very important issue for improving human health and water quality. Metallic nanoparticles such as gold and silver nanoparticles (AuNPs & AgNPs) have received much attention due to their colorimetric properties as well as localized surface plasmon resonance (LSPR) properties. AuNPs and AgNPs can easily change their color (AuNPs: Red to Pink/Blue; AgNPs: Yellow to blue) which is easily discriminated by visual inspection. Functionalization of AuNPs and AgNPs offers an excellent application in many scientific worlds as the choice of ligands/functionalizing groups is of utmost importance for their colloidal stability and function of the nanoparticles. In this review, we have discussed the colorimetric sensors of gold and silver nanoparticles based on the functionalization of organic ligands, polymers, amino acids, and proteins for the detection of Hg<sup>2+</sup> ions in an aqueous medium.

**Keywords:** Colorimetric Sensor, Gold nanoparticles, Silver nanoparticles, Toxic metal ion, Hg<sup>2+</sup>

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## INTRODUCTION AND BACKGROUND

Heavy or toxic metal ions are mainly contaminated to the environment due to their broad-spectrum application in industry as well as agriculture. Among the several heavy metal ions mercury, cadmium and lead are the most toxic to the human body as well as animals. Other than these three, the human body is also affected by many metal ions including arsenic, chromium, manganese, copper, zinc, etc. even at the minute level of exposure of these metal ions are responsible to cause several diseases to the human body. The list of some toxic metal ions and their biological effects on humans and animals is listed in Table 1.

Among them, mercury is a very well-known

toxic metal which is a culprit for several threats to human health and the environment [1]. Mercury contaminates into air, soil, and water due to the production of different sources such as gold production, coal plants, thermometers, barometers, caustic soda, and mercury lamps [2]. Mercury converts itself to methyl mercury and is ready to penetrate itself into the human body through the food chain which may damage the various organs [3-5]. Accumulation of mercury to the human body leads to various cognitive and motor disorders, including Minamata disease [4,6]. Therefore, monitoring of mercury metal ions in water (drinking, sea, lake, etc.) is very essential in terms of improving human health and water quality [7]. Several methods are used for the detection of

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# Synthesis, structural characterization, and studies of magnetic and dielectric properties of Gd<sup>3+</sup> doped cerium oxide (Ce<sub>0.90</sub>Gd<sub>0.10</sub>O<sub>2-δ</sub>)



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## ABSTRACT

To improve and modify the magneto-dielectric properties of cerium oxide, fractional incorporation of Gd<sup>3+</sup> ions in place of Ce<sup>4+</sup> in the pristine lattice was considered. Samples of Gd<sup>3+</sup> substituted CeO<sub>2</sub> (i.e., Ce<sub>0.90</sub>Gd<sub>0.10</sub>O<sub>2-δ</sub>, CGO) were synthesized by the solid state reaction method where the starting materials of CeO<sub>2</sub> and Gd<sub>2</sub>O<sub>3</sub> were heat treated at 800 °C for 10 h. X-ray diffractograms were recorded and analyzed by the Rietveld refinement method to confirm the formation of cubic structure as well as the proper and partial replacement of host cations of Ce<sup>4+</sup> by strong magnetic impurity of Gd<sup>3+</sup> ions. Transmission electron microscopy study of doped sample of Ce<sub>0.90</sub>Gd<sub>0.10</sub>O<sub>2-δ</sub> was carried to yield some important morphological behavior. The static magnetic measurements were performed by superconducting quantum interference device magnetometer. Interestingly nonlinearity due to onset of magnetic ordering was introduced which was clearly found in recorded magnetization (M) vs. field (H) curve below ~ 50 K. Analysis of magnetic behavior suggests the initiation of paramagnetic to ferromagnetic phase transition at low temperatures (below ~ 50 K). Hysteresis loops observed below ~ 50 K also suggest the onset of magnetic ordering in the doped sample, but saturation magnetization was not found owing to the fact that most of the host cations are in paramagnetic phase. The M–T curve is well fitted below ~ 50 K by a combined equation generated from 3D spin wave model and the Curie–Weiss law indicates the coexistence of paramagnetic (PM) and ferromagnetic (FM) phases in the sample. The onset of ferromagnetism in Ce<sub>0.90</sub>Gd<sub>0.10</sub>O<sub>2-δ</sub> was explained by oxygen vacancy mediated F-center exchange (FCE) coupling mechanism. Dielectric constant and ac conductivity increases with increase of temperature and frequency. The improved version of magnetic and electric properties of doped cerium oxide may be a potential candidate for dilute magnetic dielectric for applications in charge storage and sensor devices.

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## 1. Introduction

The introduction of magnetic ordering in insulating oxides have drawn enormous research interest due to their proposed use in future spintronic device [1–3]. They are phrased as Diluted Magnetic Dielectric (DMD) and expected to be served as a spin filter in future [4,5]. In this direction, few researches on transition metal (TM) doped rare earth oxides have been carried out [6–8]. The link between ferromagnetism and structural defect, especially oxygen vacancy was the main focus of these studies. The structural defects are

also leading to very interesting light emission, magnetic, catalytic, dielectric properties. We have chosen CeO<sub>2</sub> as a host instead of other rare earth oxides due to its enormous applications in solid oxide fuel cells (SOFCs), luminescence materials, gas sensors, catalysis etc. [9,10]. The abundance of Cerium is higher compared to all rare earth ions even more than Cu [11]. Moreover, CeO<sub>2</sub> has a cubic structure with lattice parameter close to that of Si, therefore CeO<sub>2</sub> devices might be integrated with conventional silicon-based electronic circuit [12]. So far, most of the oxide based diluted magnetic system have non cubic crystal structure. The introduction of magnetic ordering within the cubic CeO<sub>2</sub> may facilitate the current spintronic research and defect engineering in materials. In comparison with TMs, 4f rare earth (RE) ions are a better substitute due to larger magnetic moments and excellent optical and dielectric properties.

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# *Studies of magnetic behavior of chemically synthesized interacting superparamagnetic copper ferrite nanoparticles*

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# Studies of magnetic behavior of chemically synthesized interacting superparamagnetic copper ferrite nanoparticles

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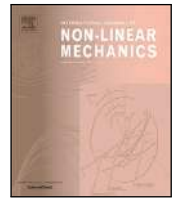
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## ABSTRACT

The magnetic property of nanocrystalline copper ferrite ( $\text{CuFe}_2\text{O}_4$ , CF) with narrow size distribution synthesized by co-precipitation technique is investigated. The occupancy of cations among the tetrahedral and octahedral sites is determined from the Rietveld analysis of the X-ray diffraction (XRD) pattern. Microstructural, optical, and magnetic properties of the ferrite nanoparticles (NPs) are analyzed in detail using high-resolution transmission electron microscopy (HRTEM), UV–Vis absorption spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, Raman spectroscopy, and superconducting quantum interference device (SQUID) magnetometer. The blue shift in optical band gap compared to bulk one is observed due to the smaller particle size. The particle size distribution inferred by mathematical analysis from the variation of difference between field cooled (FC) and zero field cooled (ZFC) magnetization with temperature supports the HRTEM observation. M–T curve initially proposes the presence of superparamagnetic (SPM) NPs with non-interacting core and interacting surface spin. Therefore magnetic behavior of the sample is explained by core–shell model. This fact is substantiated from the good fitting of M–H curves at different temperatures using a combined equation generated from ‘Law of approach’ to saturation magnetization and Langevin function. With the lowering of temperature magnetic blocking and random spin freezing process occurs. The ratio of  $M_R/M_S$  (remanent/saturation magnetization) less than 0.5 for all temperatures implies the presence of uniaxial anisotropy of the single-domain NPs. The unsaturated nature of the M–H curves may be due to the combined contribution from SPM core and spin canting in the mixed spinel  $\text{CuFe}_2\text{O}_4$ .

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# Thermocapillary instability on a film falling down a non-uniformly heated slippery incline

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## ABSTRACT

A gravity-driven, thin, incompressible liquid film flow on a non-uniformly heated, slippery inclined plane is considered within the framework of the long-wave approximation method. A mathematical model incorporating variation in surface tension with temperature has been formulated by coupling the Navier–Stokes equation, governing the flow, with the equation of energy. For the slippery substrate, the Navier slip boundary condition is used at the solid–liquid interface. An evolution equation is formed in terms of the free surface, which includes the effects of inertia, thermocapillary as well as slip length. Using the normal mode approach, linear stability analysis is carried out and a critical Reynolds number is obtained, which reflects its dependence on the Marangoni number  $Mn$  as well as slip length  $\delta$ . This depicts that  $\delta$  and  $Mn$  both have the destabilization effect on the flow field. The linear study also reveals that the inertia force has a negligible effect compare to the thermocapillary or slip. In addition, the study highlights a critical Marangoni number at which the instability sets in when the thermocapillary stress attains a critical value. The method of multiple scales is used to investigate the weakly nonlinear stability analysis of the flow. The study interprets that the variation of  $Mn$  and  $\delta$  have substantial effects on different stable/unstable zones. It also shows that within a considered parametric domain, the unconditional stable zone completely vanishes for any value of  $Mn$ , when the slip length  $\delta$  attains a critical value. The study also divulges that in the subcritical unstable (supercritical stable) zone the threshold amplitude ( $\zeta a$ ) decreases (increases) with the increment of  $Mn$  and  $\delta$ . Further, we discussed the spatial uniform solution of the complex Ginzburg–Landau equation for sideband disturbances. Employing the Crank–Nicolson method, the nonlinear evolution equation of the free surface is solved numerically in a periodic domain, considering the sinusoidal initial perturbation of small amplitude. The nonlinear simulations are found to be in good agreement with the linear and weakly nonlinear stability analysis. The evolution of the maximum ( $h_{\max}$ ) and minimum ( $h_{\min}$ ) thickness amplifies, for small change of  $Mn$  and  $\delta$ . Further, it shows that the influence of the thermocapillary force amplifies the destabilizing nature of  $\delta$ . The traveling wave solution confirms the existence of a fixed point for the considered parametric domain, chosen from the experimental data. Finally, the Hopf bifurcation of the fixed point exhibits that the nonlinear wave speed at the transcritical point increases as  $\delta$  increases but decreases as  $Mn$  increases. The noteworthy result which arises from the study is that a transcritical Hopf bifurcation exists if the slip length  $\delta > \max\left\{\left(\frac{1}{6}Mn - \frac{1}{3}\right), \frac{1}{2}\left(\frac{Mn-2}{3-Mn}\right)\right\}$ .

## 1. Introduction

The flow of thin liquid film over uniform/non-uniform heated inclined/vertical plane studied by many researchers [1–15] and is regarded an important problem both from theoretical as well as an experimental point of view. Due to the heated substrate, an instability appears in the flow field, known as Marangoni instability. Since the surface tension of the liquid is a temperature-dependent physical property, so as the heat appears from the heated surface to the interface,

the surface tension decreases for most of the common liquids, and this results in Marangoni instability. A non-dimensional number, known as the Marangoni number is held responsible to create the Marangoni instability.

For a thin film viscous force plays a significant role. For a viscous fluid, at the rigid substrate, the adhesive force that exists between the liquid and solid particles is greater than the cohesive force that exists between the liquid particles. Due to this imbalance of forces, the liquid

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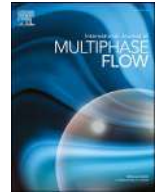
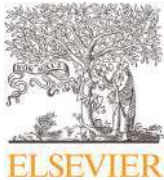
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# Interfacial phase change effect on a viscous falling film having odd viscosity down an inclined plane

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## ABSTRACT

We investigate the phase change effect at the thin film interface with broken time-reversal-symmetry falling down an inclined flat wall. We consider the impact of evaporation and as well as condensation at the fluid-vapor interface separately. The non-zero odd part of the Cauchy stress tensor with the odd viscosity coefficient, which arises due to broken-time-reversal-symmetry, adds an attractive characteristic in the flow by stabilizing the effect of evaporation/condensation. We study the long-wave instabilities of the ununiform film by deriving a non-linear evolution equation in the classical long wave expansion method framework. The one-equation model can track the free surface evolution and accounts for viscosity, gravity, surface tension, and phase change (evaporation/condensation) effects. Linear stability analysis confirms that the odd viscosity has no significant impact on the instability threshold of an evaporating film as a contrast of condensate film, where the critical Reynolds number increases with the odd-viscosity parameter  $\mu$ . While studying the weakly non-linear waves, we use *the method of multiple scales* to obtain the Complex Ginzburg Landau equation that shows both supercritical and subcritical solutions are possible for evaporating and condensate film. Interestingly, while one subcritical region is visible for an evaporating film, two subcritical unstable regions are found for condensate film. The numerical solution of the free-surface equation illustrates the finite-amplitude behavior that tends to dry out for evaporating film and rapidly increase film thickness for condensate film. The presence of odd viscosity slows down both the film thinning process for evaporation and the film thickening process for condensation. Furthermore, odd-viscosity cannot prevent film rupture in case of evaporation.

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## 1. Introduction

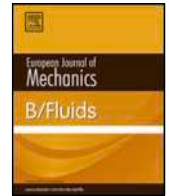
The study of a thin film is a fascinating and evergreen topic of scientific research after its broad application in physical, chemical, and biological industries. While flowing down an inclined plane, a thin layer of the liquid becomes sensitive to surface wave instabilities. If the retentional plate above which the fluid is flowing is heated or cooled, evaporation or condensation may occur at the liquid-vapor interface. In the chemical industry, films play the role of activating medium for heat transfer in drip and tower coolers, scrubbers and rectifying columns, steam boilers, evaporators, and oil-refining equipment. In these machinery types, the thin film is forced to flow through complicated paths throughout the columns. The contact between different phases is mixed up substantially, which increases inter-phasic heat and mass transfer.

Another essential property of a fluid is viscosity, a tensorial quantity, and generally, we associate it with dissipation, which measures its resistance to velocity gradients. When time-reversal symmetry is broken spontaneously or due to rotation or due to some external magnetic field's influence, the viscosity tensor possesses a non-vanishing odd part, giving rise to a dissipation-less linear response coefficient termed as Odd or Hall viscosity Avron (1998); Banerjee et al. (2017). Prior to the above studies, Avron et al. (1995) first unveiled the phenomenon of odd viscosity in the seminal work in 1995. There are many real-world systems where time-reversal symmetry of viscosity tensor is broken, and odd viscosity effects can be observed, for example, in colloidal Maggi et al. (2015), granular Tsai et al. (2005), biological Sumino et al. (2012) systems etc. However, the effect of odd viscosity has not been studied so far deep.

The primary motivation for the present study is to see the effect of odd viscosity in the interfacial phase change in thin-film flow. To the best of our knowledge, no work has been performed before to address this particular topic though this is very important for the

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# Hydrodynamic instability and wave formation of a viscous film flowing down a slippery inclined substrate: Effect of odd-viscosity

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## ABSTRACT

Hydrodynamic instability and formation of waves for thin viscous film flowing down a slippery inclined substrate with broken time-reversal-symmetry have been discussed in this present study. The effect of slip on the substrate is modeled using the Navier slip boundary condition. We have derived a nonlinear evolution model in the framework of the long-wave expansion technique. The one equation model can track the free surface evolution and involve the viscosity, gravity, surface tension, and the effect of the slip of the wall. The odd part of the Cauchy stress tensor with an odd-viscosity coefficient significantly modifies the characteristic of the film flow. We performed the linear stability analysis with the Orr Sommerfeld technique and classical temporal analysis from the model. Comparing the results shows a satisfactory agreement between Orr Sommerfeld and the model when the velocity scale is chosen as twice the free surface velocity. Analyzing the traveling wave solutions and studying different bifurcation analyzes and phase diagrams, we focused on and discussed two significant wave families, namely  $\gamma_1$  (low-wave-speed) and  $\gamma_2$  (high-wave-speed). The spatio-temporal study of the model has been performed numerically for different odd-viscosity and slip parameters. Results show that the odd-viscosity plays a stabilizing role while the slip on the substrate gives a destabilizing effect within the parameter range of our consideration.

