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*Journal of Stress Physiology & Biochemistry, Vol. 19, No. 4, 2023, pp. 63-70 ISSN 1997-0838*


**ORIGINAL ARTICLE**

# Arsenic Induced Oxidative Stress and Role of Scavenging Enzymes in Phytoremediation by *Pteris vittata* and *Eichhornia crassipes*

Supatra Sen

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Received May 23, 2023

Arsenic pollution is a growing menace in major parts of West Bengal, India and Bangladesh. Arsenic phytoremediation abilities of two common plants *Pteris vittata* and *Eichhornia crassipes* growing abundantly under natural tropical conditions of India were biochemically analyzed. Reactive oxygen species, taking total peroxide and malondialdehyde contents as the parameters, indicate the extent of arsenic induced oxidative stress, while the activities of the scavenging enzymes catalase, peroxidase and superoxide dismutase indicate the comparative effectiveness of the two plants in arsenic detoxification. Total peroxide and MDA contents were significantly higher in all samples of *Eichhornia* as compared to *Pteris* throughout the experimental period while the three scavenging enzymes *viz.* catalase, peroxidase and superoxide dismutase exhibited higher activities in *Pteris* with increasing arsenic concentration while *Eichhornia* showed a reverse trend. The comparative study reveals that *Pteris vittata* is the more efficient plant in combating and tolerating arsenic stress, as revealed by the results obtained of biochemical constituents and enzymatic profile. Of the two selected plant species, *Pteris* is found to be more effective in arsenic removal can serve as a cheap and easily available green source for arsenic detoxification.

*Key words: Arsenic toxicity, oxidative stress, reactive oxygen species, plant antioxidant defense, stress amelioration*

*Journal of Stress Physiology & Biochemistry, Vol. 19, No. 4, 2023, pp. 43-55 ISSN 1997-0838*


**ORIGINAL ARTICLE**

# Impact of Seasonal Stress on Reactive Oxygen Species and Scavenging Enzymes of Two Crop Plants Growing Under Tropical Indian Conditions

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Nearly all metabolic changes and responses in the plant life cycle are influenced by seasonal environmental conditions which profoundly affect their growth, yield and metabolism. This work was carried out under tropical environmental conditions of Kolkata, West Bengal, India in three seasons –summer, rainy and winter in two stages – preflowering and postflowering to study the effect of seasonal variations (if any) on some select antioxidants and scavenging enzyme activities in Okra (*Abelmoschus esculentus* L. Moench) and Tomato (*Lycopersicon esculentum* Mill.) to determine the favourable/unfavourable seasons for growth and yield and thus correlate with the yield quality. Favourable seasons (summer for *Abelmoschus;* winter for *Lycopersicon*) recorded low reactive oxygen species production accompanied by elevated activities of scavenging enzymes while the unfavourable seasons (winter for *Abelmoschus;* rainy for *Lycopersicon*) showed the opposite trend. These periods were marked by abundant production of free radicals (meaured as MDA and total peroxide contents), accompanied by poor scavenging and reduced detoxification of these active oxygen species by the antioxidants ( ascorbic acid) and scavenging enzymes (SOD, catalase, peroxidase, ascorbate peroxidase, glutathione reductase, ascorbic acid oxidase). These results could be well correlated with yield and yield quality of these two crop plants. The parameters under study served as useful bioassay indices of environmental stress, while the two plants acting as a measure of the prevailing environmental conditions, can serve as efficient bio indicator species. Thus, plant response to environment indicates the enormous impact of environmental stress on agricultural productivity.

*Key words: Abiotic stress, Antioxidative defense, Bioindicator, Seasonal variations*

# Impact of Wastewater from Outfall of River on Bitter Gourd: Morphological and Biochemical Studies, Peptide Synthesis and Antioxidant Activity



**Authors:** Kar, Sayanti [1]; Ghosh, Indrajit [1]; Ghosh, Amrava [2]; Aitch, Pritam [1]; Bhandari, Gupinath [1];
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**DOI:** https://doi.org/10.5276/jswtm/iswmaw/49/4/2023.384

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Abstract  References  Citations  Supplementary Data  Suggestions

River pollution poses a significant concern for the people of India who heavily rely on river water for daily needs. This study focuses on assessing the status of river pollution in West Bengal, India, with a particular emphasis on a major canal (N22° 39'08.75" E88° 21'27.60") near Dakhineswar New Jetty, known for its Kali Temple and frequent ritual activities. The region's dependence on river water is evident in daily life. Analysis of three consecutive years (2016-2018) reveals alarming levels of Total Coliform, reaching up to 8.18 x 106 MPN/100ml during the premonsoon season. Disturbingly high concentrations of Lead (0.069 mg/L) and Mercury (0.008 mg/L) are recorded. Average Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) are 2.3 mg/L and 7.9 mg/L, respectively, during the premonsoon. The impact of wastewater on Bitter Gourd (Momordica charantia L.) manifests in detrimental changes to both morphological and biochemical parameters, including total chlorophyll and protein content. Low molecular weight peptide(s) (3.0-0.5 kDa) are extracted, purified, and analyzed through ion exchange resin column, ultra-filtration, and HPLC. HPLC analysis distinguishes the presence of peptides compared to the control, revealing adverse effects of wastewater. The antioxidant activity of low molecular weight peptide(s) is demonstrated through DPPH scavenging. Bioassays, such as the germination percentage of wastewater-treated Bitter Gourd seeds,

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# Outlier detection in social networks leveraging community structure

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ARTICLE INFO

*Keywords:*
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ABSTRACT

Social networks have become an important aspect of our modern times and are gradually becoming an integral means of communication worldwide. Overwhelming amounts of data are being transferred over social networks every day. Hence ensuring security becomes a necessity. Suspicious users or spammers may pose a threat to the information and data shared by users over the network. With this in mind, outliers detection is a crucial aspect of network communication. In our paper, a new technique is proposed to identify the anomalies in a network from a global perspective by using the network community structure. In general, state-of-the-art outliers detection algorithms mainly focus on the individual nodes and their direct neighborhood. But our technique considers only those nodes which tend to belong to multiple communities or whose neighbors belong to the same community or do not belong to any community. Results after experiments on synthetic and real-world networks show an improvement of 7-10% and 29% in F-Score and Jaccard similarity, respectively, compared to the state-of-the-art algorithms. Furthermore, we achieve almost 1.83 times speedup compared to the state-of-the-art algorithms.

## 1. Introduction

In the last few decades, Social Networks (SNs) have become an important medium of communication between users around the world, where a huge amount of data and information are being shared across its users. Today, social networks like Facebook, Twitter, and others contain billions of users. It becomes extremely important to validate these users since they may pose a threat to the information being shared over the network and may result in theft, fraud, organized crime, or even terrorist activity [1]. Hence, identifying suspicious users in Social Networks has recently drawn major attention.

In general, social networks contain communities [2] where users form closely connected subgroups, so connections between the subgroups are sparse compared to those within the same subgroup [3,4]. *Outliers* in SN are defined as the users who tend to belong to more than one community or whose neighbors either belong to only one community or do not belong to any community [5]. So far, various studies have identified the outliers in SNs [6–10], but a majority of them are slow and are computation intensive.