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## 1. Introduction

The flow of liquid layers on a solid substrate is a subject of intense interest for several decades. In the film flow over a solid, impervious substrate, solid–liquid interfaces are generally modeled by a no-slip and no-penetration boundary conditions. However, Dussan & Davis [1] showed that if the usual no-slip boundary condition is imposed between the fluid and the solid surface, the motion necessarily implies a singularity of stress at the solid–liquid interface. Two approaches were suggested to remove this singularity that emerged early on, namely (i) the precursor layer model and (ii) the Navier slip condition. In the first approach, modeling a very thin precursor layer using hydrodynamics can be questionable since its thickness is only a few Angstroms. The second approach has received extensive study to remove the stress singularity by modifying the solid–liquid interface boundary condition. In 1832 during the long debate [2] over whether fluid can slide over a solid surface, Navier proposed a slip condition that states that the velocity at the boundary is proportional to the tangential component of the wall stress [3].

In the context of thin liquid film over a solid impermeable inclined plane Benjamin [4], and Yih [5] investigated the problem using no-slip and no-penetration boundary conditions in the solid–liquid interface. They performed linear stability analysis and determined the critical conditions for the onset of instability are rigorously obtained from the solution of the Orr–Sommerfeld equation under the assumption of long-wave perturbations when the Reynolds number is of order unity. In 1966 Benney [6] derived a wave evolution equation governing the flow by regular perturbation technique in terms of flow depth by expanding the variables in powers of the long-wave parameter. An extensive review of the literature for the film flow over flat inclined/vertical substrates with various effects can be found in Fulford [7], Lin & Wang [8], Chang [9], Hanratty [10], Chang & Demekhin [11].

In most of the articles mentioned above and references therein, the no-slip and no-penetration boundary conditions are used in the solid–liquid interface. Later, Pascal [12] considered the linear stability of a film falling on a permeable interface modeled by the Navier slip condition. Such a semi-empirical velocity slip boundary condition was initially proposed by Beavers & Joseph [13]. Under an assumption of small permeability, Pascal analyzed the Orr–Sommerfeld equation in connection with a linear stability analysis to obtain critical conditions for the onset of instability. Saffman [14] provided a theoretical justification of



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# Thermocapillary instability and wave formation on a viscous film flowing down an inclined plane with linear temperature variation: Effect of odd viscosity

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 Sanghasri Mukhopadhyay, and  Asim Mukhopadhyay



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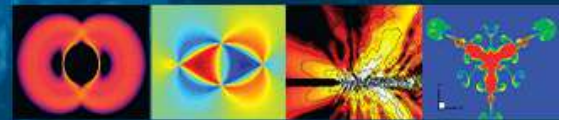


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# Thermocapillary instability and wave formation on a viscous film flowing down an inclined plane with linear temperature variation: Effect of odd viscosity

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## ABSTRACT

Thermocapillary instability and formation of waves for a thin viscous falling film with broken time-reversal-symmetry have been discussed in this present study. The film is flowing over a flat, rigid inclined plate with linear temperature variation. The presence of the odd part of the Cauchy stress tensor with odd viscosity coefficient brings new characteristics in thin film flow. The nonlinear evolution model, which tracks the free surface formation for this problem, has been developed using classical long-wave expansion method. Due to the presence of odd viscosity in the liquid, the evolution equation modified significantly. Both spatial and temporal analysis for linear stability has been performed along with the investigation of weakly nonlinear waves, leading the free-surface equation into the famous Kuramoto–Sivashinsky equation. Periodic stationary wave solutions of the full evolution equation confirm the existence of two significant wave families,  $\gamma_1$  and  $\gamma_2$ , which are discussed in detail. Formation of the dynamical system and study of different bifurcation analysis and phases diagrams are also studied. The spatiotemporal evolution of the model has been analyzed numerically for different values of the odd viscosity parameter and Marangoni number. The odd viscosity gives stabilizing effect while the increase in Marangoni number increases the instability.

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## I. INTRODUCTION

Hydrodynamics is a discipline of science concerned with forces acting on or exerted by fluids. Viscosity customarily measures the resistance of the fluid to velocity gradients. Viscosity is a tensor, and normally we associate viscosity with dissipation. However, in a breakthrough insight, Avron and Elgart<sup>1</sup> demonstrated that, in a classical fluid, when time-reversal symmetry is broken, either spontaneously or due to an external magnetic field or rotation, the viscosity tensor can have a nonvanishing odd part, giving rise to a dissipation-less linear response coefficient termed as odd or Hall viscosity. Realistic odd viscosity effects can be observed frequently, in granular,<sup>2</sup> biological,<sup>3</sup> and colloidal<sup>4</sup> systems, since time-reversal symmetry is broken in such systems. However, the effect of odd viscosity has drawn attention to the researchers only in recent years. In the context of swimming strategies,<sup>5</sup> the efficiency of the swimmer is under the sway of odd viscosity. Hydrodynamics of chiral (asymmetric in such a way that the structure and its mirror image are not superimposable) active fluids was studied by Banerjee *et al.*<sup>6</sup> They showed odd viscosity in chiral active fluids

can lead to a density and pressure excess within vortex cores. In bubble dynamics, the steady state of the bubble explicitly depends on odd viscosity, which is a classical example of a free surface boundary in hydrodynamics in which odd viscosity plays a significant role.<sup>7</sup> Abanov *et al.*<sup>8</sup> studied free surface dynamics of two-dimensional incompressible fluids with odd viscosity. They established that the surface waves are chiral and even exist in the absence of gravity and vanishing shear viscosity. Within the small surface angle approximation, they found that the equation of motion leads to a new class of nonlinear chiral dynamics governed by a complex Burger's equation with imaginary viscosity and an additional analytical requirement that enforces chirality. Kirkins and Andreev<sup>9</sup> investigated the effects of odd viscosity on the thermocapillary instability of a viscous liquid film sitting on a uniformly heated solid substrate by considering a fixed temperature gradient across the free surface. They found that the odd viscosity incipient waves can suppress thermocapillary instability, leading to the stabilization of thin liquid film. In addition, there are experimental observations in the flow of ferrofluids<sup>10</sup> that cannot be



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## Complex Dynamics of an Eco-Epidemic System with Disease in Prey Species

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The objective of this study is to investigate the complex dynamics of an eco-epidemic predator–prey system where disease is transmitted in prey species and predator population is being provided with alternative food. Holling type-II functional response is taken into consideration for interaction of predator and prey species. The half saturation constant for infected prey, the growth rate of susceptible prey and force of infection play a significant role to create complex dynamics in this predator–prey system where alternative food is present. It is seen that healthy disease-free system is possible here. The system shows some important dynamics viz. stable coexistence, Hopf bifurcation, period doubling bifurcation and chaos. The analytical results obtained from the model are justified numerically.

*Keywords:* Eco-epidemiological system; stability; bifurcation; alternative food; chaos.

### 1. Introduction

Researchers rightly have paid great attention to the eco-epidemiological issues recently to study the effect of infection. It has also been the topic of wide interest in the literature. In ecology, parasite plays a major role for various reasons. It has the ability to alter the quantitative dynamics of their host population. It can also create high amplitude oscillations in abundance and may even cause the extinction of host population. Ecosystems with regard to competing species is now the topic of greater interest in the field of bio-mathematical literature. The pioneering work of Anderson and May [1991] on epidemic model describes the dynamics of disease transmission. Subsequently, many researchers

[Huang *et al.*, 2019; Shaikh *et al.*, 2018; Biswas *et al.*, 2018; Mbava *et al.*, 2017] have paid attention to study predator–prey model with infection in predator. Disease in prey is assumed in the models [Chattopadhyay & Arino, 1999; Hethcote *et al.*, 2004; Lu *et al.*, 2019; Meng *et al.*, 2018; Saha & Samanta, 2019; Simon & Rabago, 2018] and disease in both prey and predator is considered in [Kant & Kumar, 2017; Mandal *et al.*, 2018]. In [Guin *et al.*, 2015; Guin & Mandal, 2014; Guin & Baek, 2018; Pal *et al.*, 2014; Pal *et al.*, 2011; Han *et al.*, 2020; Sarwardi *et al.*, 2011a], the authors studied the predator–prey models with and without disease. The widely studied topic in theoretical ecology is the predator–prey interaction. The interaction is

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# Control of Japanese encephalitis by active principles, 3-(2-Hydroxyphenoxy)-1, 2-propanediol isolated from n-hexane extract of leaf of *Mesua ferrea* Linn.

Someshwar Singha<sup>1</sup>

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## Abstract

Japanese encephalitis is a vector borne disease and the best procedure for control of this disease is control of vector population. Now a day use of phyto-chemicals more preferred over use of chemical insecticides. Isolation, purification and determination of chemical structures of bioactive compounds were done successfully from n-hexane extract of leaf of *M. ferrea*. The compounds shows better potentiality to control *Cx. vishnui* 3rd instars larvae. n-hexane extract of leaf of *M. ferrea* was prepared by Soxhlet apparatus and further used for bioassay against 3rd instars larvae of *Cx. vishnui*. n-hexane extract was further fractioned by Thin layer chromatography to isolate bioactive compounds. From different band of TLC, bioactive compounds bearing band was isolated by bioassay test. Structures of active principles were determined by FTIR, gas chromatography, mass spectrometry and with the help of library data list. Cent percent mortality of *Cx. vishnui* larvae was recorded at 45 ppm concentration of n-hexane extract of *M. ferrea* after 72 h of exposure. In isolated bioactive compounds 3-(2-Hydroxyphenoxy)-1, 2-propanediol is one of predominant compound, may be responsible for mortality of *Cx. vishnui* larvae. LC<sub>50</sub> value for *Cx. vishnui* 3rd instars larvae of active compound are 26.76, 25.64 and 20.32 ppm for 24 h, 48 h and 72 h respectively. No mortality were recorded when sub lethal concentration (LC<sub>50</sub>) of 24 h of bioactive compound applied on non-target organisms i.e. *Chironomus circumdatus*, *Daphnia*, *Diplonychus* etc. The compound i.e. 3-(2-Hydroxyphenoxy)-1, 2-propanediol is predominant compound of active principles and its chemical structure is determine which is major component of n-hexane extract of leaf of *M. ferrea*. These bioactive principles are safe for other organisms (non-target) those share the same natural habitat.

**Keywords** Vector control · n-hexane extract · *Mesua ferrea* · *Culex vishnui* · Japanese encephalitis · Active principles

## Introduction

Mosquitoes constitute a major public health hazard having the potential and lethal capacity to kill more than a million victims a year around the world (Vatandoost and Vaziri 2001). Mosquito borne diseases such as malaria, filariasis, dengue, yellow fever and encephalitis are continuing to be major health problems for the.

People (Das and Ansari 2003). Japanese encephalitis caused by the mosquito bearing Japanese encephalitis virus (Mahmud et al. 2010). According to WHO more than 3 billion people of South-East Asia and Western Pacific regions are

under the risk of JE transmission. The symptoms of the JE are quick start of high fever, headache, neck stiffness, coma, seizures, spastic paralysis and death. 30% mortality occurs among affected individual bearing disease symptoms. *Culex vishnui* Theoblad belonging to the *Cx. vishnui* group is the most important vector of JE in India, Srilanka and Thailand (Lindahl et al. 2012).

Different strategies have been taken to reduce the spreading of mosquito-borne diseases in many regions of the world. However, control of such diseases are becoming increasingly difficult because the over production of detoxifying mechanisms of chemical insecticides as well as emergence of pesticide resistance has been reported for *Culex* species (Severini et al. 1993). Biological control of larval mosquitoes by the application of plant products is one of the important techniques which affords a cheap, easy to use and environment friendly method. Search for natural pesticides which do not have any ill effects on the non target organisms and are easily

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# A Geospatial Morphometric Analysis of Kulbera and Daurighara River Basins in Western Part of Purulia District of West Bengal, India



Shambhu Nath Sing Mura

**Abstract:** Morphometric analysis is used to understand the hydrological process and assessment of hydrological characteristics of surface water basin. In the present paper, an attempt has been made to study the detail morphometric characteristics of Kulbera and Daurighara river basin, which are tributaries of Subarnarekha River in Purulia district, West Bengal. For detailed study, SRTM data has been used for preparing digital elevation model (DEM), and Geographic Information System (GIS) has been used for the analysis of linear, areal, and relief aspects of the basins. Watershed boundary, flow accumulation, flow length, stream ordering have been prepared by using ILWIS 3.0. Different thematic maps i.e. elevation, geology, drainage density, slope and longitudinal profiles of river channels have been prepared by using QGIS 3.0 and MapInfo 10.0 GIS software. More than 58 morphometric parameters of all aspects of the basins have been computed. On the basis of morphometric analysis it has been argued that the erosional development has progressed well beyond maturity and that the drainage development is controlled by lithology. Besides, it can be concluded that this study will also be very useful for rain water harvesting planning and watershed management.

**Keywords :** Morphometric Analysis, SRTM (DEM), Kulbera & Daurighara and RSGIS.

## I. INTRODUCTION

Water is a valuable resource and an essential human need. Demands of water already exceed supply in many parts of the world and many more areas are expected to experience the imbalance of demand and supply in the near future. Climate change will have significant impacts on water resources around the world because of the close connections between the climate and hydrological cycle. Watershed management plays an important role of it and watershed morphometry study is an important aspect in its management [1- 4]. Morphometry analysis of a watershed is helpful in understanding the impact of stream morphometry. Morphometry analysis is the measurement and mathematical analysis of the configuration of the Earth's surface, shape and dimension of its landforms [5-6]. Morphometric analysis tool and technique is one of the most important to determine and evaluate drainage basin responses to climate change and drainage characteristics [7], flash flood hazard [8], and

hydrological processes [9]. Flood analysis in the river basins needs geomorphological parameters which govern the hydrological response of the river basin [10]. The morphometric characteristics at the watershed scale may contain important information regarding its formation and development because all hydrologic and geomorphic processes occur within the watershed. Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watershed [11]. Remote sensing technique has been developed for the analysis of the stream morphometry and it is a powerful tool in recent past. Remote sensing has the capacity to get information for an extensive and remote zones and it is also a very useful technique in analyzing the morphometry in any drainage system. Remote sensing and GIS techniques have developed as an effective tool for the watershed development programmes. Morphometry analysis is used in watershed prioritization and it helps to understand hydrological characteristics of the watershed like structure, relief of the watershed, stream network, platform and topology [12-14]. Linear features, areal aspects, gradient of channel network and ground slope of the drainage basin are required for morphometric analysis. Watershed is used as a basic unit for morphometric analysis in a logical choice. Remote sensing and Geographical Information System (GIS) is a powerful tool in recent years, which plays a vital role for understanding the hydrogeological conditions, prevailing climate, geological structure and geomorphology of the drainage basin [15]. Geographical Information System (GIS) technique is a much efficient and time saving technique which are suitable for spatial planning. Manipulation and retrieval of large data base can be handled by the GIS more effectively. It can also solve many complex issues besides facilitating retrieval and querying of data [16]. Morphometry characteristics of the basin help us for the management of rainwater harvesting in the watershed.