This paper shows a fast way to find outliers in social networks by using the network's community structure. The search space is greatly reduced by focusing on only the pendant nodes and *community boundary nodes* (CBNs),[1] which are most likely to be outliers. We then evaluate the association of the CBNs within their communities using a node-based metric called *permanence* [11].

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[1] Community boundary nodes are those nodes that contain inter-community edges.

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# Mixed synchronization in multiplex networks of counter-rotating oscillators

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*Keywords:*
Counter-rotating oscillators
Relay mixed synchronization
Mixed intralayer and interlayer synchronization
Multiplex network
Master stability function analysis

ABSTRACT

In this study, we introduce a novel concept known as "mixed synchronization" within the context of two indirectly coupled counter-rotating oscillators. Our investigation begins by exploring the dynamics of two co-rotating oscillators when they are connected through a counter-rotating relay oscillator. Remarkably, this coupling mechanism leads to the emergence of what we term "relay synchronization," which signifies complete synchronization between the outer oscillators. This intriguing phenomenon lays the foundation for our subsequent exploration. We delve deeper into the dynamics of counter-rotating oscillators and discover that when two such oscillators are linked through relay oscillators, a distinct form of synchronization arises, which we aptly term "relay mixed synchronization." Notably, this reveals that even if counter-rotating oscillators are part of a larger network and indirectly coupled through a simple diffusive mechanism, it is possible to induce mixed synchronization. We extend the same innovative concept to the realm of multiplex networks, which consist of a finite number of counter-rotating oscillators in each layers and we explore both intralayer and interlayer mixed synchronization states. We verify the mixed synchronization state by master stability function analysis. We numerically verify the results by considering limit cycle and chaotic oscillators. This extension of our concept to multiplex networks showcases the versatility and applicability of mixed synchronization in diverse scenarios.

## 1. Introduction

In the past few decades, complex networks have emerged as one of the most active research areas due to their excellent modeling of coupled dynamical systems in physics, biology, social sciences, and engineering [1,2]. A network is composed of a collection of nodes and a set of links between them [3], and as an extension of such networks, most of the complex systems in the real world can have effectively modeled as multilayer networks [4], for example, transportation networks [5], neuronal networks [6], social networks [7] etc. A multilayer network is simply a collection of networks with a set of links between the nodes in different layers, which are named interlayer links, and the links within a layer are called intralayer links. However, a particular type of multilayer network is a multiplex network in which each layer is composed of the same set of nodes, and the interlayer links between the replica nodes of adjacent layers are one-to-one, but each layer may represent different interactions, the state of the corresponding nodes in each layer can be different, and the connections between the nodes (intralayer networks) can differ from layer to layer. By studying multiplex networks, we can better understand real-world systems' underlying structural and dynamical characteristics.

Synchronization [8–10], wherein the system individuals evolve in unison, is one of the fascinating phenomena observed in multiplex networks, which have captivated a lot of attention in the area of network research. Numerous types of synchronization phenomena occur in multiplex networks such as cluster synchronization [11], antiphase synchronization [12], explosive synchronization [13,14], chimera states [15,16], intralayer synchronization [17], interlayer synchronization [18–20], and relay interlayer synchronization (RIS) [21,22]. Here, in this article, we will define two new types of synchronization: mixed intralayer and mixed interlayer synchronization. It has been reported earlier that the state variables of the coupled counter-rotating oscillators emerge into a mixed synchronization (MS), where a pair of state variables develops a complete synchronization (CS) state while another pair is in an antisynchronization (AS) state [23]. But what will happen if we consider two indirectly coupled counter-rotating identical oscillators coupled via another one or more oscillators? We see that MS again appears for that case also. Then we extend it up to a multiplex network. Correspondingly we have to define two new types of synchronization namely ‘‘mixed intralayer and mixed interlayer synchronization’’, which is the main focus of this report.

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# Water hyacinth (*Eichhornia crassipes* and *Epipremnum aureum*) - a potent tool for the removal of cadmium and chromium from industrial discharges

Himshweta Singh[a], Vishal Tripathi[b], Alka[c], Harish Chandra Joshi[d], Gaurav Kumar[e,*], Gaurav Pant[f,*], Kaizar Hossain[g,*], Akil Ahmad[h], Mohammed B. Alshammari[h]

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**ABSTRACT**

Industrial discharge is one of the major reasons for increasing heavy metal intoxication in the ecosystem and is a cause of global apprehension. The introduction of policies for periodically limited duration shutdown of industries might provide a way forward for reducing the pollutant loads in river bodies. Further, hyper-accumulator plants could serve as cost-effective alternatives to conventional sewage treatment facilities but comparative studies with native water hyacinth as natural water filtration systems with limnological studies and risk assessment remain to be determined. We here investigated the most polluted industrial effluent among ten industries during SARS-CoV-2 pandemic confinement (pre- and post-lockdown, that is, February 2020 and October 2020) in Mathura industrial area, India in terms of chromium and cadmium toxicity. Besides, the biosorbent potential of native *Eichhornia crassipes* and *Epipremnum aureum* plants was also estimated by triplicate batch experiments (7 d) from the most polluted industrial effluent. For risk assessment, the Metal Quality Index (MQI), Pearson's correlation coefficient analysis, and Heavy Metal Pollution Index (HPI) were calculated, while the students' paired sample *t*-test was employed to determine the statistical significance of changes in HPI and MQI. The findings revealed that the mean HPI for Cr (166,545 and 53,797) and Cd (96.11 and 9.78) were found to be extremely high during the pre-lockdown period which reduced significantly in the post-lockdown period. For student's *t*-test analysis, the *p*-values for the investigated sites were initiated to be considerably below the 0.05 level of significance. While results demonstrate removal efficiency of 67.66% and 61.22%, respectively in *E. crassipes*, whereas it was 44.26% and 38.90% in *E. aureum*. Low levels of student's *t*-test and *p*-values suggest a transient statistical impact of pandemic confinement on the water quality of studied sites and may help to alter pollution control policies and actions to make sure the environment is sustainable and safe. In addition, information makes it possible to conclude that money plants and water hyacinths both are effective candidates for removing chromium and cadmium from industrial effluents. This paper also summarizes the prospects for the scientific area of biosorption and bioaccumulation, focusing on its underlying assumptions, potential environmental benefits, and practical applications.

*Keywords:* Heavy metals; Biosorption; *Eichhornia crassipes; Epipremnum aureum;* Industrial effluents

* Corresponding authors.