## II. STUDY AREA

Kulbera and Saurighara rivers are the tributary of Subarnarekha River and these basin are contiguous basin to each other. Kulbera and Daurighara river basins are covered an area of 118.50 sq. km. and 160.04 sq. km. respectively and the area is located between  $23^{\circ} 06' 45''$  N to  $23^{\circ} 16' 56''$  N latitude and  $85^{\circ} 54' 30''$  E to  $86^{\circ} 08' 39''$  E longitude (Figure 1).

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# Morphometric Analysis of Kumari River Basin Using Geospatial Approach in Purulia District of West Bengal, India

Shambhu Nath Sing Mura

**Abstract**— The morphometric analysis of the drainage basin plays an important role in the geohydrological nature of the drainage basin and it expresses the prevailing evolutionary history of the basin. Remote Sensing (RS) and Geographic Information System (GIS) have emerged as an important tool in demarcation of drainage basin, pattern and groundwater potential and its planning. Geospatial techniques can be used for the identification of morphological characteristics of the drainage basin. In this study, SRTM data has been used to extract the basin boundary and various morphometric parameters of Kumari river basin. The morphometric parameters of the basin deals with linear, areal and relief features such as stream order (Nu), stream length (Lu), bifurcation ratio (Rb), drainage density (Dd), stream frequency (Fs), elongation ratio (Re), circulatory ratio (Rc), texture ratio (Rt), length of overland flow (Lg), and form factor ratio (Rf) etc. have been dealt in the present study. Morphometric analysis of Kumari drainage basin reveals that it is a 7th order and dendritic type of drainage basin thereby indicates homogeneity in texture and lack of structural control. In the Kumari watershed, total number of stream is 2087 whereas first order stream is 1577 and second order stream is 386, 87 third order stream, 28 fourth order stream, 6 fifth order stream, 2 sixth order stream and one seventh order stream. First order stream length is maximum and it decreases with increasing stream order. In this study, morphometric analysis is a useful tool for the sustainable development and planning strategies in control the soil erosion and conservation of water resources.

**Abstract**— Morphometric Analysis, RS & GIS, Water Resource, Management, Kumari River Basin

## 1 INTRODUCTION

THE drainage basins are the most important fundamental units of the watershed management and in terms of geomorphic characteristics of fluvial landscape. Geographical Information System (GIS) and Remote Sensing (RS) have used for understanding the morphometric characteristics of river channel and its drainage network. Morphometry indices of the watershed interpret the hydrological characteristics of a river basin [1]. Morphometric analysis has been used to identify the relationship of various parameters in the watershed. It is a comparative morphometric parameters evaluation of various watersheds to know different geomorphological and topographical condition. Watershed is a natural is a natural hydrological entity from which surface runoff flows to defined drained, channel, stream at a particular point [2]. Morphometric parameters of the watershed is very important for watershed planning and management and it gives an idea about the basin characteristics such as slope, topography, soil condition, runoff characteristics, surface water potential etc. [3]. The most common morphometric parameters of the watershed are stream order, stream number, stream length, mean stream length, stream length ratio, bifurcation ratio, mean bifurcation ratio, drainage density, drainage texture, stream frequency, relief ratio, form factor, elongation ratio, circulatory ratio, length of overland flow etc. [4]. In many papers has defined

the formula of each parameters as same. There is no complete classification for all parameters. Several papers have stated that resulted values of certain parameter are either high or low and it indicates condition but the range of value is not included. There are no statements of the implication of high and low value of a particular morphometric parameter. The quantitative analysis of morphometric parameters likes linear, relief and areal are immense utility in river basin evaluation, watershed prioritization for flood and water conservation and natural resource management [5]. Drainage basin in the semi arid region is conducive to flash flood generation [6]. GIS helps to create data base for the watershed which is used for carrying out spatial analysis and decision makers informing appropriate measure for critically affected areas [7]. This study will help in better understanding the hydrological characteristics of the basin, flood potentiality, drainage management, groundwater potential and erosion for watershed planning and management.

## 2 METHODOLOGY AND DATA BASE

For the study of morphometric parameters of the basin are effective done using modern RS and GIS techniques. Kumari watershed map is a sub-watershed drainage basin of Kangsabati watershed was prepared with the help of Survey of India (SoI) toposheets and SRTM-DEM data and then it was digitized. SoI toposheets number 73E/15, 73E/16, 73I/3 and 73I/4 have been used to extract morphometry parameters for the present study. A geo-hydro processing model was used for

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## **ON MODEL ROBUSTNESS IN DISCRETE DESIGN(S) SET UP: A TEACHER’S MANUAL**

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**Abstract:** The problem studied here involves choice of optimum designs for estimation of a full set of treatment effects contrasts in a block design (BD) setup, when positional effects may also be present, besides treatment and block effects. The experimenter is not sure about which of the two models, viz. a block design model or a row-column design model is appropriate. Using weights on the optimality criteria in the two set-ups based on prior knowledge, robust designs are investigated.

**Keywords and phrases:** Discrete set-up, Model robust designs, BIB designs, Youden Square designs.

### **1. INTRODUCTION**

Substantial literature has accumulated on the theory of optimum designs both in the regression and discrete set-up. Optimum designs are determined for the estimation of parameters or functions of the parameters of the model assumed. The approaches and methodologies or treatments in the two set-ups viz. discrete and continuous, are completely different. There is a vast literature on the theory of optimum designs and related construction procedures for both regression and discrete designs. Generally optimality studies, as in other statistical investigations, are based on a set of assumptions. Naturally the question arises : how far an optimum design in a given set-up remains optimum when one or more of the assumptions are violated. Parallel to optimality studies, several researchers investigated the robustness aspects of

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डॉ. सत्यप्रसादमिश्रः\*

### शोधसारः

आर्यभूमौ आर्यभाषा सर्वेषां मनुष्याणां हृत्सु विद्यते। अस्माकं पुण्यभूमेः भारतवर्षस्य सर्वप्राचीना इयं संस्कृतभाषा। अस्याः भाषायाः गौरवं विश्वे सर्वत्र विद्यते। एषा कापि विद्या नास्ति या अनया भाषया नैव विरचिता भवति। भाषायाः अनुशासनं येन शास्त्रेण विहितं तत्तु व्याकरणशास्त्रम्। अस्मिन् शास्त्रे उपदिष्टेषु बहुषु विषयेषु कारकप्रकरणान्तर्गतं कर्मकारक-विषयमाधृत्य मया प्रस्तूयते। संस्कृतवाङ्मये वाक्येषु प्रयोज्यमानानि पदानि सुवन्तं तिङन्तञ्चेति द्विधा विभज्यन्ते। 'सुप्तिङन्तं पदम्'-1.4.14 इति सूत्रेण महर्षिणा पाणिनिनोक्तमेतत्। 'उद्याप्रातिपदिकात्' 4.1.1 इति सूत्रेण ज्ञायते प्रातिपदिकेभ्यः सुप्-प्रत्ययाः भवन्ति। प्रातिपदिकेभ्यः सुप्-प्रत्ययाः कारकादनन्तरं जायन्ते। संस्कृतव्याकरणे उपदिष्टेषु षट्सु कारकेषु कर्मकारकस्य लक्षणं विभागश्च शोधपत्रेऽस्मिन् मया पर्यालोचितम्। प्रक्रियात्मक-व्याकरणे दार्शनिक-व्याकरणे च कर्मकारकस्य विषयः उल्लिखितः आसीत्। कर्मकारकस्य लक्षणे वैयाकरणैः स्व स्व वुद्धिवलेन यथोपयुक्तप्रमाणैः सह सुदीर्घं विश्लेषणं कृतम्। तेषां विश्लेषणं मतवादञ्च संग्रह्य शोधपत्रमिदं मया प्रस्तुतम्। अत्र कर्मकारकस्य विषये पाणिनीयवैयाकरणानाम् अपाणिनीय-वैयाकरणानाञ्च वचनं मया संगृहीतम्।

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# নবেন্দু ঘোষের ছোটগল্পে সমাজ বাস্তবতা

কারিমুল চৌধুরী

নবেন্দু ঘোষ মূলত বিশ শতকের চারের দশকের শুরুর লেখক। তিনি ছিলেন প্রগতিশীল ও সমাজমনস্ক শিল্পীসচেতন ব্যক্তি। 'আমার সাহিত্যজীবন' শীর্ষক নিবন্ধে তিনি জানিয়েছেন—

“আমি সেই সময়ে মানুষের দুঃখ দুর্দশায় ভয়ানক অবিভূত হয়ে পড়তাম; দারিদ্র, হিংসা ও কপটতা একেবারে সহ্য করতে পারতাম না, জাতিভেদ ও শ্রেণীভেদ আমার মনে বিদ্রোহের সঞ্চার করতো, অসাম্য ও শোষণের বিরুদ্ধে যুদ্ধ করতে ইচ্ছা হত। সেইসঙ্গে এক ধরনের দার্শনিক চিন্তাও আমার মনকে প্রায় আচ্ছন্ন করত যা সেই বয়সের পক্ষে অস্বাভাবিক ছিল— এই ধরনের চিন্তা যে সংসার অনিত্য, জীবন ক্ষণস্থায়ী, এই জীবনের হাট যেমন একদিন বসে তেমনি একদিন সাজও হয়। একটি আকুল বাসনার ভার নামত, তীব্রভাবে মন চাইত দুঃখের কথা বলতে, মন চাইত এমনভাবে বলি যাতে আমার পাঠকেরা আমার গল্পের চরিত্র এবং প্রতিপাদ্যের সঙ্গে একাত্মবোধ করেন...।” এই সময়কাল ছিল ১৯৩৬ খ্রিস্টাব্দ নাগাদ। এই সময়ের অভিজ্ঞতা তাঁর ছোটগল্পকে সমৃদ্ধ করে তুলেছে।

ছোটগল্পকার হিসাবেই বাংলা সাহিত্যে নবেন্দু ঘোষের প্রথম আবির্ভাব ঘটে। ১৯৪৩ খ্রিস্টাব্দে দুর্ভিক্ষ-মহাস্তরের প্রেক্ষাপটে রচনা করেন তাঁর 'কঙ্কি' গল্পটি। আলোচ্য গল্পে মহাস্তরের ভয়ঙ্কর চিত্র ফুটিয়ে তুলেছেন গল্পকার। একদিকে বুর্জোয়া মধ্যবিত্ত ও ধনী এবং অন্যদিকে সর্বহারা দরিদ্র— এই দুইয়ের বিরোধে খাদ্যাভাবে সর্বহারাদের অসহায়তার চিত্র কলকাতায় সমবেত অনন্যমূল মানুসদের দিয়ে অঙ্কন করেছেন গল্পকার। সেখানে ক্ষুধার্ত মিছিলের আতর্নাদ, মিছিল ক্রমশ এগোয় ডাস্টবিনের দিকে।

'কঙ্কি' গল্পের কেন্দ্রের আছে দুর্ভিক্ষের কারণে আসা একটি পরিবারের কত্রী মা— তারা, তার মেয়ে দুর্গা, ছেলে ভোলা এবং একটি শিশুপুত্র। তারার জীবনধারণের উৎস হল ডাস্টবিনের খাদ্য। দীর্ঘদিনের অনশনে সামান্য ভাতের জন্য তারার যে আর্তি প্রকাশিত হয়েছে তার চিত্র যেমন বাস্তব তেমনি অমানবিক :

“খাদ্য লইয়া দুই ভাইবোন আবার মারামারি আরম্ভ করিয়াছে। তারা তাহাদের মধ্যে গিয়া জোর করিয়া আধমুঠো কাড়িয়া লইয়া বুকের ছেলেটার মুখে দিল। ছেলেটা তাহা গিলিল। ছেলেটাকে খাওয়াইতে আর ভোলা ও দুর্গার খাওয়া দেখিতে তারার রসনায় জল আসিল। ভাত! আঃ! সে ক্ষীণকণ্ঠে ডাকিল, দুগগা, মা, ক্যামন নাগছে

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## REMEMBERING PARTITION OF BENGAL AND THE LIBERATION WAR OF BANGLADESH

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### Abstract

Memory and amnesia are always at the core of the relation between human beings and History. The interplay between past and present, memory and amnesia are always considered as a shape giver to investigate the earlier years of cataclysmic events. Partition is an empirical reality of human civilization. But how far it is possible to recreate that defunct memory of the horror and anxiety through a speculative narrative? Even if one embarks on this project can he bring forth something more than an exhaustive history of the Liberation War. The partition of Bengal in 1947 and the Bangladesh liberation war of 1971 are the major tumultuous episodes dismantled the course of history –millions of people become homeless, abducted and decapitated by the name of religion and politicized nationalism. The cataclysmic events of partition is not a matter of contingency –one has to understand the political and religious agenda of Pakistani colonialism and the ‘localized’ narratives that led the liberation war of Bangladesh. It is rightly unjustful to target one specific religion to withhold the other. The history of Bengal partition is not about the division of Bengal, Pakistan and Bangladesh but a grim reality of the scapegoats of the country.

Keywords : convulsion, racism, identity, violence



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Partition and liberation war are not synonymous. Historians prefer the phrase ‘Partition of Bengal’ whereas they use ‘Bangladesh Liberation War’ while narrating the events of Bengal and Bangladesh. Does the partition leads the liberation war or the liberation war leads the partition? Are the narratives reliable enough to underscore a specific conclusion? where from the historian should begin the narrative? Bangladesh as a separate nation has emerged not due to any specific movement that a historian can probably claim. while one may begin with the 1905 partition embedded in the ‘divide and rule’ policy to safeguard and dictate the provincial state of Bengal contains nearly eighty million people before the convulsion. while other critics may not agree with the same assumption that led such

cataclysmic events. The chronology remains ambiguous when the course of the events itself appear ambiguous. This paper is an attempt to justify and redefine the problems of historiography, locating the fissures in the documentation of such narrative. Amrita Bazar Patrika had organized a survey on 23rd April 1947 regarding the partition of Bengal. The framed question was “do you want a separate homeland for Bengali Hindus?” and the poll reports that 98.3% were in favour of division. Surprisingly 99.6% Hindus responded to the poll and demanded Partition.

The Hindu community believe in tranquil cohabitation and solely follows the virtues of ‘Samskara’ and ‘Karma’. Peace is their religion. They embrace anything pitiable, denounce communalism

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# Perversion, Homophobia and Language difference: A Study of Joe Orton

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## Abstract

In the course of time the nuances of human activity rationalize the cultural standpoint of the generation though it cannot be described accurately. The cultural politics of perversion requires justification in post 1950's Britain. Is perversion merely a psychological disorder? Does the domain strictly confined within sexual orientation? Does perverseness have a language? why homosexual desire is considered as a perverse desire? This paper scrutinizes the heteronormative nuances of sexuality and the experiences of a certain community being considered by the society as pervert in the Plays of Joe Orton who is a British playwright and diarist.

Key words : stereotype, perversion, sexuality, gaze

Joe Orton explores the post world war II English theatre where the emotional poverty is interweaved much with sexual disempowerment. The erotic subjects deal with distinctive identities in which sexual and racial factors interconnect with class and gender constructions. People were confused about the nuances of sexual morality when they no longer believed in theological canons and hardly there was no room for adherence of virtues. perversion suggests a deviation from the connotations of moral, indeed theological later changed its course in sexual denotations when psychoanalysis and sexology interpret its multidirectional operative forces. Orton perhaps, demands to project the ideology of perverse fascination publicly for our natural emotion has become perverse and wishes to create a subversive community to counter it. Perversion indeed, can serve as a drive for a social, economic and political change. Its existence is not merely restricted within a sexual orientation. Racism, avariciousness and war are all forms of perverseness for it is an expression of resistance to difference.