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Review

# Perspectives on Usage of Functional Nanomaterials in Antimicrobial Therapy for Antibiotic-Resistant Bacterial Infections

Arun Karnwal,* Gaurav Kumar, Gaurav Pant, Kaizar Hossain,* Akil Ahmad, and Mohammed B. Alshammari

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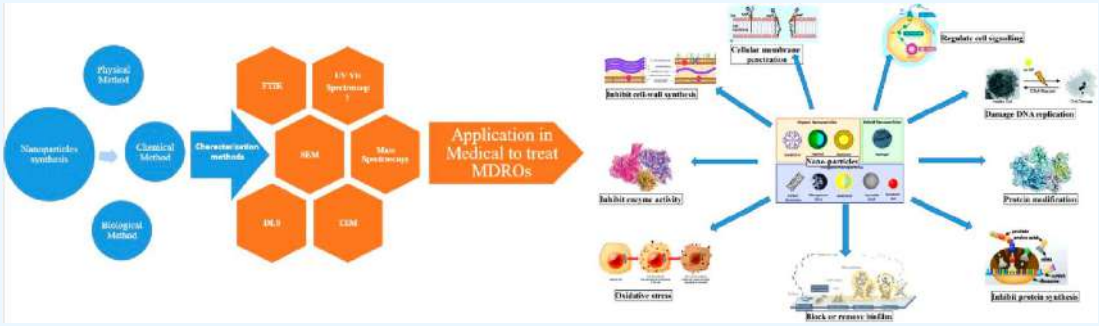


**ABSTRACT:** The clinical applications of nanotechnology are emerging as widely popular, particularly as a potential treatment approach for infectious diseases. Diseases associated with multiple drug-resistant organisms (MDROs) are a global concern of morbidity and mortality. The prevalence of infections caused by antibiotic-resistant bacterial strains has increased the urgency associated with researching and developing novel bactericidal medicines or unorthodox methods capable of combating antimicrobial resistance. Nanomaterial-based treatments are promising for treating severe bacterial infections because they bypass antibiotic resistance mechanisms. Nanomaterial-based approaches, especially those that do not rely on small-molecule antimicrobials, display potential since they can bypass drug-resistant bacteria systems. Nanoparticles (NPs) are small enough to pass through the cell membranes of pathogenic bacteria and interfere with essential molecular pathways. They can also target biofilms and eliminate infections that have proven difficult to treat. In this review, we described the antibacterial mechanisms of NPs against bacteria and the parameters involved in targeting established antibiotic resistance and biofilms. Finally, yet importantly, we talked about NPs and the various ways they can be utilized, including as delivery methods, intrinsic antimicrobials, or a mixture.



## 1. INTRODUCTION

Bacteria were the oldest living things to be identified on Earth, and throughout billions of years, they have evolved to become extraordinarily adaptable to the environment.[1] During the 20th century, the discovery of antibiotics was considered one of the most important medical discoveries ever made. It commenced with Salvarsan, among the first drugs to cure syphilis without harming sufferers.[2] Although, research on antibiotics did not begin until 1928 when Alexander Fleming discovered penicillin by accident. This research reached its pinnacle in the 1950s and 1960s, which emerged as the "golden period" of antibiotics study. During 1930 and 1962, over 20 new antimicrobial classes were discovered; however, new bacteria strains emerged that were resistant to existing antibiotics, making it even more difficult for drug companies to find new compounds that have antibacterial activity.[2,3] The development of antibiotic resistance in bacteria has led to the difficult problem of treating resistant infections. The emergence of bacteria that are resistant to multiple drugs is a global problem that is increasing the risk of morbidity and mortality among infected people and having a negative impact on the clinical outcome of a diverse range of patients like those admitted into the ICU, recently operated on or undergoing operation, organ transplant, or treatment for cancer.[4,5] Antibiotic resistance was identified as a global problem in a report published in 2017 by the WHO Global Antimicrobial Surveillance System. The anticipated cost of treating infections that are resistant to antibiotics is high (about US$50,000 per individual), and the annual cost to society is estimated to be US$20 billion.[6] This already serious threat to public health is made even worse because there are so

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# Critical Watershed Prioritization through Multi-Criteria Decision-Making Techniques and Geographical Information System Integration for Watershed Management

**Sudipto Halder [1], Abhishek RoyChowdhury [2,*], Sayanti Kar [3], Debdas Ray [4] and Gupinath Bhandari [5]**

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**Abstract:** The Precambrian hard rock topography of the Manbhum-Singhbhum plateau, which is well known for its semi-arid climates prone to drought, is often seen in Purulia district in West Bengal, India. Despite the district's middling groundwater capacity, 17 out of 20 blocks have exorbitant fluoride pollution in the groundwater that negatively impacts the health of local residents. Approximately 13% of the whole area suffers from severe erosion. It is evident that the river Kangsabati and its tributaries are not well fed by rainwater and thereby there is always a dearth of ground water. The aim of this study was to identify and prioritize integral watersheds in the Purulia area using Multi-Criteria Decision Making (MCDM) and Geographic Information Systems (GIS). The evaluation was carried out in the Bandu sub-watershed, which contains five micro watersheds: 2A2B5m, 2A2B5k, 2A2B5h, 2A2B5b, and 2A2B5j. The analysis considered five major factors: lithological properties, land use and land cover, soil erosion, groundwater recharge, and hydrogeomorphology. The weights of these criteria were determined by the Analytical Hierarchy Process (AHP) model, which was then prioritized using the Techniques for Order of Preference by Similarity to the Ideal Solution (TOPSIS) technique. This study emphasized an integrated approach to assess watershed hazards and to establish rational conservation goals. The Central Ground Water Board (CGWB) of India report was referred during data analysis. As a result of this study, the 2A2B5k watershed emerged as the most critical due to its susceptibility across the analyzed parameters. This thorough plan demonstrated the usefulness of identifying watershed threads and prioritizing conservation efforts.

**Keywords:** Multicriteria Decision-Making techniques; Geographic Information System; Analytical Hierarchy Process; Technique for Order of Preference by Similarity to Ideal Solution; Central Ground Water Board



**Citation:** Halder, S.; RoyChowdhury, A.; Kar, S.; Ray, D.; Bhandari, G. Critical Watershed Prioritization through Multi-Criteria Decision-Making Techniques and Geographical Information System Integration for Watershed Management. *Sustainability* **2024**, *16*, 3467. https://doi.org/10.3390/su16083467

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## 1. Introduction

Critical watershed identification is the process of assessing and prioritizing watersheds based on different attributes and traits to ascertain their significance and susceptibility for environmental preservation and natural resource management. Setting watersheds as a top priority helps to improve overall water resource management by facilitating the implementation of artificial recharge zonation and promoting the development of soil and groundwater [1]. In order to map the drainage network and prioritize soil and water conservation efforts in susceptible areas, a methodical scientific technique is utilized to rank sub-watersheds within a basin. Hydrologists claim that as morphometric analysis provides an accurate and quantitative picture of Earth's topography; it garners greater attention in

# Impact of Wastewater from Outfall of River on Bitter Gourd: Morphological and Biochemical Studies, Peptide Synthesis and Antioxidant Activity



**Authors:** Kar, Sayanti [1]; Ghosh, Indrajit [1]; Ghosh, Amrava [2]; Aitch, Pritam [1]; Bhandari, Gupinath [1];
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**DOI:** https://doi.org/10.5276/jswtm/iswmaw/49/4/2023.384

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River pollution poses a significant concern for the people of India who heavily rely on river water for daily needs. This study focuses on assessing the status of river pollution in West Bengal, India, with a particular emphasis on a major canal (N22° 39'08.75" E88° 21'27.60") near Dakhineswar New Jetty, known for its Kali Temple and frequent ritual activities. The region's dependence on river water is evident in daily life. Analysis of three consecutive years (2016-2018) reveals alarming levels of Total Coliform, reaching up to 8.18 x 106 MPN/100ml during the premonsoon season. Disturbingly high concentrations of Lead (0.069 mg/L) and Mercury (0.008 mg/L) are recorded. Average Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) are 2.3 mg/L and 7.9 mg/L, respectively, during the premonsoon. The impact of wastewater on Bitter Gourd (Momordica charantia L.) manifests in detrimental changes to both morphological and biochemical parameters, including total chlorophyll and protein content. Low molecular weight peptide(s) (3.0-0.5 kDa) are extracted, purified, and analyzed through ion exchange resin column, ultra-filtration, and HPLC. HPLC analysis distinguishes the presence of peptides compared to the control, revealing adverse effects of wastewater. The antioxidant activity of low molecular weight peptide(s) is demonstrated through DPPH scavenging. Bioassays, such as the germination percentage of wastewater-treated Bitter Gourd seeds,

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ORIGINAL ARTICLE

# An investigation of small and marginal holder farmers' adaptation strategies to climate variability and its determinants in coastal agriculture: evidence from east coast of India

**Sumit Panja**[1] · **Sayani Mukhopadhyay**[1]

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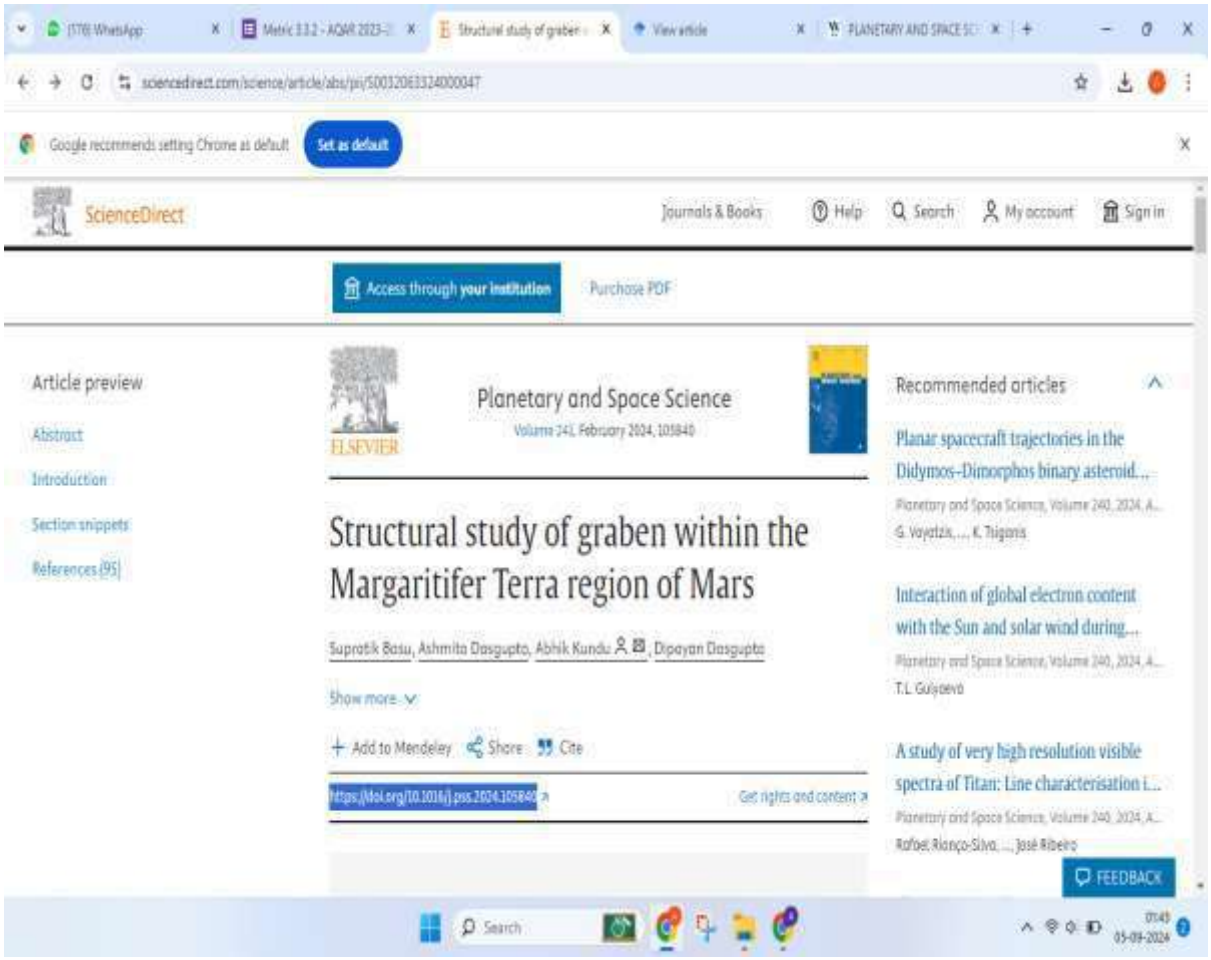
## Abstract

The Intergovernmental Panel on Climate Change (IPCC) has mentioned that coastal areas would be the worst sufferers of climate change-induced variabilities and extremes, severely affecting the farming community, particularly in developing countries. Farmers are developing different field-based and livelihood-based adaptive mechanisms depending on several socio-economic, institutional and locational factors. Previous studies were concentrated on agriculture and its adaptation strategies against climate change, but considering coastal agriculture in the context of climate variability is largely unexplored. This study aims to find controlling factors of coping mechanisms against climate variability for coastal agriculture on the east coast of India. A questionnaire survey and focused group discussion have been conducted to collect and validate farmers' perceptions of climate variability. The study has applied a binary logit model and established that socio-economic farming system attributes and locational factors influence farmers' decision to adopt farm-level and livelihood adaptations. Most farmers (> 80%) have perceived that rainfall variability has increased, which is a major issue for agriculture in this area. The logistic regression models successfully predicted nearly 70% of the variables in each model. The model indicated that variables like experience, education, land ownership, involvement with marine fishing and distance from the coast influenced adaptation mechanisms against climate variability. The findings of the study have underlined the factors that need more attention for better management of coastal agriculture in the context of climate variability and can help to formulate better climate adaptation policies in the coastal areas of India and areas with similar backgrounds.

**Keywords** Climate variability · Coping mechanism · Farmers' perception · Logistic regression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RESEARCH ARTICLE

# Biochemical Responses in Zebra Fish (*Danio rerio*) on Acute Cadmium Exposure Under Temperature Variations

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**Abstract** Increased urbanization and human activities have led to global warming and the discharge of heavy metals into water. With this background, the current study was aimed to assess the effect of cadmium (Cd) upon acute exposure (3–8 mg/L) and increasing temperature (18–34 °C) using zebra fish (*Danio rerio*), a representative small indigenous freshwater fish. Changes in glucose, total protein, free and conjugated bilirubin, cholesterol, triglycerides, and heat shock proteins in hepatic tissue homogenate supernatant were measured to understand the toxicological effects of these two stressors. Among different biochemical parameters, glucose level exhibited a highly significant increase ($p < 0.05$) in fishes maintained at 34 °C and exposed to Cd (416 ± 02 mg/L) compared to the control group (276 ± 13 mg/L). At higher temperatures, zebrafish mortality due to cadmium exposure increased, indicated by a lower median lethal concentration. This was accompanied by a notable increase in the expression of heat shock proteins 70 and 90. The study confirms that temperature is a potent environmental factor confounding cadmium toxicity.