In orton's society there was no belief in conventional morality, nor was there any felt need to keep a fidelity within marriage. J.M.Carstairs, professor of psychological medicine in Edinburgh surveyed that divorces in pre-war period was eight thousand increased thirty-two thousand in 1950s and continued to rise. Marriage turns out to be a constant negotiation paves the rise of




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### Insurance Parameters, Linkages between Investment and Economic Growth in India

Shrikant Madar<sup>1</sup>  
Sheetal D. Arondekar<sup>2</sup>

With the advent of private sector life insurance firms, the post-2000 period has led to fierce competition amongst the firms to retain existing and attract prospective consumers with their innovative life insurance products. This paper is an attempt to examine the trends and performance of the life insurance sector in India and to analyze the impact of this sector's investment on the gross domestic product(GDP)for the period from 2000-01 to 2019-20. The database for this study is purely dependent on secondary sources namely, the Handbook on Indian Insurance Statistics and RBI. Data were analyzed using MS-Excel and GRETl Software and results were presented in the form of tables and graphs. For effective data analysis, the econometrics models such as linear trend line analysis, Log-linear model, and correlation analysis were applied. The performance of the life insurance sector is assessed using the parameters, viz., insurance penetration, and insurance density. The study reveals that life insurance density and penetration have an increasing trend that results in the overall growth of the economy and also shows that investment in the life insurance sector has a significant association with India's GDP.

**Keywords:** Insurance, Investment, Economic Growth, Hypothesis testing, Econometric and Statistical Methods.

**JEL Codes:** G22, P45, F43, C12, C10

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### Does High Trade Volume Affect the Fiscal Deficit of India? An Econometric Investigation

Diptarghya Bhattacharjee<sup>1</sup>

This paper establishes the relation between fiscal deficit and trade volume of India and apart from trade volume also the other variables are government final consumption expenditure and share of defence expenditure of total GDP of India and the theory says that the trade volume has the negative relation with the fiscal deficit but by using the Engle-Granger two step cointegration approach it is found that there is the cointegration between fiscal deficit, trade volume, government final consumption expenditure and share of defence expenditure even though there is no cointegration between trade volume and fiscal deficit solely and also having the positive relation between trade volume and fiscal deficit in case of India which contradicts the theory and the only reason is high import which raises the expenditure of government and the fiscal deficit is suppressed if there is the balance trade and also government should increase the tax base and which will automatically reduce the government expenditure and fiscal deficit as well.

**Keywords:** Fiscal deficit; Trade volume; Government final consumption expenditure; Share of defence expenditure

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### Maternal and Child Health Deprivation Scenario - An Analysis of Longitudinal Data Across Selected SAARC Countries

Soumyendra Kishore Datta<sup>1</sup>

Tanushree De<sup>2</sup>

The issue of health care benefits for females during maternity and that of children should be considered in an integrated manner and not in isolation. Children health deprivation often gets aggravated due to inadequacy in maternal health condition. It is rightly viewed that child bearing phase of mother and condition at delivery constitute the prime definite life incidents that have a bearing on the health status of a child's future life courses. In this context, a maternal health deprivation index and child health deprivation index based on some relevant components are developed in the context of six SAARC countries over 2000-2016. Principal component method and UNDP goalpost method are applied in this context for deriving the indices and corresponding ranks. The variation in these indices are further tried to be explained by considering several relevant factors. A recursive simultaneous equation structure is applied for explaining the simultaneity in variation of these two deprivation indices. It is observed that provision of several health related benefits needs to be made in order to lift the poor state of maternal and child health in some of the considered countries.

**Keywords :** Maternal Health, Child Health, Deprivation Index, Simultaneous Equation, SAARC Countries.

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### Policy Transmission Channels and the Economy: Structural Vector Autoregression Estimation of the Monetary Policy Effects

T. Lakshmanasamy<sup>1</sup>

## Investigating the present status, spatial change, and emerging issues related to riparian wetlands of Bhagirathi–Jalangi Floodplain (BJF) in lower deltaic West Bengal, India

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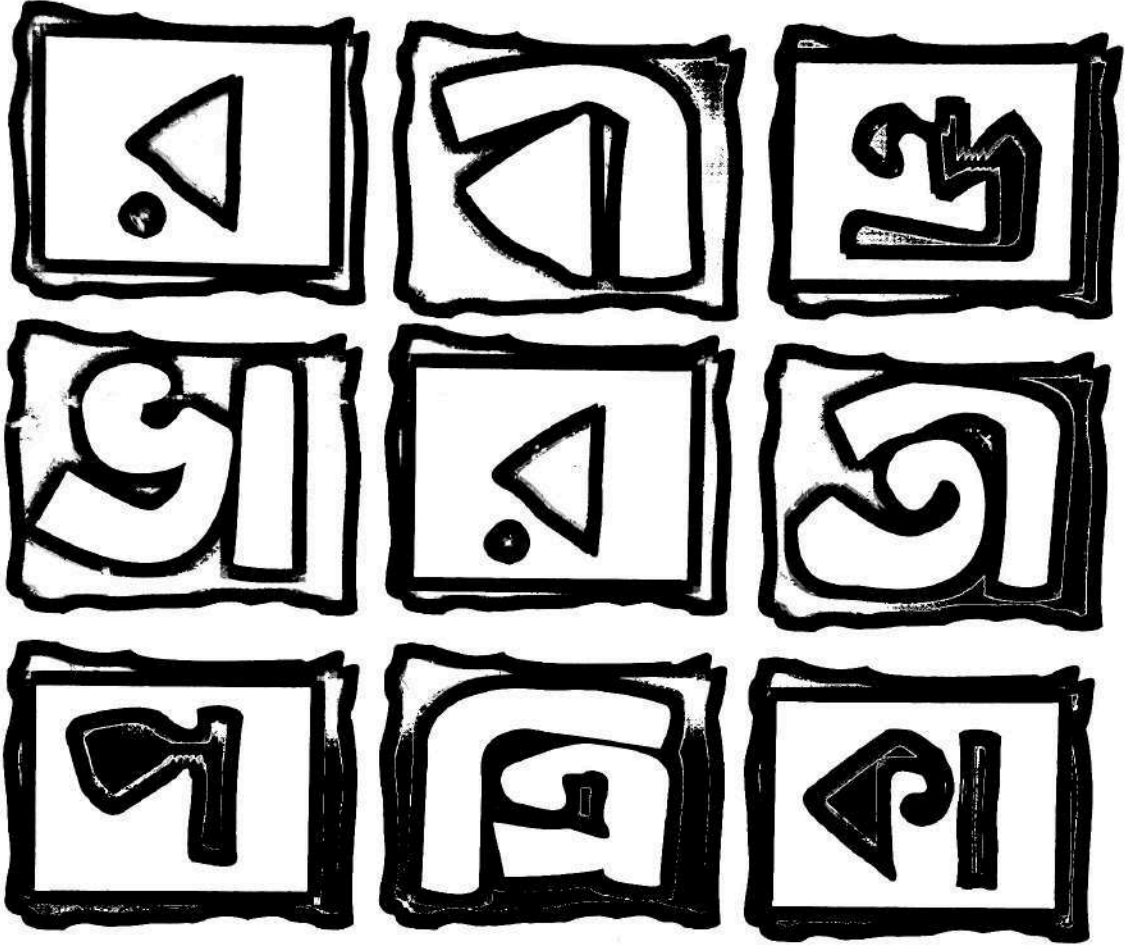
### Abstract

Floodplain wetlands have considerable ecological and economic significance. The study area, consisting of the Bhagirathi–Jalangi Floodplain (BJF), is endowed with numerous wetlands. Based on the tentative time of origin and wetland index map, the investigation selects eight major riparian wetlands and their surroundings from the meander belt of the rivers Bhagirathi and Jalangi. The study primarily emphasizes on periodic mapping for areal change detection and identification of emerging issues between 1955 and 2018. The data used for the present research includes Topographical maps, Landsat imagery, Google maps, Sentinel 2B imagery of different time periods and some ancient maps which depict the old courses of river Bhagirathi and Jalangi. By using geospatial techniques and field investigation, the study reveals that from 1955 to 2018, wetlands have been shrinking rapidly. It is found from the investigation that total wetland area has reduced by about 39.60% due to land reclamation and wetland transformation. The land use change detection depicts that agricultural expansion, which has increased up to 35%, is the dominant control factor for wetland decay. More than 87% of the selected wetlands have experienced area loss. Among the selected wetlands, 25% have lost more than 90% of their areal extent during the stipulated study period. Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) are the two indices used for measuring the concentration of aquatic plants. Geospatial analysis suggests that the NDVI value is higher in pre-monsoon season in comparison with post-monsoon. High NDVI value which is  $\geq 0.51$  covers more than 81% of the wetland surface area. In contrast, low NDWI value ( $\leq 0.20$ ), covering more than 60% of the wetland surface area, is found in 75% of the selected wetlands. The study finally concludes that due to accelerated anthropogenic intervention floodplain wetlands in the BJF require special attention to ensure future sustainability.

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# রবীন্দ্রভারতী পত্রিকা

রবীন্দ্রস্মরণ সংখ্যা। ১৪২৮



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সংক্ষিপ্তসার

মানুষের জীবিকার সঙ্গে জীবনযাপনের সম্পর্ক গভীরভাবে বহু শতাব্দীব্যাপী জড়িয়ে আছে। উৎপাদনের সঙ্গে ঘনিষ্ঠসূত্রে জড়িয়ে আছে শ্রমশক্তি আর শ্রমশক্তিকে প্রতিদিন সম্পদ সৃষ্টির কাজে ব্যবহার করে মানুষের কর্মসম্পন্ন। আদিপর্বে কয়লা খাদানে বাউরি ও সাঁওতাল পরিবার ভিত্তিতে খনি শ্রমিক হিসাবে কাজে যোগদান করেছিল। পরবর্তীকালে ছোটনাগপুর, বিহার, উত্তরপ্রদেশ থেকে বিভিন্ন জাতির মানুষ খনিশ্রমিক হিসাবে কাজে যোগদান করেছিল। গড়ে উঠেছিল জাতিভিত্তিক কোড়া, বীওড়া, নুনিয়াবন্তি, মনসুরীবীওড়া প্রভৃতি। দ্বিতীয় বিশ্বযুদ্ধের কালে শ্রমিক সমস্যা সমাধানের জন্য প্রতিষ্ঠিত হয়েছিল 'কোলফিল্ড সেন্ট্রাল রিক্রুটিং অর্গানাইজেশন'। এই বহিরাগত শ্রমিকদের 'অতিপ্রায়িত হওয়ার পশ্চাতে 'push' ও 'pull' factor কে দায়ী করেছেন অনেকে। এ বিষয়ে রণজিৎ দাসগুপ্ত, এ. ডি. হান, আনন্দ এ ইয়ং, আর চান্দভারকার, তীর্থকর রায় প্রমুখের নাম উল্লেখযোগ্য। শ্রমিক সংগ্রহ করা হত জমিদারী পদ্ধতির সরাসরি বা সর্দারি পদ্ধতি, অপ্রত্যক্ষ পদ্ধতি ও ঔপনিবেশিক সরকার কর্তৃক পদ্ধতিতে। কয়লাখনি অঞ্চলের শ্রমিকরা বংশ পরম্পরায় 'progency of labour force' তৈরি করেছিল। এই অভিবাসিত কয়লা শ্রমিকেরা শ্রমিক শ্রেণি হিসাবে চেতনা অর্জনের পরিবর্তে একই সঙ্গে একজন কৃষক ও একজন খনি কর্মী হিসাবে সাংস্কৃতিক আয় দ্বৈত সম্ভব হয়ে রেখে চলতে পছন্দ করত। সুতরাং ১৮৭০ সাল থেকে ১৯৪৭ সাল পর্যন্ত বর্ধমান জেলার আসানসোল ও রানীগঞ্জের কয়লা খনিতে আদিপর্বে নিযুক্ত শ্রমিক, পরবর্তীকালে অভিপ্রায়িত শ্রমিকদের আগমন ও কারণ, শ্রমিকদের নিয়ে আসা ও নিয়োগের পদ্ধতি, জাতিব্যবস্থা, কাজের পরিবেশ এবং দ্বিতীয় বিশ্বযুদ্ধের পরবর্তী কালের শ্রমিক নিয়োগের পরিবর্তিত পদ্ধতি অনুসন্ধানই এই নিবন্ধের উদ্দেশ্য।

সূচকশব্দ : কয়লাখনি, শ্রমিক, সর্দার, অভিপ্রায়ন, নিয়োগপদ্ধতি।

বর্ধমান জেলার কয়লাখনি অঞ্চল বলতে যে বিস্তীর্ণ ক্ষেত্রকে বোঝায় তা বর্ধমান জেলার আসানসোল ও দুর্গাপুর মহকুমা দুটির বিস্তীর্ণ অঞ্চল এবং পার্শ্ববর্তী হল বিহারের ধানবাদ জেলা ও সাঁওতাল পরগনার কিছু অঞ্চল এবং পশ্চিমবঙ্গের দামোদরের দক্ষিণে পুরুলিয়া ও বাঁকুড়ার অববাহিকা অঞ্চল ও অজয় নদের উত্তরে অবস্থিত বীরভূম জেলার অববাহিকা অঞ্চল। বীরভূম অবশ্য এখনও কয়লাখনির সক্রিয় মানচিত্রে চিহ্নিত হয়নি। এই কয়লাখনি ক্ষেত্রে, মগমা থেকে দুর্গাপুর, দৈর্ঘ্য ৭৫ কিলোমিটার ও উত্তর-দক্ষিণে প্রস্থে ৩৫ কিলোমিটার। মোট ক্ষেত্রফল ১৫৬০ বর্গ কিলোমিটার। বর্তমান 'আসানসোল-দুর্গাপুর উন্নয়ন অঞ্চল' (বুদবুদ থানা অঞ্চল বাদে আসানসোল ও দুর্গাপুর মহকুমা) এর ক্ষেত্রফল ১৬২৫.৯ বর্গ কিলোমিটার। তার মধ্যে ১৩৫৭.৪ বর্গ কিলোমিটার গ্রামীণ ও ২৬৮.৫ বর্গ কিলোমিটার শহরাঞ্চল। ১৯৭১-৮১ খ্রিস্টাব্দের মধ্যে ১৫৬.১ বর্গ কিলোমিটার গ্রামাঞ্চল শহর এলাকায় রূপান্তরিত হয়েছে।

১৮৭২ সালে বর্ধমান, কাটোয়া, কালনা, জাহানাবাদ, বুদবুদ ও রানীগঞ্জ এই ৬টি মহকুমা নিয়ে গঠিত হয়েছিল সৈনিকার বর্ধমান জেলা। মোট লোকসংখ্যা ছিল ১৮,৬১,৬৬৩। জেলার মোট আয়তন ৩৫১৩ বর্গমাইল। মোট গ্রাম ছিল ৫১৯১। মোট শহর মাত্র ৬।

# Weakly viscoelastic film on a slippery slope

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## ABSTRACT

We study the stability of weakly viscoelastic film (Walter's B<sup>0</sup>) flowing down under gravity along a slippery inclined plane. The focus is to investigate the interaction of the bottom slip with the viscoelastic parameter as well as the influence of the other flow parameters on the stability of the flow. For the slippery substrate, we use the Navier-slip boundary condition at the solid-liquid interface. The dimensionless slip length  $\beta$  is first assumed to be small and its order is considered same as the order of the film aspect ratio  $\epsilon = H/L$ , where  $H$  is the mean film thickness and  $L$  is a typical wavelength. To discuss the coupled effect of slip length  $\beta$  and viscoelastic parameter  $\gamma$ , we have used the classical Benney equation model (BEM) as well as the weighted residual method (WRM). For linear stability, the normal mode analysis is carried out to capture the instability threshold. The critical Reynolds numbers ( $Re_c$ ) are obtained for BEM and WRM separately for the system. We found that the first-order WRM is a better choice to capture the instability threshold in comparison with a first-order BEM when  $\beta$  is small. Another noteworthy result we obtain is that, in the absence of  $\beta$ , WRM and BEM yield the same expression for the critical Reynolds number. Further, we have extended the study for moderate values of  $\beta$ , that is,  $\beta$  of order unity and it is found that both BEM and WRM are able to capture the effects of  $\beta$  and  $\gamma$ . We derive the Orr-Sommerfeld (OS) type eigenvalue problem and an asymptotic analysis is performed for small perturbation wavenumbers, which gives an expression for the critical Reynolds number for the instability of very long perturbations. The critical Reynolds number obtained by the OS eigenvalue problem exactly matches with that obtained by BEM. Finally, we validate our analytical predictions by performing a direct numerical simulation of the WRM and good agreement between the results of the linear stability analysis, weighted residual model, and the numerical simulations is found.