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# Perspectives on Emerging Trends and Technologies in Digital Journalism

Debastuti Dasgupta and Alok Kumar Sahai*

*Journalism has seen a sea change in the way data and information are gathered, processed, produced, distributed and consumed. This calls for novel and more efficient ways to process and distribute news content. With the shortened attention spans and a multitude of offerings, only the most attractive and captivating content will find takers and the associated advertising revenues.*

*New-age technologies such as artificial intelligence, machine learning, robotics, virtual reality and augmented reality have automated the news and entertainment content creation process. With the rise and popularity of interactive and immersive content and social media publishing, consumers have become co-creators of content. The miniaturization of consumer electronics has reduced the size of screens while multiplying the number a million times.*

*Artificial intelligence has enabled micro-targeting of the consumer as per his choice while VR/AR provide an immersive experience. Digital tracking of consumers makes it possible to change the style and flavour of the content. Already AI applications like Chat GPT have started creating content and by 2050 AI-enabled writing and reporting might be the norm. This paper presents a panoramic view of the emerging trends and technologies taking place in the field of journalism.*

**Keywords:** *Artificial intelligence, Virtual reality, Augmented reality, Robotic journalism, Blockchain, Chat GPT*

## I. INTRODUCTION

Information touches our everyday lives in more than one way. A flurry of messages calls for our attention all day long. Global news, current affairs, traffic, sports fixtures, and financial updates are coming from all directions. Our sensory organs of eyes and ears are constantly barraged by a multitude of threads of news ranging from simple text messages to highly complex multimedia messages. Even if we are not looking for news it comes to us often creating information overload and deluge (Shenk, 1997). This marks a sea change, in the way news media is consumed today, brought

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# SATYAJIT RAY AS A DOCUMENTARIAN: A STUDY ON *RABINDRANATH TAGORE AND SUKUMAR RAY*

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## ABSTRACT

Satyajit Ray, renowned globally for his cinematic brilliance, also left an indelible mark as a documentary filmmaker. It is to be mentioned here that the literatures and writings on Ray's documentary are very less in number. Ray's documentaries on Rabindranath Tagore encapsulate the multifaceted persona of the Nobel laureate, exploring his literary contributions, artistic vision, and philosophical ideologies. Through meticulous research and visual finesse, Ray elucidates Tagore's timeless relevance, weaving together archival footage and dramatic reenactments to present a holistic portrayal of the poet's life and legacy. In his exploration of *Sukumar Ray*, Satyajit Ray ventures into the whimsical world of children's literature and satire to commemorate the centenary birth anniversary.

This paper tries to discuss on documentaries made by Ray with special emphasis on *Rabindranath Tagore and Sukumar Ray*. Besides reviewing relevant literatures, the researchers have tried to describe two documentaries vividly. In addition to this, they also have taken insightful interviews of three literary and film scholars to understand Ray as documentarian. The interviews were analysed and conclusion have been drawn on the basis of that. The paper shows, beyond mere biographical documentation, Satyajit Ray's documentaries serve as nuanced reflections on the socio-cultural milieu of their respective times, offering profound insights into the artistic legacies of Rabindranath Tagore and Sukumar Ray. The paper serves to highlight the intricate nature of Ray's documentary legacy and its ongoing significance in influencing conversations within Indian cinema.

**Keywords:** Documentary Film, Satyajit Ray, Rabindranath Tagore, Sukumar Ray

## 1. INTRODUCTION

Most people associate the Indian filmmaking industry with commercial rom-coms, vibrant songs, dance, fictional dramas, etc. but India has a rich history of documentary filmmaking that was started well before India's independence in 1947. In 1888 'Pundalik Dada' by H.S. Bhatwadekar became the first Indian documentary and Bhatwadekar became the one who started exploring the non-fiction genre of cinema. Later on, many popular filmmakers like P.V Pathy, D.G. Tendulkar, K.S Hirlekar started working on documentaries based on Indian themes. Indian

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# Lorentz and gauge invariance of quantum space

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Motivated by the generalized uncertainty principle, we derive a discrete picture of the space that respects Lorentz symmetry as well as gauge symmetry by setting an equivalency between the linear Generalized Uncertainty Principle (GUP) correction term and electromagnetic interaction term in the Dirac equation. We derived a wave function solution that satisfies this equivalency. This discreteness may explain the crystal and quasicrystal structures observed in nature at different energy scales.

*Keywords*: Lorentz; gauge invariance; quantum; generalized uncertainty principle; Dirac equation.

## 1. Introduction

Various approaches of quantum gravity predict an existence of minimum measurable length.[1–17] The minimal length and the Generalized Uncertainty Principle (GUP) models attracted experimental and observational studies on atomic physics,[18,19] quantum optics,[20] gravitational bar detectors,[21] quantum gravitational decoherence,[22] condensed matter physics,[23] cold atoms[24] and gravitational waves.[25] A review on minimal length theories can be found in Ref. 26. One of the GUP models

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# Ricci-cubic holographic dark energy

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ABSTRACT

In this work, we propose the Ricci-cubic holographic dark energy model. The model is inspired by the cubic curvature invariant formed by the contraction of three Riemann tensors. A combination of Ricci scalar and the cubic invariant is used to describe the infrared cutoff of the holographic dark energy. Such a construction is extremely useful since the evolution does not depend on the past or future features of the universe, but completely on its present features. Moreover, the use of invariants makes the theory more fundamental in nature. We have constructed the model and studied its cosmological features. The analytical solutions of various cosmological parameters such as the density parameter, equation of state parameter, and deceleration parameter are extracted and their behaviour is studied. It is seen that the holographic dark energy model can exhibit all the cosmological epoch, sequentially starting from radiation in the early universe, followed by matter, and finally the dark energy dominated epoch at late times. The equation of state parameter shows that the model can exhibit quintessence nature, phantom-divide crossing, and even phantom nature depending on the choice of parameter spaces.



## 1. Introduction

Observations from the SN Ia supernovae have confirmed that of late, the universe has entered in an accelerated expansion phase [1,2]. It is obvious that the long standing matter dominated epoch has come to an end. There are various theoretical framework which can explain this unusual phenomenon, of which, the most usual one is the cosmological constant $\Lambda$ [3]. But in order to find a solution of the dynamical nature one needs to introduce extra degrees of freedom beyond the standard framework of general relativity (GR) [4] and standard model of particle physics. Moreover explaining the entire thermal history of the universe including the early time inflation is always an issue. Modification of GR can be done via two different avenues. The first one is by introducing modifications in the geometrical sector giving rise to *modified gravity theories* [5–7]. The other way is to modify the matter sector thus introducing exotic components with negative pressure known as *dark energy* (DE) [8]. Both these concepts employ extra degrees of freedom as desirable.