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## I. INTRODUCTION

A vast body of the literature is devoted to the stability and dynamics of thin-film flow in the case of Newtonian fluids<sup>1–4</sup> following the pioneering works of Kapitza and Kapitza,<sup>5</sup> Benjamin,<sup>6</sup> and Yih.<sup>7</sup> However, there are many applications in which the fluid deviates from the Newtonian behavior. These applications include molten metals/lava flows, thin coating processes in the industry, manufacturing of plastics, and the movement of several biological fluids.<sup>8,9</sup> Blood and mucus are two typical examples of non-Newtonian fluids within our own bodies. In these cases, the shear stress must be a nonlinear function of the local strain rate. Non-Newtonian fluids can be grouped

mainly in three general classes: (a) time-independent (memoryless fluid) or generalized Newtonian fluids (GNF), (b) time-dependent, and (c) viscoelastic fluids. For GNFs, the value of the strain rate at a point is determined only by the current value of the shear stress at that point. The GNFs can further be categorized as shear-thinning, shear-thickening, power-law, or the Ostwald-de Waele relationship and viscoplastic fluids. On the other hand, the time-dependent fluids are those where the relation between the shear stress and strain rate shows dependence on the duration of kinematic and shearing history. Time-dependent fluids may be further sub-divided into two categories: (a) thixotropy and (b) rheopexy or negative thixotropy. In this study, we



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## Complex Dynamics of an Eco-Epidemic System with Disease in Prey Species

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The objective of this study is to investigate the complex dynamics of an eco-epidemic predator–prey system where disease is transmitted in prey species and predator population is being provided with alternative food. Holling type-II functional response is taken into consideration for interaction of predator and prey species. The half saturation constant for infected prey, the growth rate of susceptible prey and force of infection play a significant role to create complex dynamics in this predator–prey system where alternative food is present. It is seen that healthy disease-free system is possible here. The system shows some important dynamics viz. stable coexistence, Hopf bifurcation, period doubling bifurcation and chaos. The analytical results obtained from the model are justified numerically.

*Keywords:* Eco-epidemiological system; stability; bifurcation; alternative food; chaos.

### 1. Introduction

Researchers rightly have paid great attention to the eco-epidemiological issues recently to study the effect of infection. It has also been the topic of wide interest in the literature. In ecology, parasite plays a major role for various reasons. It has the ability to alter the quantitative dynamics of their host population. It can also create high amplitude oscillations in abundance and may even cause the extinction of host population. Ecosystems with regard to competing species is now the topic of greater interest in the field of bio-mathematical literature. The pioneering work of [Anderson and May, 1991] on epidemic model describes the dynamics of disease transmission. Subsequently, many researchers

[Huang *et al.*, 2019; Shaikh *et al.*, 2018; Biswas *et al.*, 2018; Mbava *et al.*, 2017] have paid attention to study predator–prey model with infection in predator. Disease in prey is assumed in the models [Chattopadhyay & Arino, 1999; Hethcote *et al.*, 2004; Lu *et al.*, 2019; Meng *et al.*, 2018; Saha & Samanta, 2019; Simon & Rabago, 2018] and disease in both prey and predator is considered in [Kant & Kumar, 2017; Mandal *et al.*, 2018]. In [Guin *et al.*, 2015; Guin & Mandal, 2014; Guin & Baek, 2018; Pal *et al.*, 2014; Pal *et al.*, 2011; Han *et al.*, 2020; Sarwardi *et al.*, 2011a], the authors studied the predator–prey models with and without disease. The widely studied topic in theoretical ecology is the predator–prey interaction. The interaction is

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# ছিটমহলের গল্প : জীবনের বিচিত্র সংকটের প্রতিচ্ছবি কারিমুল চৌধুরী

বাংলা কথাসাহিত্যের আঙিনায় 'ছিটমহলের গল্প' বিষয়গত দিক দিয়ে একটি নতুন মাত্রা সংযোজন করেছে। মাইগ্রেশন, পার্টিশন নিয়ে বাংলা সাহিত্যে আলাপ-আলোচনা হলেও ছিটমহল নিয়ে সেই অর্থে আলোচনা হয়নি বললেই চলে। ছিটমহল নিয়ে বাংলাসাহিত্যে একধরণের সাহিত্যিক নীরবতা লক্ষণীয়। অথচ কথাসাহিত্যের ধরুর এটি একটি সম্ভবনাময় পরিসর।

এখন প্রশ্ন হল ছিটমহল কি? কেন এই ছিটমহল? ছিটমহল বলতে আমরা বুঝি একটি দেশের বিচ্ছিন্ন ভূখণ্ডকে, যেখানে পার্শ্ববর্তী দেশের নাগরিকরা বসবাস করে। অর্থাৎ রাষ্ট্রের যে অংশ অন্য রাষ্ট্রের মধ্যে পড়ে। ইংরেজিতে একে বলা হয় 'Enclave'। পৃথিবীতে এই মূহূর্তে ২২৩ ছিটমহল বর্তমান। যেমন— স্পেনের 'মেলিয়া ও চেগটা', ইউরোপের ভ্যাটিক্যান সিটি, যুক্তরাষ্ট্রের জিব্রাল্টার, দক্ষিণ আফ্রিকার লেনোথো, ইতালির সানম্যারিনো। ভারত ও বাংলাদেশের মধ্যে যে ছিটমহল ছিল তা বিশ্বের বৃহত্তম ছিটমহল। ভারতের মূল ভূখণ্ডের রয়েছে বাংলাদেশের ৫১টি ছিট, যার ক্ষয়তন ৭১১০ একর। আর বাংলাদেশের মধ্যে রয়েছে ভারতীয় ১১১টি ছিট, যার ক্ষয়তন ১৭১৬০ একর। ছিটমহল গড়ে ওঠার নানা ইতিহাস বৃত্তান্ত রয়েছে। আগ্রহী পাঠকেরা পড়ে নিতে পারেন দেবব্রত চাকীর 'ব্রাত্যজনের বৃত্তান্ত: প্রসঙ্গ ভারত বাংলাদেশের ছিটমহল' বইটি (সোপান)। ছিটমহল সম্পর্কে একটি প্রচলিত মিশ্র হল কোচবিহারের মহারাজা কোন এক সময়ে রংপুরের নবাবের সঙ্গে কিছু পরগণা বাজি প্রদে পাশা খেলেছিলেন। রাজার ইচ্ছাপূরণ করতে সাধারণ প্রজাদের হত হতে হত হত। যে সমস্ত প্রজা এতিমদন কোচবিহারের রাজাকে বাজনা দিয়ে এসেছিল, রাজার ইচ্ছাপূরণ করতে তাদের মূহূর্তের মধ্যে হয়ে যেতে হতো রংপুরের নবাবের প্রজা। রংপুরের প্রজাদের ক্ষেত্রেও বিপরীত পরিস্থিতি ঘটেছিল। তবে একটি দেশের রাজনীতি, ইতিহাস ও সংকট থেকে অন্যদেশের রাজনীতি-ইতিহাস আলোচনা, সংকট ও সমস্যা, নিব্যাচিত কিছু গল্পের নিরিখে আমরা ছিটমহলের রাষ্ট্রহীন মানুষদের জীবনযাত্রা, সংকট, লোকায়ত বিশ্বাস, ধর্মীয়সংস্কার ব্যক্তি হৃদয়ের আশা-আকাঙ্ক্ষাকে বিচার চেষ্টা করব।



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# Weakly viscoelastic film flowing down a rotating inclined plane

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## ABSTRACT

We investigate the nonlinear stability of a thin viscoelastic film flowing under the effects of gravity and Coriolis and centrifugal forces. We assume that the viscoelastic liquid satisfies the rheological property of Walters' liquid B'. We may consider this case as a viscoelastic flow down a rotating cone and far from the apex. Using the classical long wave expansion technique, we derive a nonlinear evolution equation describing the shape of the liquid interface as a function of space and time and also derive its stability characteristics. We solve the physical system in a two-step procedure. In the first step, we use the normal mode method to characterize the linear nature. The linear study reveals that the linear growth rate is invariant with the Coriolis effect but is significantly affected by the viscoelastic parameter  $\Gamma$  as well as the Taylor number  $Ta$ . It is found that both  $\Gamma$  and  $Ta$  destabilize the flow. In the second step, we solve an elaborated nonlinear film flow model based on the method of multiple scales and demarcate different instability zones. The weakly nonlinear study shows that with an increase in  $\Gamma$  and  $Ta$ , the supercritical stable region and the explosion area increase whereas the unconditional stable and the subcritical unstable region shrink. Finally, on validating our analytical predictions by performing a direct numerical simulation, a good agreement between the results of the linear stability analysis, weakly nonlinear stability analysis, and the numerical simulations is found.

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## 1. INTRODUCTION

The stability of thin liquid films falling down a rotating inclined plane is one of the most important instability phenomena both from the practical and theoretical points of view. Davalos-Orozco and Ruiz-Chavarria<sup>1</sup> first investigated the instability of a thin film flowing down a rotating inclined plane. To neglect the effect of the centrifugal force, they considered the region of investigation very near to the axis of rotation. They described the linear instability of the film in the limit of small wave numbers as well as small Reynolds numbers. They showed the crucial stabilizing role of the Coriolis force on the evolution of thin film dynamics. Furthermore, Davalos-Orozco and Busse<sup>2</sup> studied the instability of a thin liquid film flowing under the effects of gravity, Coriolis as well as the centrifugal force. In order to capture the centrifugal force effects, they considered the region of flow far from the axis of rotation. They showed that the film flowing down a rotating inclined plane is more stable than the flow on a horizontal rotating plane up to a certain critical value of rotation, whereas the situation is reversed above this rate of rotation. They also obtained an equation describing the nonlinear evolution of surface waves and described an

equation including dispersion as well as dissipation, whose solutions may possess solitary waves. Mukhopadhyay and Mukhopadhyay<sup>3</sup> investigated the stability and dynamics of a thin viscous liquid film flowing down a rotating non-uniformly heated inclined plane. They assumed that the rotation is small and considered the region of investigation very far from the axis of rotation to investigate the role of centrifugal force in the instability mechanism. Using the long-wave expansion technique, they constructed a Benney-like free surface evolution equation in terms of the film thickness at any instant. They performed both linear and weakly nonlinear stability analyses. Their linear study revealed that the growth of linear perturbation is independent of the Rossby number ( $Ro$ ) but depends on the Taylor number ( $Ta$ ) as well as the Marangoni number ( $Mn$ ). They showed the destabilizing behavior of  $Mn$  as well as  $Ta$ . In addition, they observed that the Coriolis force is dominant at very small rotation, while for a relatively large rotation the centrifugal force dominates the flow field. Using the momentum-integral method, Mukhopadhyay *et al.*<sup>4</sup> studied the stability of a thin liquid film flowing down a rotating inclined plane. Considering a self-similar velocity profile for specific ranges of flow





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## Effect of odd-viscosity on the dynamics and stability of a thin liquid film flowing down on a vertical moving plate

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## ABSTRACT

In this study, we focus on the problem of hydrodynamic instability of a thin, viscous, Newtonian liquid film with broken time-reversal-symmetry flowing down along the surface of a vertical moving plate. The presence of odd viscosity gives rise to new terms in the pressure gradient of the flow. Utilizing the classical long-wave perturbation method, we obtain the analytical solutions as well as derive the nonlinear evolution equation of Benney-type in terms of film thickness  $h(x, t)$  which is significantly modified due to the presence of odd viscosity in the liquid. We solve the linear model by using the normal mode approach and for three different conditions, namely, the quiescent, up-moving and down-moving plate velocity. The linear study shows that the effect of the down-moving motion of the vertical plate is to enhance the stability of the film flow whereas the up-moving motion of the vertical plate tends to reduce it. Further, the study shows that odd viscosity always has a stabilizing effect on the flow field. In addition, the Orr-Sommerfeld equation is also derived and solved analytically to obtain the critical Reynolds number. Finally, we show the numerical solution of the evolution equation in a periodic domain which clearly demonstrates the role of odd-viscosity on the dynamics of the plate motions of thin film flows coating in isothermal environments. Our study clearly shows how odd viscosity influences the stability of the flow.

## 1. Introduction

The dynamics of thin film waves has received much attention from various industries due to its dramatic effect on the transport rate of mass, heat and momentum in designing distillation and adsorption columns, evaporators, condensers, nuclear reactor emergency cooling system, etc [1–4]. Liquid films play a central role in many engineering applications, biological and physiological processes, and geophysics, to name a few. Apart from the fascination they hold for theoreticians for their rich dynamics, their great practical importance is evidenced by the existence of extensive reviews covering a large number of fundamental and applied studies [5–7], to which the reader is referred for a panoramic view of the subject. Such dynamics are related to the nonlinear spatiotemporal evolution of their free surface when subjected to various thermal, structural, and mechanical factors. The dissipative nature of such a thin liquid has led to the understanding of wave pattern formations at its free surface as a consequence of energy flow within the fluid. Thus, under isothermal conditions, when the flow takes place on an inclined/vertical plate, these factors encompass the

competitive actions of hydrostatic pressure as well as inertia. When these actions turn in favour of the latter i.e., when the Reynolds number crosses a critical value, the geometry of the basic flow modifies.