There are various candidates of DE available in the literature. Chaplygin gas models [9–13] and scalar field models are notable examples. The holographic principle, which has its origin in the black hole thermodynamics, states that the entropy of a system is characterized by its area and not by its volume [14,15]. Holographic dark energy (HDE) [16–18] has been developed in connection with this holographic principle, which also has connections with the string theory [14,19]. It is known that a quantum field theory has connections with an ultraviolet cutoff which is the largest distance possible under the framework [20]. This ultraviolet cutoff in turn has direct connection with the vacuum energy, which will be a form of dark energy of the holographic origin. For an extensive review on HDE the reader may refer to [21]. There have been extensive research on HDE both in its basic and extended forms and with time the model has been quite successful [22–28]. One of the major success of HDE models have been its compatibility with the observational data [29–31].

It is an accepted fact that the HDE density is proportional to the inverse square of the infrared cutoff $L$ given by,

$$\rho_{DE} = \frac{3c}{\kappa^2 L^2} \tag{1}$$

where $\kappa^2$ is the gravitational constant and $c$ is a parameter. However in connection with the cosmological application of the holographic principle there is no accepted idea about what the infrared cutoff should be. The most common choices are the Hubble radius and the particle horizon which are incapable of driving the cosmic acceleration [32]. Finally it is the future event horizon that suits the scenario and can suitably act as the infrared cutoff [18]. Although this choice suits the scenario well, there are some logical problems associated with it. The present value of the dark energy density is actually determined by the future evolution of the DE, which is quite an uncomfortable concept to deal with. So further attempts have been made in the quest of finding

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# Reconstruction of $f(T,\mathcal{T})$ Lagrangian for various cosmological scenarios

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ABSTRACT

In this paper we explore a reconstruction scheme in the background of the $f(T,\mathcal{T})$ gravity theory for different cosmological scenarios, where $T$ is the scalar torsion and $\mathcal{T}$ is the trace of the energy-momentum tensor. Using the reconstruction technique $f(T,\mathcal{T})$ Lagrangian is constructed for different cosmological eras such as dust, $\Lambda CDM$, perfect fluid, etc. Both minimal and non-minimal matter coupled models are considered for this purpose. Different cosmological scenarios such as power law expansion, de-Sitter expansion, etc. have been considered, and using them Lagrangian functionals are constructed. Mathematical viabilities of all the constructed functionals have been investigated. The physical implications of the obtained solutions are discussed in detail. To check the cosmological compatibility of the constructed $f(T,\mathcal{T})$ functionals we have generated plots of important parameters like the equation of state parameter and deceleration parameter. It is seen that the reconstructed models are perfectly compatible with the late time accelerated expansion of the universe.

## 1. Introduction

In the beginning, it was believed that the universe expanded due to the momentum gained from the big bang. At present the most comprehensive theory of gravity accessible to us is the theory of General Relativity(GR) [1] formulated by Albert Einstein in 1916. It represents one of the most fundamental discoveries of modern physics. After a period of extensive research GR has been more and more easy to handle. With many of its predictions coming true GR is now the cornerstone of gravity research, astronomy, astrophysics and cosmology. In the current cosmological scenario, there are two fundamental questions that have triggered the main object of theoretical and observational physics. One of them is symbolized by the dark matter, an important but invisible component in the current universe that interacts gravitationally on massive galaxies. The other fundamental question of modern cosmology is represented by the phenomenon of dark energy. At the turn of the last century two separate observational studies from far-off type Ia Supernovae (SNIa) demonstrated that the universe is expanding at an accelerated rate. With this observation the concepts of dark energy and dark matter came into existence [2,3]. In view of the attractive nature of gravity, the existence of the dark energy phenomenon signified a paradigm shift in cosmology and theoretical physics. Since then, numerous theoretical hypotheses that can explain the dynamics and core characteristics of this phenomena have been put forth in the scientific literature [4]. According to the most recent astrophysical measurements, the universe is composed of roughly 27% dark matter, 68% dark energy, and around 5% regular baryonic matter [5,6].

Under the scope of general relativity the late universe is assumed to be dominated by a cosmological constant. On the other hand the galaxies and the galaxy clusters ensures the existence of a large amount of dark matter which keeps a strong gravitational attraction between the galaxies and prevents them from breaking apart. These two components together make up the $\Lambda$CDM model, which can explain both the late time acceleration as well the early time radiation dominated epoch of the universe. The $\Lambda$CDM model is the simplest model that can explain the dynamics of the universe as observed on the basic level. But the model is not free from pathologies. The $\Lambda$CDM model suffers from the cosmological constant problem [7] which is the disparity between the observed value of the cosmological constant and the value realized from the quantum regime. The model also fails to resolve the singularity issues surrounding black holes and the big bang and also seems to have a growing tension in some parameters in the late universe [8]. These issues serve as motivation to modify the gravitational framework, and give rise to modified gravity models. The simplest modification is brought about in the $f(R)$ gravity [9–13] where the gravity Lagrangian $R$ is replaced by its arbitrary function $f(R)$ in the Einstein–Hilbert action. It was seen that apart from the curvature description of gravity, we can also have a torsion based equivalent formulation of general relativity. Einstein developed the teleparallel

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# Rotational and inverse-square potential effects on harmonic oscillator confined by flux field in a space–time with screw dislocation

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This research paper delves into the study of a nonrelativistic quantum system, considering the interplay of noninertial effects induced by a rotating frame and confinement by the Aharonov–Bohm (AB) flux field with potential in the backdrop of topological defects, specifically a screw dislocation. We first focus on the harmonic oscillator problem, incorporating an inverse-square repulsive potential. Notably, it becomes evident that the energy eigenvalues and wave functions are intricately influenced by multiple factors: the topological defect parameter $\beta$ (representing the screw dislocation), the presence of a rotating frame engaged in constant angular motion with speed $\Omega$ and the external potential. Then we study the quantum behavior of nonrelativistic particles, engaging in interactions governed by an inverse-square potential, all while taking into account the effects of the rotating frame. In both scenarios, a significant observation is made: the quantum flux field's existence brings about a shift in the energy spectrum. This phenomenon bears a resemblance to the electromagnetic Aharonov–Bohm effect.

*Keywords*: Quantum mechanics; solutions of wave equation; bound states; theories and models of crystal defects; geometric quantum phase; special functions.

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THE EUROPEAN PHYSICAL JOURNAL C



Regular Article - Theoretical Physics

# Relativistic model of anisotropic star with Bose–Einstein density depiction

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**Abstract** In this article, we present a new model for anisotropic compact stars confined to physical dark matter (DM) based on the Bose–Einstein DM density profile and a *bag* model type equation of state (EoS). The obtained solutions are physically well-behaved and represent the physical and stable matter configuration by satisfying the energy conditions, causality conditions, and essential conditions on the stability factor and adiabatic index. The solutions supporting the matter sphere are in an equilibrium state by satisfying the generalized TOV equation. We also find the surface redshift, compactness parameter at the surface, maximum mass, and interestingly, all these values are under the desired range that makes our solution more physically viable. Here, the radially symmetric profiles of energy density, radial and transverse pressures are demonstrated.