The study on the wave evolution on a falling film started with the pioneering experiment by Kapitza and Kapitza [8]. They showed a wide variety of wavy flow regimes: harmonic waves, large amplitude periodic waves and solitary waves. The type of flow depends on the perturbations put into the system. All observed waves are long with respect to the film thickness. Later Benjamin [9] and Yih [10] investigated the linear stability analysis of the liquid film flowing down an inclined plane where they determined the critical Reynolds number as a function of the angle of inclination. Yih [10] showed that with sufficiently long wavelength, the parallel flow of a vertically falling layer is always unstable to periodic perturbations. Further, based on the solution of the Orr-Sommerfeld equations, he obtained the critical conditions for the onset of instability under the assumption of long-wave perturbations and for the case in which the Reynolds number is of order unity. Using the method of small parameters, Benney [11]

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# Surface wave and thermocapillary instabilities on flowing film under the sway of Hall viscosity

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## ABSTRACT

The present study investigates the influence of Hall/odd-viscosity on the surface wave and thermocapillary instabilities in a thin viscous film flowing down an inclined plane. A detailed analysis considering a generalized scaling for the velocity field to understand the effect of odd-viscosity in the hydrodynamic and thermocapillary modes of instabilities has been performed, and later the results are presented for a specific velocity scale. Starting with Orr–Sommerfeld (OS) linear stability analysis for all ranges of wavenumber and then constructing two low-dimensional models; namely, the Long wave expansion model (LWE) and the Weighted residual integral boundary layer model (WRIBL) under the assumption of small wavenumber are analysed for linear and nonlinear behaviour of the instabilities analytically and numerically. Two energy transferring mechanisms reinforce each other to the disturbance: hydrodynamic H-mode and thermocapillary S-mode are focused and found that the odd viscosity plays a stabilizing role for both the modes of instabilities. For small Reynolds number ( $Re$ ) values, both LWE and WRIBL models give consistent results as that of the OS. However, for a large value of  $Re$ , WRIBL gives way better match with OS than LWE. Increasing odd viscosity flattens the streamlines in a moving frame of reference, confirming the odd viscosity's stabilizing effect. However, being non-dissipative, odd viscosity has no significant influence on the temperature field. In a static frame, the intensity of capillary separation and flow reversal phenomena decreases with the increase of odd viscosity, confirming its stabilizing effect on the flow.

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## 1. Introduction

Hydrodynamics of falling film on a flat surface usually involve the classical fluid motion due to gravitational pressure gradient and become unstable when inertia overcomes hydrostatic pressure effects. The disturbance emanates at the free surface, where the vorticity is produced by the base flow shear stress. With the disturbing interface, as advected by the base flow, the perturbation vorticity becomes out of phase to cause the amplification of the disturbance at the interface.

When a fluid layer is allowed to flow over a heated surface, the dynamics are regulated by several competing mechanisms. The first one is the classical long-wave instability developed from the isothermal flows, which was first studied experimentally by Kapitza and Kapitza [1] where a wide variety of wavy regimes, like a rolling wave with a capillary hill, a series of nearly solitary waves or almost harmonic waves of falling liquid films had been observed. This mode of instability is known as the hydrodynamic

mode or H-mode in the literature. This instability mode was analysed theoretically in more detail by Benjamin [2] and Yih [3]. The key findings of these analyses are that the instability of the film manifested as a gravity-driven surface wave of long-wavelength disturbances and for a critical value of the Reynolds number, given by  $Re_c = 5 \cot \beta / 6$ , ( $\beta$  being the inclination angle), beyond which flow become unstable. Benney [4] exploited the relative thinness of the liquid layer and carried out an asymptotic analysis which yielded a single evolution equation for the thickness of the layer. Gjevik [5] improved the accuracy of the asymptotic expansions and obtained an equation for the evolution of the thickness, referred to as the Benney equation (BE). Unfortunately, this equation suffers from an artificial singularity for sufficiently large Reynolds numbers. However, it is much simpler than the full dynamic equations. The BE model is proved to be consistent and frequently used to study the weakly non-linear behaviour of film flows for example, film evaporation (Joo et al. [6]), non-uniform heating [7], topographical effects (Kalliadasis et al. [8]), Van der Waals force (Tan et al. [9]), a chemical reaction (Trevelyan et al. [10]), etc.

Scheid et al. [11] have studied the validation domain of Benny equation deeply with the Marangoni effect. They ultimately concluded that BE would remain useful as a consistent falling film

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# Long-wave instabilities of evaporating/condensing viscous film flowing down a wavy inclined wall: Interfacial phase change effect of uniform layers

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# Long-wave instabilities of evaporating/condensing viscous film flowing down a wavy inclined wall: Interfacial phase change effect of uniform layers

Cite as: Phys. Fluids **34**, 042124 (2022); doi: [10.1063/5.0089068](https://doi.org/10.1063/5.0089068)

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## ABSTRACT

The interfacial phase change effect on a thin film flowing down an undulated wall has been investigated in the present study. The study is performed for a general periodic undulated bottom of moderate steepness that is long compared to the film thickness, followed by a case study over the sinusoidal bottom. The long-wave instabilities of the ununiform film are used by deriving a nonlinear evolution equation in the classical long-wave expansion method framework. The one-equation model can track the free surface evolution and involve the bottom undulation, viscosity, gravity, surface tension, and phase change (evaporation/condensation) effects. Linear stability analysis shows that the bottom steepness  $\zeta$  has a dual role. In the downhill region, increasing  $\zeta$  destabilizes, whereas increasing  $\zeta$  stabilizes in the uphill region. Weakly nonlinear waves are studied using the method of multiple scales to obtain the complex Ginzburg–Landau equation. The results show that both supercritical and subcritical solutions are possible for evaporating and condensate film. Interestingly, while one subcritical region is visible for an evaporating film, two subcritical unstable regions are found for condensate film. The numerical solution of the free-surface equation demonstrates the finite-amplitude behavior that tends to dry out for an evaporating film. For condensate film, the thickness increases rapidly. The rupture dynamics highly depend on the initial perturbation, and the bottom steepness has a negligible effect on it. Kutateladze number has a significant impact on the stability characteristic of the film flow as it represents a sort of efficiency of phase change that occurs at the interface.

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## I. INTRODUCTION

Falling liquid film on an inclined/vertical plane substrate is one of the most important hydrodynamic problems that exhibit a wide variety of spatial and temporal structures. It is a convectively unstable open-flow hydrodynamic system, governed by Navier–Stokes equations coupled with equation of continuity with appropriate boundary conditions, except when the Reynolds number and angle of inclination are small enough and surface tension is large enough and in that case flow remains parallel, laminar, and unidirectional down the plane surface. The problem is extensively studied experimentally, numerically, and analytically for a long time. Wave evolution on falling liquid film has been extensively studied over the last few decades, starting from the pioneering work by Kapitza and Kapitza.<sup>1,2</sup> Where a wide variety of wavy regimes, like a rolling wave with a capillary hill, a series of nearly solitary waves or almost harmonic waves of falling liquid films

had been observed. In this situation, the stability and its criteria for falling films are needed to be understood. Reportedly, the beginning works in the field of stability analysis or falling films were done by Benjamin<sup>3</sup> and Yih<sup>4</sup> who investigated the long-wave instability of falling film over an inclined plane theoretically. They determined the phase velocity of the waves and critical Reynolds number for the transition, respectively. Benny<sup>5</sup> derived a wave evolution equation governing the flow by regular perturbation technique in terms of flow depth by expanding the variables in powers of the long-wave parameter. Turkyilmazoglu *et al.*<sup>6,7</sup> recently worked on the absolute and convective instabilities on boundary layer flow problems. An absolute instability is appropriate for unstable flow if its response to an impulse in time and space amplifies unboundedly everywhere in space for a large time.

A detailed review can be found previous research studies.<sup>8–13</sup>



OPEN

## Influence of Allee effect on the spatiotemporal behavior of a diffusive predator–prey model with Crowley–Martin type response function

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The present paper is dealt with a predator–prey model in which the growth of the prey population is influenced by the Allee effect while the predator species are contended with the prey population following the Crowley–Martin type response function. The proposed model is comprehensively analyzed in terms of stability and manifestation of bifurcation of the system. The system unveils the bi-stability together with the existence of a separatrix. In view of the eminence of spatial ecology, the dynamical complexity emanating from the induction of the Allee effect in prey species of a Crowley–Martin reaction–diffusion predator–prey model is also investigated profoundly. The results of numerical simulations reveal that the present system dynamics is motivated by both the Allee effect and diffusion-controlled pattern formation growth to hot spots, stripe-hot spot mixtures, stripes, labyrinthine, stripe-cold spot mixtures, and cold spots replication. The theoretical consequences of the spatiotemporal model under study are validated through numerical simulations.

During the last couple of decades, the Allee effect, together with its immediate consequences on ecology and conservation of biomass has been drawing attention to the researchers<sup>1,2</sup>. The Allee effect usually refers to a process that alleviates the growth rate for small population density<sup>2</sup>. For example, the Allee effect in prey population is designated by the fact that the prey species possess a probability of localized extinction, causing the specialist predator to suffer from looking for resources thereby. This may result in saturation in consumption that goes against the assumption in the realm of ecological system<sup>3–6</sup>. The concept of the Allee effect was widely accepted and gained momentum in major recognition towards the golden period of the late eighties of the 20th century<sup>7–11</sup>. It has been reported that the induction of the Allee effect in the predator–prey interacting system leads to various dynamical complexities<sup>12–16</sup> where the researchers highlighted mainly on the conditions for extinction and survival of the population. Diverse factors, including mating limitation, cooperative defense, combined feeding, and environmental conditioning, give rise to the growth of prey species influenced by the Allee effect. Of all these factors, the mating constraint<sup>17</sup> seems to be the most pervasive one as it becomes difficult to locate the mating individuals at low density.

In the event of one, multi Allee effects exerting impact on a single population concomitantly, the situation may be expressed as single, double, or multiple Allee effects, respectively. It can be either multiplicative or additive. The most known increasing function that describes this effect is

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# व्यासश्रीः VYĀSĀŚRĪH

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## उत्तररामचरिते प्रकृतिचेतना

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## विषयसारः (Abstract) :

अस्मिन् विश्वसंसारे प्रकृतिचेतनायां मानवानां मनसि निगूढः संयोगः सर्वदैव विद्यते नास्ति खलु संशयः। प्रकृतिं विना मानवानामस्तित्वमस्यां पृथिव्यां कदापि न सम्भवति। अस्मिन् ब्रह्माण्डमण्डले यथा सूर्यचन्द्रादिग्रहानामवस्थानं विस्मयोत्पादनं करोति तथा सृष्टिचक्रे उद्भिदप्राणिसमूहानां जन्ममरणव्यापारे आदिकालाद् अस्माकं मनसि विविधः प्रश्नः समुपजायते। अथर्ववेदसंहितायां द्वादशकाण्डे पृथिवीसूक्ते सृष्टिकार्यविषये स्पष्टतया प्राणस्पन्दनरूपविषयः मन्त्रेणोद्घोषितः। संस्कृतसाहित्ये तस्माद् विविधेन महाकविना नाट्यकारेण च प्रकृतिवर्णनं समुल्लिखितम्। महाकविभवभूतिविरचिते उत्तररामचरिते प्रकृतिचित्रणमभूत्पूर्वव्यापारम्। अस्मिन् नाटके यथा विविधानां प्राणिनां चलाचलं लक्षणीयं तथैव प्राकृतिकभूतं वनसौन्दर्यं सत्यमेव सहृदयपाठकवर्गानामुपभोग्यमनिर्वचनीयञ्चेति मम विषयस्य संक्षिप्तसारः।

## उपक्रमणिका :

विश्वसृष्टेरादिकालादधुनापि प्रकृत्या सह मानवानामेकः अविच्छेदः सम्पर्कः वर्तते। युगादतिक्रम्य इदाणीमपि मानवानां सर्वेषां सृष्टिकार्यमूलोत्स्वरूपसमन्वयभूता भवति इयं प्रकृतिचेतना। प्रसङ्गेऽस्मिन् अथर्ववेदे द्वादशकाण्डे पृथिवीसूक्ते विद्यते एकस्मिन् मन्त्रे<sup>1</sup> यत् - अस्यां पृथिव्यां यथा विद्यन्ते समुद्रनदीजलाशयप्रभृतयः तथा सम्भूताः सन्ति शस्याः मनुष्याश्चेति। अस्मिन् धरातले प्राणशीलाः कम्पनशीलाः च सर्वे एव स्पन्दिताः भवन्ति। तर्हि संस्कृतविविधकाव्येषु प्रकृतिवर्णनमेकं सहृदयपाठकवर्गानां समीपे आनन्दजनकव्यापारमेव नास्ति खलु संशयः। विधातुः सृष्टिकार्ये आसमुद्रात् हिमाचलपर्यन्तं सकलं प्रकृतिनिर्देशनं विस्मयकरं मनोमुग्धकरञ्चेति व्यापारं मानवानां चित्तेषु। विज्ञानशिल्पसाहित्यचारुकलानां सृजनीशक्तिः समुपजायते प्रकृतिमाश्रित्य। काव्येषु नाटकेषु प्रवक्ष्ये च यथायथं प्रकृतिवर्णनं मानवजीवने वैपरीत्यं सूचयति मार्गचालनाय। तस्माद् नाट्यकारः भवभूतिः तदीये उत्तररामचरिते स्वातन्त्र्येण समुज्ज्वलेन च प्रकृतिचित्रवर्णने स्वप्रतिभया अभिनवपरिचयप्रदाने सिद्धहस्तः बभूव।

## विषयोपस्थापनम् :

संस्कृतकाव्येषु सप्ताङ्कसमन्वितस्य उत्तररामचरितस्य नाटकस्य विशिष्टं स्थानं चिराय सहृदयपाठकवर्गानां मनसि विराजते। यतः विविधेषु काव्येषु वर्णनीयविषयरूपेण उद्दीपकविभावरूपेण वा केकारवं ज्योत्स्नावर्णनं विहगानां कोलाहलं चेति लक्षणीयं विविधैः कविभिः समुल्लेखनैः। परन्तु महाकविभवभूतिः एतत् मार्गं विहाय किञ्चिदन्यमार्गमवलम्बनं चकार एवं तस्य लेखने वैलक्षण्यं जायते। प्रकृतेः गाम्भीर्यं, अरण्यणां भयानकदृश्यवर्णने, रुक्षपर्वतशृङ्गानां निविडमालायां, क्वचिच्च पर्वतानां सानुदेशे प्राकृतिकचित्राङ्कने, कदापि वा गिरिगुहायां जलप्रपातानां शब्दोल्लेखने, भीतजनकजीवजन्तुनां समुल्लेखने च महाकविः भवभूतिः आसीत् अन्यतमः श्रेष्ठः नाट्यकारः मागनिर्देशकश्चेति। प्रसङ्गेऽस्मिन् डॉ. भानुदत्तः इति प्रख्यातस्य विदुषः मतं<sup>2</sup> प्रतिधानयोग्यम्। उत्तररामचरितस्य प्रथमाङ्के आस्माभिः दृश्यते यत् श्रीरामचन्द्रं प्रति संवर्धनाज्ञापनाय सुहृदसदृशाः समुपस्थिताः आसन् प्लवङ्गराक्षसाः<sup>3</sup>। अस्य नाटकस्य विशिष्टत्वं भवति प्रथमाङ्के चित्रफलकप्रदर्शनं यत् लक्षणेन प्रदर्शितं श्रीरामचन्द्रमुद्दिश्य। अनेन चित्रप्रदर्शनेन श्रीरामचन्द्रसीतादेवीद्वयस्य स्मृतिचारणमेकमभिनवव्यापारम्। अनेन कौशलेन यथा विविधानां विषयाणां समुपस्थापनसमकं दृष्टिं हरति तथा प्रकृतिवर्णनस्य सुनिपुणं मार्गं महाकविः भवभूतिः प्रदर्शनं चकार। यथा परिलक्ष्यते अस्माभिः यत् श्रीरामचन्द्रवचनान् इङ्गुदीवृक्षस्य<sup>4</sup> कथा। अपि च अस्माभिः ज्ञायते चित्रफलकदर्शनेन लक्षणवचनमाश्रित्य यत् कालिन्दीतटे श्यामनामक वटवृक्षस्य<sup>5</sup> प्रसङ्गः। विषयवर्णनावसरे प्रथमे अङ्के सीतादेव्याः कथाछलेन पुण्यसलिला गङ्गेति<sup>6</sup> नद्याः चित्रं चित्रितं नाट्यकारेण। अपरतः लक्षणवचने यथा विन्धारण्ये विराधसंवादः लक्षणीयः तथैव अन्यत्र रामचन्द्रकथनेन लभते पार्वत्यनदीनां सौन्दर्यवर्णनं<sup>7</sup> वैखानसाश्रमस्थितवृक्षस्य अवस्थानञ्च। अनेन वर्णनेन प्रकृत्याः स्वाभाविकसौन्दर्यमुपभोगं येन सहृदयपाठकवर्गस्य



## SEASONAL VARIATION IN MOSQUITO LARVICIDAL POTENTIALITY OF *Holoptelea integrifolia*

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### AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author SS contributed to methodology, data collection, statistical analysis, writing original manuscript. Author GC contributed supervision of total work, checking and editing of manuscripts. Both authors read and approved the final manuscript.