## 1 Introduction

The general relativity (GR) theory of Einstein proved incredibly effective in explaining the gravitational phenomena at both cosmological and astrophysical scales. Through the intrinsic gravitational systems, such as star and galaxy structures, which make up a sizable portion of our observable Universe, this theory of gravity achieves important achievements. The study of the evolution of these self-gravitating systems plays a crucial part in revealing the composition, evolution, and age of the universe, among other hidden characteristics. The process of gravitational collapse towards the demise of a celestial structure, which results in the production of compact star objects, is one of the key stages in the evolution of celestial structures. These end-points in the evolution of common celestial formations, or compact star objects, make for excellent research sites for the characteristics and make-up of high-density matter. Numerous compact stellar objects with high densities have recently been found [1], and they are frequently mistaken for pulsars, rotating stars with powerful magnetic fields.

In most galaxies, stars are dispersed in gas and dust clouds with non-uniformly distributed materials. All active stars eventually reach a point in their evolution when the radiation pressure from the internal nuclear fusions can no longer withstand the gravitational pull of space. The star experiences stellar death at this point when it collapses beneath the weight of itself [2]. This is the process that creates a compact star, also known as an extremely dense and compact stellar remnant, for the majority of stars. In other words, the evolution of common stars ends with compact stars, which also include white dwarfs, neutron stars, black holes, and quark stars. Compact star formation may potentially be influenced by the phase separations of the early universe after the Big Bang. Compact stars are distinguished from other stars by their extremely high density and the absence of nuclear processes inside of them. They are unable to support themselves against gravity because of this. The pressure of degraded gas acts as a resistance to gravity in white dwarfs and neutron stars. The star material is infinitely compressed in black holes, where the force of gravity entirely outweighs all other forces and results in infinite density [3]. A dense white dwarf is created when the core of a star similar to the Sun entirely collapses due to nuclear fuel exhaustion. However, an extremely dense neutron star or black hole is created when the inert iron cores

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# Unveiling the fifth state of matter: Insights into ultra-hot plasma and its applications

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This paper presents a study of the dissociation energy of the N–S poles of a quantum magnetic particle, carried out from both classical and quantum mechanical perspectives. A simple model of a harmonic oscillator is employed to estimate the dissociation energy of the N–S poles, as well as the corresponding breakdown temperature and internal pressure. The results indicate that the separation of magnetic poles occurs in two states: (a) in an ultra-hot plasma medium with extremely high temperatures, such as in the core of a hot star and (b) at extremely high pressures, such as between internal plates in complex superlattices of layered solids.

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High Energy Physics – Theory

# Gravitational collapse in energy-momentum squared gravity: Nature of singularities

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ABSTRACT

In this paper we explore a collapsing scenario in the background of energy-momentum squared gravity (EMSG). EMSG claims to have terms that originate from the quantum gravity effects mimicking loop quantum gravity. As a result the framework admits a bounce at a finite time thus avoiding a singularity. So the question that naturally arises: Is there any realistic chance of formation of a black hole or the quantum gravity effects are strong enough to totally avoid such a pathology? Motivated from this we are interested in studying a gravitational collapse mechanism in the background of EMSG and investigate the fate of such a process. We model the spacetime of a massive star by the Vaidya metric and derive the field equations in EMSG. Then using the equations we go on to study a gravitational collapse mechanism, on two specific models of EMSG with different forms of curvature-matter coupling. The prime objective is to probe the nature of singularity (if formed) as the end state of the collapse. We see that none of the models generically admit the formation of black holes as the end state of collapse, but on the contrary they support the formation of naked singularities. This can be attributed to the quantum fluctuations of the gravitational interactions at the fundamental level.

**Contents**



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# Nonrelativistic quantum particles interacting with pseudoharmonic-type potential under flux field in a topological defect geometry

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In this work, we investigate the quantum motions of nonrelativistic particles interacting with a potential in the presence of the Aharonov–Bohm (AB) flux field within a topological defect geometry, for example space–time with a distortion of a vertical line into a vertical spiral. We begin by deriving the radial Schrödinger wave equation, incorporating an anharmonic oscillator potential, which is a superposition of a harmonic oscillator and an inverse square potential, along with a constant term. The eigenvalue solution is obtained through the confluent Heun equation focusing on the ground state energy level and the radial wave function for the radial mode $n = 1$ as an example and analyze the results. Subsequently, we use these results to molecular potential models, considering pseudoharmonic and shifted pseudoharmonic potentials. The derived eigenvalue solutions provide insights into the behavior of particles within these potentials. Expanding our exploration, we study the quantum system featuring only an inverse square potential in the presence of the quantum flux field in the same geometry background. Employing the same procedure, we determine the ground state energy level and the radial wave function. Notably, our findings reveal that the eigenvalue solutions are significantly

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RESEARCH ARTICLE

# CHROMOSOMAL STUDY OF MUTAGENESIS INDUCED BY GAMMA RAYS ON BONE MARROW CELLS OF HOUSE MUSK SHREW *SUNCUS MURINUS*

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**SUMMARY** Ionizing radiations such as X rays and gamma rays are used in nuclear reactors, spaceships, cancer therapy, taking images of internal bones, etc. but are detrimental to living cells and tissues. In the present investigation, 2 different doses of gamma radiations (0.8 Gy and 2.40 Gy) were used on bone marrow cells of house musk shrew, *Suncus murinus*. The animals were subjected to whole body γ-irradiation exposure in 2 different sets. Seven different types of chromosomal aberrations were scored from bone marrow cells of the shrew, after 4 different time intervals post γ-exposure, at 1 h, 16 h, 48 h and 1 wk (168 h). As a result, in case of both 0.8 Gy and 2.4 Gy exposures, the maximum percentage of aberrations had been obtained after 16 h of exposure (9.06% in case of 0.8 Gy and 12.38% in case of 2.4 Gy) while minimum was observed after 1 wk of exposure. On the other hand, when compared among the types of aberrations, the maximum frequency of aberrations in mitotic chromosomes were observed with centromeric dissociation for both the doses of γ rays (1.97% in case of 0.8 Gy and 2.90% in case of 2.4 Gy), while ring chromosomes scored the minimum. Further, statistical analysis of the data reveals that the aberrations are non-random in distribution. They are somewhat time-dependent and centromeric regions of some chromosomes are most vulnerable to γ irradiation.

**Keywords:** *Suncus murinus,* gamma radiation, chromosomal aberrations, mitotic chromosomes.

## INTRODUCTION

Chromosomal aberrations had been studied in wide varieties of animals such as mice, fish, grasshoppers, monkeys, and even in plants. Pioneering work by Muller (1927) on artificial mutagenesis in *Drosophila melanogaster* and development of *ClB* technique paved the path for study of the effect of radiations on chromosomes (Gardner & Snustad, 1984). Later, innumerable researchers had worked in such domain and some notable works are, Krause & Ziegler (1906) on mammalian tissue, Amato (1911) and Grasnick (1918) on amphibian eggs and larva, Mohr (1918) and Stadler (1928) on maize chromosomes, Goodspeed & Olson (1928) on *Nicotiana* sp. Other significant workers in this field are Carlson (1938, 1940, 1941a, 1941b), Carlson et al. (1949), Manna & Mazumder (1962, 1967, 1968), Mazumder & Manna (1967) and Holleander (1964). Even work on common Rhesus monkey, *Macaca mulatta* had been pursued by Koshi-chenko & Semenov (1975) and Van & Paul (1976). Sur & Manna (1987) had studied the effect of X rays on grasshopper chromosomes, Sarkar & Manna (2001) studied the effect of nitrogen fixing bacterium *Beijerinckia indica* on 3 mammalian models i.e. shrew, monkey and cat. Sur (2004) had reported the effect of X rays and