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### ABSTRACT

Japanese encephalitis (JE) which was previously known as Japanese B encephalitis, is caused by the Japanese encephalitis virus. Plant produced the photochemical mainly for their own defense mechanism is experimentally used to control varieties of insect pests or vectors. Crude extract (0.1%, 0.2%, 0.3%, 0.4% and 0.5%) of leaves of *Holoptelea integrifolia* when applied on third instars mosquito larvae in successive seasons i.e. Summer, Rainy and Winter, caused 100 percent mortality at 0.5% concentration in summer after 72 h of exposure. In Winter, also a 100 percent mortality of the third instars of *Cx. vishnui* group larvae were noticed after 48 h of exposure at 0.5% concentration. Out of three predominant seasons in West Bengal, variation in the mortality of *Cx. vishnui* group larvae by crude extract of *H. integrifolia* leaf are well established and mortality increases with higher extract concentration and time of exposure. Highest mortality was noted in Rainy season followed by Summer and Winter.

**Keywords:** *Holoptelea integrifolia*; *Culex vishnui*; mortality; mosquito; larvae; seasonal variation.

### 1. INTRODUCTION

Mosquito belonging to the family Culicidae is divided into three sub families namely Culicinae, Anophelinae, and Toxorhynchitinae, in which all the disease transmitting vectors are included. Female

mosquito uses blood meal as protein and vitamin source for egg development. According to NVBDCP (National Vector Borne Disease Control programme) under The Ministry of Health and Family Welfare, Government of India. *Culex vishnui* is the chief vector of Japanese Encephalitis in different parts of India,

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RESEARCH ARTICLE



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## ADOPTION OF ENGLISH LANGUAGE: AN INSTRUMENT TO COUNTER PATRIARCHAL OPPRESSION IN THE WORKS OF KAMALA DAS

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### Abstract

In the initial days of post-colonial India the acceptance of English language as a medium of expression in literary works was seen against Nationalistic approach. In that juncture Kamala Das's (1934-2009) adoption of English language over her mother tongue Malayalam was considered an audacious act. And this was due to the fact that being a woman she choose powerful English language as her medium of writing. In my paper I've tried to show the probable reasons behind Das's use of English language in delivering her literary works. Among numerous reasons the most important one is the dominating nature of this language that helps Das to release the suppressed self of being a woman. English language has a masculine nature and using it according to someone's needs require inherent power. And the same in case of Das becomes really a matter of audacity as she challenges the male-dominated society in her works.

Keywords: Indian Writing in English, Feminism, Gender Study, Confessional Poems.

Kamala Das (1934-2009), a bilingual writer of both Malayalam and English languages, is widely known as an Indian English Writer. She is considered as a seminal poet writing in Indian English. She started writing in a post-colonial India. Her first poem was published in 1947. That was a time when literature(s) of significant quantity and quality, as well, were being produced in numerous regional languages in India. In post-1947 scenario writing in Indian languages was considered having a nationalistic approach. Apart from this, there was a tendency to underestimate the value of literature written by an Indian in the English language as an inferior one. It was generally considered that

literature of seminal value could only be written in writer's mother language as according to them it was an impossible task to acquire other languages as a medium of spontaneous expression. The same argument was voiced by Buddhadeva Bose, a prominent Bengali writer and critic, in 1963, "Indo-Anglian poetry is a blind alley, lined with curio shops, leading nowhere" (415). And it was not Bose alone, there were other critics too who were thinking in the same manner.

K.R.S. Iyengar was well aware of the fact and in the formative years of Indian Writing in English (earlier known as Indo-Anglian Literature), when

# Synthesis and Characterization of 1*H*-Imidazole-4,5-dicarboxylic Acid-Functionalized Silver Nanoparticles: Dual Colorimetric Sensors of Zn<sup>2+</sup> and Homocysteine

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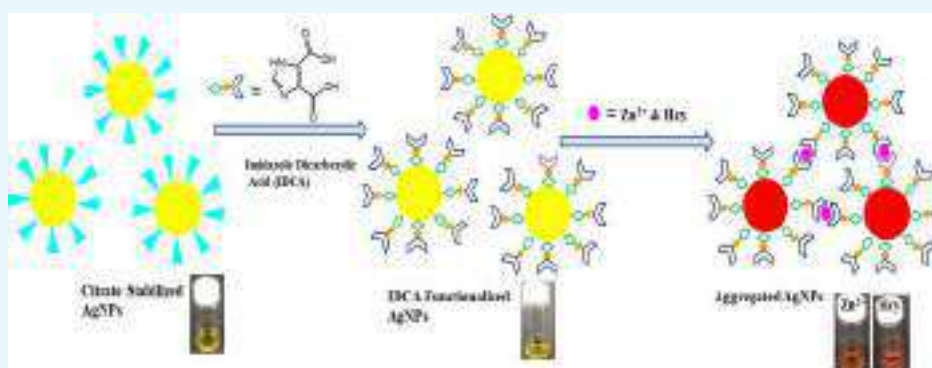
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**ABSTRACT:** A colorimetric assay has been developed for Zn<sup>2+</sup> and homocysteine (Hcy) detection using functionalized silver nanoparticles (AgNPs). AgNPs have been synthesized using silver nitrate, where sodium citrate is used as a stabilizing agent and NaBH<sub>4</sub> as a reducing agent. Then, the nanoparticles (citrate@AgNPs) were functionalized with 1*H*-imidazole-4,5-dicarboxylic acid (IDCA). UV–visible and FTIR spectra suggested that IDCA was functionalized on the surface of citrate@AgNPs through the N atom of the imidazole ring. The IDCA-functionalized silver nanoparticles (IDCA@AgNPs) simultaneously detected Zn<sup>2+</sup> and Hcy from aqueous solution and showed different responses to the two analytes (Zn<sup>2+</sup> and Hcy) based on the aggregation-induced color change of IDCA@AgNPs. They showed the color change from yellow to red, which was easily discriminated by visual inspection as well as UV–visible spectroscopy. The surface plasmon resonance absorbance values of Zn<sup>2+</sup> and Hcy are 485 and 512 nm, respectively, when Zn<sup>2+</sup> and Hcy react with IDCA@AgNPs. IDCA@AgNPs showed linearity with Zn<sup>2+</sup> and Hcy concentrations, with the detection limit of 2.38 μM and 0.54 nM, respectively (S/N = 3). The IDCA@AgNPs showed excellent selectivity toward Zn<sup>2+</sup> and Hcy compared to the different metal ions and amino acids, respectively. Optimal detection was achieved toward Zn<sup>2+</sup> and Hcy in the pH range 3–10. In addition, IDCA@AgNPs were used to detect Zn<sup>2+</sup> and Hcy from lake water, showing low interference.

## 1. INTRODUCTION

Zinc is the second most abundant transition element after iron, which participates in various aspects in biological metabolism. It plays various roles in the synthetic routes within cells,<sup>1</sup> normal growth of human body,<sup>2</sup> and normal brain function.<sup>3</sup> It is normally nontoxic, but uptake by humans due to high environmental concentrations of Zn<sup>2+</sup> ion causes pulmonary manifestations, fever, chills, and gastroenteritis. Thus, the determination of trace amounts of Zn<sup>2+</sup> ion is currently of great interest in medical sciences as well as environmental monitoring.

On the other hand, Hcy is a sulfur-containing amino acid in which a free –SH group is present as in cysteine, and Hcy is the intermediate formed during the conversion of methionine to cysteine. Free Hcy is not available naturally as it exists in plasma, in disulfide form as well as in protein-bound form. Therefore, it is complicated to determine the total Hcy after

the reduction of disulfide. The normal concentration of Hcy in plasma ranges from 5 to 15 μM. The condition when the level of Hcy is above 15 μM is defined as hyperhomocysteinemia. High plasma levels of Hcy are associated with several diseases such as cardiovascular disease,<sup>4</sup> Alzheimer's disease,<sup>5</sup> neural tube defects,<sup>6</sup> and osteoporosis.<sup>7</sup> Hence, the determination of Hcy in plasma or protein is highly important.

Currently, there are common techniques employed for the detection of Hcy or Zn<sup>2+</sup>, such as atomic absorption spectroscopy (AAS),<sup>8</sup> fluorescence,<sup>9</sup> electrochemical meth-

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## Falling liquid films on a slippery substrate with variable fluid properties

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## ABSTRACT

We investigate the stability of a gravity-driven, thin, Newtonian liquid flowing on a uniformly heated slippery inclined plane. We construct a mathematical model of the flow that comprises the Navier–Stokes equation coupled with the equation of energy. While the rest of the boundary conditions are standard for thin-film problems, we apply a Navier slip boundary condition at the solid–liquid interface. We assume that the fluid thermophysical properties — density, dynamical viscosity, surface tension, and thermal diffusivity vary linearly with temperature as long as the change in temperature is small. In the analysis part, we follow the standard long-wave theory and construct a nonlinear evolution equation for the film thickness. This is followed by a linear and weakly nonlinear stability analysis. The linear analysis allows us to compute the critical Reynolds number of our problem and from this study, we conclude that the slippery substrate destabilizes the film flow. The weakly nonlinear stability analysis finds a finer description of various stable/unstable zones. Finally, we perform a numerical simulation of the evolution equation in a periodic domain using spectral methods. Our numerical results support the analytical predictions of the instability threshold using the linear and weakly nonlinear theories. The influence of the small Biot number is also investigated in presence of the slip length together with the variable fluid properties.

## 1. Introduction

The instability phenomenon of an isothermal or non-isothermal thin wavy liquid film flowing down an inclined or vertical plane is a rich area of investigation. It draws the attention of physicists, mathematicians and engineers because of its theoretical and practical importance. The inertia driven flow of thin film along an inclined plane leads to instability and the formation of free surface waves. This phenomenon was first observed by Kapitza & Kapitza and their experimental findings are mentioned in [1]. The area developed tremendously in subsequent decades and the relevant literature is quite vast. We refer the reader to references like [2–5] where the basic problem and its various extensions are discussed.

Most of these works concern with the instability of the flow along an isothermal or nonisothermal inclined plane and many disregard the variation of different thermo-physical properties as temperature varies. However, a number of fluid properties such as density, viscosity, surface tension, thermal diffusivity, specific heat, etc. are functions of temperature. For a more accurate description of the system, these parameters should be included in the model in such a way that their dependence on temperature gets reflected in the study.

Later Pascal et al. [6] investigated the question of the onset of instability of thin films on a uniformly heated incline, where they considered the linear dependence of density, thermal conductivity, viscosity, specific heat and surface tension on temperature. They did the linear stability analysis and found the critical Reynolds number ( $Re_c$ ) in specific cases, i.e., considering  $Bi = 0$  and  $Bi \rightarrow \infty$ . They also calculated the  $Re_c$  in the general case where asymptotic expansion was carried out assuming small Biot number and small variation of the viscosity and thermal conductivity with temperature. As  $Bi$  increases from 0,  $Re_c$  initially shows a decreasing trend, then it attains a minimum value and after this it increases when  $Bi$  increases. D'Alema et al. [7] studied the effects of linear variation of different thermophysical quantities, barring specific heat, on a uniformly heated incline. This study does not assume certain parameter values to be small (like in [6]) and is suitable for investigation on larger parameter domains.

Mukhopadhyay & Chattopadhyay [8] proposed an analytical model for long-wave instability of thin film flowing down a uniformly heated inclined plane considering a linear variation of various thermophysical properties. They constructed an evolution equation for  $h(x, t)$ , the film thickness. Due to the computational difficulty, they restricted their

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# On the food chain model with prey refuge and fear effect

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## Abstract

Of concern the present study deals with an updated food chain model in a natural environment with the inclusion of fear effect in the prey population through Holling type II functional response in presence of prey refuge effect. The present model is affluent with intra-specific competition among the hunter species having specific mortality. The model system emphasizes its characteristics in the proximity of the probable equilibrium position in the realm of biological dynamics. The response of the system is explored further for its stability analysis based on prerequisites and Hopf-bifurcation phenomena as well with respect to some significant model parameters. Extensive numerical simulation reveals the validity of the proposed model so as to indicate the ecological implications.

Keywords: (Food chain model, Fear effect, Intra-specific competition, Prey refuge, Coexistence state, Stability, Hopf-bifurcations)

2020 MSC: 34K18, 34K20, 37B25, 37G15

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## 1 Introduction

Mathematical model formulations including prey-predator, food chain and other ecological models and their analyses have established a new trend of research in theoretical ecology (cf. [21], [23], [18], [22]). The predator-prey interaction mechanism plays an important role in the behaviour of the proposed model.

In the ecosystem, there are enormous numbers of species of different kinds, of which prey and predator species play crucial role in various types of interactions among the species in the system. Quite often the interaction between the prey and the predator becomes the center of attraction in an ecosystem [24], [35] for complete understanding their dynamical behavior. For this purpose, various mathematical models [16], [27] have been made use of so that the outcomes of the models depending on model parameters often yielded new dimension in the domain of research. With the evolution of mathematical models in ecosystem, Rosenzweig and MacArthur [31] developed a model by combining Lotka- Volterra modified model having logistic growth rate for prey with predation rate of predator by using Holling type II [15] in order to establish their findings closer to the real situation. Many more researchers [11], [14] put forward three-dimensional models and explored various changes with the motivation of looking at different domains of interest. Such modifications include many factors in the realm of the dynamics of the ecosystem like fear effect, prey harvesting, delay effect, intra-specific competition and hunting cooperation as well [25], [8], [9], [28], [32]. A nonautonomous predator-prey model with fear, prey refuge and additional food together has been studied in [36]. The influence of Allee [33] with defense mechanism in the dynamical complexity is however, nor ruled out from the investigation. Evolutionary process in nature has been studied to illustrate the diversity of living animals [6], [38].

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# Circular-lattice microstructured optical fibers with near-zero ultra-flattened chromatic dispersion and high birefringence

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 Flattened Dispersion  
 High Birefringence  
 Mode Effective Area  
 Nonlinearity

## ABSTRACT

In the present study, a dispersion flattened microstructured optical fiber (MOF) with extremely low dispersion value and high birefringence is proposed. The proposed MOF is composed by manipulating the number of air-holes, presents in different rings of a regular circular-lattice MOF. The dispersion and birefringence characteristics of the proposed MOF are numerically analyzed by applying finite difference field convergence approach. Moreover, the other light-guiding characteristics, e.g., fundamental mode-field pattern, effective refractive index, effective mode-field area and nonlinear characteristics of the fiber are explored as well. Numerical results show that flattened dispersion around  $0 \pm 1.3$  ps/(nm.km) can be reached inside the spectral range 1120–2100 nm bounding a huge bandwidth of 980 nm. Numerical results also show that birefringence with the order of  $10^{-4}$  can be obtained at 1550 nm.

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## 1. Introduction

Microstructured optical fibers or photonic crystal fibers (PCFs) are a special variety of optical fibers which offer significantly improved modal characteristics compared to conventional silica fibers [1]. Unlike the conventional fibers, MOFs are drawn by one material ingredient, generally un-doped silica, having a microstructured cladding that runs down their entire length around the silica core. The cladding microstructure is constructed by a periodic array of air-holes arranged in the form of varies lattice pattern. By manipulating the structural parameters of the lattice microstructure, it is possible to manage the guiding properties of these fibers [2]. The major properties, e.g., endlessly single-mode utility, controllable dispersion, ultrahigh birefringence, ultrahigh nonlinearity etc., are important in this regard. Conventional core-cladding telecommunication fibers possess large positive dispersion and hence impose restrictions in many practical applications. However, the advent of MOF has made remarkable progress in the field of dispersion management. In recent times, MOFs have become an excellent candidate for dispersion management in optical fibers [3,4].

Chromatic dispersion represents one of the most significant characteristics of an optical fiber that determines the information

carrying capability and bit rate of a fiber-optic communication system. Besides, fiber-dispersion plays an important task in many non-telecom applications too. Therefore, management of fiber dispersion is very crucial in practical utilizations. For many practical applications, optical fibers are intentionally designed with low dispersion value around a particular wavelength. Mostly, this low value of dispersion parameter is required to be accomplished over a broad spectral range in the vicinity of low loss region, i.e., around 1550 nm. Up till now, various dispersion tailoring procedures in MOF have been reported by which near-zero and flattened dispersion over a certain wavelength interval can be achieved [5–9]. For example, selectively decreased hole diameter [5], selectively liquid-filled air-holes [6,7], formation of a defect at the fiber core [8], modification of number of holes in different rings [9] etc. are the efficient ways to acquire such flattened dispersion property.

Besides dispersion, birefringence is another key aspect accomplished in several applications in optics and photonics where the electromagnetic wave is needed to sustain its polarization status. Highly birefringent fibers have been extensively employed to maintain polarization in many applications, particularly, in the field of fiber-optic sensors [10–11]. High birefringence in MOF can be introduced by destroying the circular symmetry of microstructured cladding by means of modifying geometry or positioning of the air holes [12–14]. Huge design flexibility in MOFs has offered a handy and dynamic platform to realize fibers having high

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# Quantitative analysis of the magnetic properties of a mixture of single- and multi-domain Zn-substituted $\text{CuFe}_2\text{O}_4$ nanoparticles with canted spin

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## ABSTRACT

Zn-substituted copper ferrite nanoparticles (NPs) with size distribution 7–13 nm have been synthesized by a combination of sonochemical and standard co-precipitation methods. The crystallite size, phase purity, as well as cationic distribution are obtained from the Rietveld analysis of X-ray diffraction pattern. The transmission band near  $575\text{ cm}^{-1}$  in FTIR spectrum represents the intrinsic metal oxide stretching vibrations at tetrahedral lattice site. The Raman spectra not only confirm the metal–oxygen bonds in tetrahedral/octahedral lattice sites, but also the phase purity of the sample. Using the log-normal distribution of particle sizes as obtained in HRTEM analysis,  $\Delta M$  vs.  $T$  curve [where  $\Delta M$  corresponds to difference between field-cooled (FC) and zero field-cooled (ZFC) magnetization] are mathematically fitted and mean blocking temperature, anisotropy constant and average frequency of oscillation of SPM particles are obtained from fitted data. The minor deviation from the experimental curve and theoretical fitting suggests that our system is mostly composed of single-domain (Super-paramagnetic) particles but a fraction of multi-domain (Ferromagnetic) particles are also present, which also contribute to magnetic responses. The temperature dependence of the magneto-crystalline anisotropy constant is also derived using the “law of approach” (LA) to saturation. We have fitted all the hysteresis curves and contribution of each magnetic phase (SPM, FM and PM) is extracted quantitatively from fitting. The present work is aimed to explore the underlying physics of ferrite system consisting of multiple magnetic phases.

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# Determination of exchange integrals and effect of cationic site occupancy (8b/24d) on the structural and magnetic properties of nanocrystalline Mn-doped Gd<sub>2</sub>O<sub>3</sub>



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## ABSTRACT

Mn doped Gd<sub>2(1-x)Mn<sub>2x</sub>O<sub>3</sub></sub> (x = 0.03, 0.05) nanoparticles were prepared by simple co-precipitation method. The distribution of the cations in the six coordinated 8b and 24d sites were determined from Rietveld analysis. In addition, the cation-anion-cation bonds length which are responsible for the super-exchange interaction was extracted to describe the magnetic interaction in the samples. Transmission electron microscopy (TEM) and Raman spectroscopy were employed to investigate the microstructure and presence of any impurity (if any) phase of the samples. X-ray photoelectron spectroscopy (XPS) reveals the decrease in the number of Gd-O bonding and a corresponding increase in Mn-O bonding due to the successful replacement of Gd ions by Mn ions as the concentration increases. The first (nearest neighbor) and second exchange integral (next to nearest neighbor) were determined from molecular field model and the values confirm the occurrence of the antiferromagnetic interaction in the samples. The anomalies in the  $\frac{1}{\chi}$  vs. T data and non-linearity in M-H curve at 5 K were successfully interpreted by the cationic distribution in different local symmetry sites.

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## 1. Introduction

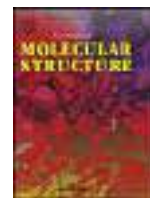
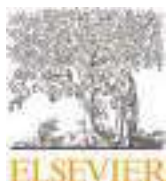
The field of dilute magnetic semiconductor/dielectric (DMS/DMD) is studied with many doped or undoped rare earth oxides. In this regard, recently gadolinium oxide (Gd<sub>2</sub>O<sub>3</sub>) has become one of the attractive compounds. Gadolinium (Gd) has a great affinity towards oxygen, thus forms oxides easily. It is one of the leading rare earth oxides having fascinating qualities like low toxicity, crystallographic stability at high temperature (up to 2325 °C), thermal and chemical stability, high mechanical strength, large spin-only

magnetic moment, high dielectric constant ( $k \approx 18$ ) and wide optical band gap (5.4 eV) [1–5]. These outstanding properties make Gd<sub>2</sub>O<sub>3</sub> an attractive candidate for its use in the field of bio-medical science viz., as contrast agent for improved imaging in magnetic resonance imaging (MRI) [6], drug delivery carriers [7], material for cryogenic magnetocaloric refrigeration [8] and in various fields of technology as sensors, catalysts, and in magnetic and optoelectronic devices [9]. At room temperature, Gd<sub>2</sub>O<sub>3</sub> crystallizes in cubic bixbyite structure with space group  $Ia\bar{3}$  where the cations occupy octahedral positions 24d of coordinates (u, 0,  $\frac{1}{4}$ ) with  $C_2$  (two-fold rotational symmetry) point symmetry and 8b of coordinates ( $\frac{1}{4}$ ,  $\frac{1}{4}$ ,  $\frac{1}{4}$ ) with point symmetry  $C_{3i}$  (three-fold rotational inversion symmetry). Oxygen is placed in general position 48e coordinates (x, y, z). Due to this special structure, dopant ions may replace host Gd<sup>3+</sup> ions preferentially or randomly over two cationic sites (8b and 24d). In  $C_{3i}$  site, the two oxygen vacancies lie on one face diagonal while in  $C_2$  site, the two oxygen vacancies lie on one body diagonal. Cations residing at these

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# Microstructural investigation of sonochemically synthesized Zn substituted $\text{CuFe}_2\text{O}_4$ nanoparticles for heterogeneous green catalytic click chemistry and dye degradation

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## ABSTRACT

Heterogeneous green catalysis by means of magnetically separable nanometal-oxide catalysts is an attractive field of present day research. The microstructural characterization, optical and magnetic properties of sonochemically synthesized Zn substituted  $\text{CuFe}_2\text{O}_4$  (CZF) nanoparticles (NPs) are investigated and compared with the unsubstituted  $\text{CuFe}_2\text{O}_4$ . PXRD (powder X-ray diffraction) pattern and HRTEM (high-resolution transmission electron microscopy) observation with FTIR (Fourier transform infrared) spectroscopy are applied to analyze the microstructural and optical properties of nanosized ( $\sim 14.7$  nm) zinc substituted copper ferrite. Rietveld refinement of the PXRD pattern reveals the mixed spinel structure of zinc substituted copper ferrite NPs. Magnetic data confirms the presence of ferromagnetic/ferrimagnetic phase with some admixture of finer superparamagnetic (SPM) nanophases within the sample. The lack of saturation in the M-H loops is due to the presence of spin-canting as well as SPM NPs in the system. These coupled Zn substituted  $\text{CuFe}_2\text{O}_4$  magnetic NPs are used as a heterogeneous catalyst for three-component Huisgen 1,3-dipolar CuAAC green catalytic click reactions in aqueous media and dye degradation. Its catalytic reactivity has been compared with  $\text{CuFe}_2\text{O}_4$  NPs. By this synthesized magnetic catalytic CZF NPs, we have successfully coupled alkyl halides and boronic acids with terminal alkynes to obtain 1,4-disubstituted 1,2,3-triazoles in good to excellent yields within a short time. The Heterogeneity, reproducibility and reusability of the catalyst has been also tested successfully up to several cycles without significant decrease in the product yield. We have explored CZF NPs as magnetically separable heterogeneous green catalyst for multi-component click reaction. Our synthesized CZF NPs has been used as photocatalyst for the photo degradation of organic dyes under visible light irradiation. The results demonstrate that the unique features of the CZF NPs make it an excellent material for a click chemistry catalyst as well as a highly active photocatalyst under visible light irradiation.

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## 1. Introduction

Heterogeneous green catalytic click chemistry is becoming an increasingly important field owing to some specific properties: a) green chemistry: the reaction proceeds in neat condition, only in presence of catalyst, b) ease of separation: the catalyst can be separated from the reaction mixture by simple filtration, c) click chemistry: click chemistry gives very high yield of desired products and maximum conversion [1]. Catalytic click chemistry involves highly efficient organic reactions of two or more chemical com-

ponents in a single step or consecutive steps to synthesize the desired product(s) under eco-benign conditions. The MOFs [2], metal NPs [3], metal-oxide NPs [4] etc. are some common heterogeneous catalysts employed in such click chemistry, but the practice of using magnetically separable spinel ferrites in this field is relatively infrequent [5]. On the other hand, Copper catalyzed azide-alkyne cycloaddition (CuAAC) is a prime example of "click chemistry" reaction having applications in organic synthesis, surface and polymer chemistry, medicinal chemistry, chemical biology and materials science. The CuAAC reaction transforms terminal alkynes and organic azides exclusively into 1,4-disubstituted 1,2,3-triazoles.

Nowadays, the nano-structured spinel ferrites have come out as powerful aspirant in the field of material science due to their ex-

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# Row–Column Designs with Minimum Non-orthogonality Indices

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## Abstract

Orthogonality is an important concept in design of experiments. In the block design context, when a design is not orthogonal, some measures of or indices to non-orthogonality and characterization of designs possessing minimum non-orthogonality indices are available in the literature. In this paper, for the row–column design set-up, similar indices to non-orthogonality have been proposed and designs possessing minimum non-orthogonality indices have been characterized.

**Keywords** Block design · Row–column design · Non-orthogonal design · Non-orthogonality index · Balanced incomplete block design · Balanced block design · Youden square design · Generalized Youden design

## 1 Introduction

Consider a row–column (R–C) design set-up with  $v$  treatments in a rectangular  $k_1 \times k_2$  array with  $k_1$  rows and  $k_2$  columns and with no missing observations. Let  $\mathbf{y}$  be the vector of observations following the model:

$$\mathbf{y} = \mu \mathbf{1} + D_1 \boldsymbol{\beta} + D_2 \boldsymbol{\pi} + D_3 \boldsymbol{\tau} + \mathbf{e} \quad (1.1)$$

where (1)  $\mu$ ,  $\boldsymbol{\beta}$ ,  $\boldsymbol{\pi}$  and  $\boldsymbol{\tau}$  stand respectively for the fixed mean effect, vectors of row, column and treatment effects; (2)  $\mathbf{e}$  is a vector of random errors, assumed to have null mean vector and dispersion matrix  $\sigma^2 \mathbf{I}_n$ ,  $\mathbf{I}_n$  being an identity matrix of order  $n = k_1 \times k_2$ ; (3)  $D_1$ ,  $D_2$  and  $D_3$  represent respectively the observation vs. row, column and treatment incidence matrices; (4)  $\mathbf{1}$  is an  $n \times 1$  vector with all elements unity.

We restrict to the class D of row–column (R–C) designs which ensures estimability of all contrasts belonging to treatment, row and column effects simultaneously.

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## Chemical characterization of n-alkane compounds in the leaves of *Holoptelea integrifolia* and its repellence against Japanese encephalitis vector

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**ABSTRACT:** Epicuticular wax extract bearing n-alkane compounds were isolated from leaves of *Holoptelea integrifolia* and its chemical characterization was done by GC-MS analysis. Seven n-alkane compounds were isolated from epicuticular wax of *H. integrifolia*, which are Undecane [C<sub>11</sub>H<sub>24</sub>], Decane 5-methyl- [C<sub>11</sub>H<sub>24</sub>], Dodecane [C<sub>12</sub>H<sub>26</sub>], Undecane, 3,6-dimethyl- [C<sub>12</sub>H<sub>26</sub>], Hexadecane, 2,6,10,14-tetramethyl- [C<sub>20</sub>H<sub>42</sub>], Tridecane [C<sub>13</sub>H<sub>28</sub>], and Tetradecane [C<sub>14</sub>H<sub>30</sub>]. Different concentrations of crude extract as well as epicuticular wax extract bearing n-alkane each @ 2, 4 and 5 ppm cm<sup>-2</sup> applied on human hand surface for repellence against *Culex vishnui* (vectors of JE) and at different time of exposure, gave a maximum protection of 73.33 per cent in the case of crude extract, and 94.33 per cent with epicuticular wax extract, both at 5 ppm cm<sup>-2</sup>, up to five hours of exposure. © 2022 Association for Advancement of Entomology

**KEYWORDS:** Indian Elm tree, epicuticular wax extract, repellent, *Culex vishnui* group

Mosquito at the time of blood feeding transmits extremely harmful pathogens from host to host causing malaria, yellow fever, dengue, zika, filariasis, and Japanese encephalitis (JE). Female mosquito uses blood meal as protein and vitamin source for egg development and blood proteins are used as building blocks for the synthesis of egg yolk proteins. The first major epidemic of JE in India was reported from Bankura and Burdwan districts of West Bengal in 1973 (Curic *et al.*, 2014), caused by the mosquito borne JE virus (Mahmud *et al.*, 2010). According to WHO (1981) more than 3 billion people of South-East Asia and Western Pacific regions are under the risk of JE transmission. Extracts of different parts of several plants have been reported earlier as mosquito repellent along with others

activities (Adhikari *et al.*, 2012; Rawani *et al.*, 2012; Adhikari and Chandra, 2014; Bhattacharya and Chandra, 2014; Halder *et al.*, 2014).

Epicuticular wax on the surface of plant leaves and other parts of the plant plays an important ecological role in interaction with insects as attractant or deterrent (Muller, 2006). *Holoptelea integrifolia* (Roxb.) belonging to the family Ulmaceae and commonly known as the Indian Elm tree, is found all over the Indian peninsula (Mahmud *et al.*, 2010). From ancient times, this tree was well known due to its medical importance. Traditionally different parts of this plant were used for the treatment of different diseases like inflammation, gastritis, dyspepsia, colic, intestinal worms, vomiting, wound

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