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# Production Optimization of Feather Hydrolysate and Use as a Promising Nitogen-Rich Fertilizer for Rice (*Oryza Sativa*) Production

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**Present agriculture sector mostly depend on synthetic fertilizer for better crop. Feather is a rich source of protein and nitrogen. It was degraded by Keratinolytic bacteria Bacillus wiedmanni SAB10 in poultry litter sole media. Feather hydrolysate was produce from solid state fermentation process and fermentation condition was optimized through OVAT (One Variable At A Time) system. In this process feather (1.25%w/v) was fully degraded in poultry litter(1%w/v) with in 48 hrs at pH 10.After the fermentation cell free feather hydrolysate use in rice plant in different concentration and different mode. Liquid feather hydrolysate produced from solid state fermentation contain important amount of protein (3.12mg/ml) and amino acid(792$\mu$g/ml) that enhances the rice plant growth in pot trial condition. After application Group D Plants leaves have been reported to have higher levels of total chlorophyll (5.25mg/g of dry wt), IAA (17.23$\mu$g/ml)..Carbohydrate contain of rice has increased 1.6 fold than control Following the spraying of feather hydrolysate (300 $\mu$l/ml), the phenolic (1.71 fold) and flavonoid (1.52 fold) contents significantly increased.. The novelty of our investigation is we use here two wasted products and convert them a valuable product.**

**Keywords:** Agro ecosystem; Bacillus wiedmanni; Feather hydrolysate; SAB10 Rice plants.

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ORIGINAL PAPER

# EnCPdock: a web-interface for direct conjoint comparative analyses of complementarity and binding energetics in inter-protein associations

**Gargi Biswas[1] · Debasish Mukherjee[2] · Nalok Dutta[3] · Prithwi Ghosh[4] · Sankar Basu[5]**

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## Abstract

**Context** Protein–protein interaction (PPI) is a key component linked to virtually all cellular processes. Be it an enzyme catalysis ('classic type functions' of proteins) or a signal transduction ('non-classic'), proteins generally function involving stable or quasi-stable multi-protein associations. The physical basis for such associations is inherent in the combined effect of shape and electrostatic complementarities (Sc, EC) of the interacting protein partners at their interface, which provides indirect probabilistic estimates of the stability and affinity of the interaction. While Sc is a necessary criterion for inter-protein associations, EC can be favorable as well as disfavored (e.g., in transient interactions). Estimating equilibrium thermodynamic parameters ($\Delta G_{\text{binding}}$, $K_{\text{d}}$) by experimental means is costly and time consuming, thereby opening windows for computational structural interventions. Attempts to empirically probe $\Delta G_{\text{binding}}$ from coarse-grain structural descriptors (primarily, surface area based terms) have lately been overtaken by physics-based, knowledge-based and their hybrid approaches (MM/PBSA, FoldX, etc.) that directly compute $\Delta G_{\text{binding}}$ without involving intermediate structural descriptors.

**Methods** Here, we present EnCPdock (https://www.scinetmol.in/EnCPdock/), a user-friendly web-interface for the direct conjoint comparative analyses of complementarity and binding energetics in proteins. EnCPdock returns an AI-predicted $\Delta G_{\text{binding}}$ computed by combining complementarity (Sc, EC) and other high-level structural descriptors (input feature vectors), and renders a prediction accuracy comparable to the state-of-the-art. EnCPdock further locates a PPI complex in terms of its {Sc, EC} values (taken as an ordered pair) in the two-dimensional complementarity plot (CP). In addition, it also generates mobile molecular graphics of the interfacial atomic contact network for further analyses. EnCPdock also furnishes individual feature trends along with the relative probability estimates ($\text{Pr}_{\text{fmax}}$) of the obtained feature-scores with respect to the events of their highest observed frequencies. Together, these functionalities are of real practical use for structural tinkering and intervention as might be relevant in the design of targeted protein-interfaces. Combining all its features and applications, EnCPdock presents a unique online tool that should be beneficial to structural biologists and researchers across related fraternities.

**Keywords** Protein–protein interactions (PPI) · Complementarity · Complementarity plot (CP) · Binding free energy ($\Delta G_{\text{binding}}$) · Support vector regression machines · Feature trends · EnCPdock

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# Combining Complementarity and Binding Energetics in the Assessment of Protein Interactions: EnCPdock—A Practical Manual

GARGI BISWAS,[1] DEBASISH MUKHERJEE,[2] and SANKAR BASU[3]



## ABSTRACT

**The combined effect of shape and electrostatic complementarities (Sc, EC) at the interface of the interacting protein partners (PPI) serves as the physical basis for such associations and is a strong determinant of their binding energetics. EnCPdock (https://www.scinetmol.in/EnCPdock/) presents a comprehensive web platform for the direct conjoint comparative analyses of complementarity and binding energetics in PPIs. It elegantly interlinks the dual nature of local (Sc) and nonlocal complementarity (EC) in PPIs using the complementarity plot. It further derives an AI-based $\Delta G_{binding}$ with a prediction accuracy comparable to the *state of the art*. This book chapter presents a practical manual to conceptualize and implement EnCPdock with its various features and functionalities, collectively having the potential to serve as a valuable protein engineering tool in the design of novel protein interfaces.**

**Keywords:** complementarity, complementarity plot, free energy of binding, protein–protein interaction, structure-based thermodynamics.

## 1. INTRODUCTION

Design of novel therapeutic agents and the engineering of proteins with desired functionalities are interconnected forefront of modern biomedical research. On one hand, understanding the thermodynamics and kinetics of protein–protein interactions (PPIs) is essential in identifying and validating potential drug targets (Feng et al., 2017), whereas on the other hand, protein–protein-binding energetics play a pivotal role in rational protein engineering, interface design, and modulation of PPIs (Sable and Jois, 2015). Apart from the applications, the interaction between protein complexes is also crucial for deciphering their roles in cellular processes, diseases, mechanisms, and signal transduction pathways (Keskin et al., 2008). A significant portion of the data concerning protein–protein-binding energetics is encoded within the structural features of protein complexes (Zhang et al., 2012). The three-dimensional arrangement of proteins within these complexes reveals critical

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# Modified host defence peptide GF19 slows TNT-mediated spread of corneal herpes simplex virus serotype I infection

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**Corneal HSV-1 infections are a leading cause of infectious blindness globally by triggering tissue damage due to the intense inflammation. HSV-1 infections are treated mainly with antiviral drugs that clear the infections but are inefficient as prophylactics. The body produces innate cationic host defence peptides (cHDP), such as the cathelicidin LL37. Various epithelia, including the corneal epithelium, express LL37. cHDPs can cause disintegration of pathogen membranes, stimulate chemokine production, and attract immune cells. Here, we selected GF17, a peptide containing the LL37 fragment with bioactivity but with minimal cytotoxicity, and added two cell-penetrating amino acids to enhance its activity. The resulting GF19 was relatively cell-friendly, inducing only partial activation of antigen presenting immune cells in vitro. We showed that HSV-1 spreads by tunneling nanotubes in cultured human corneal epithelial cells. GF19 given before infection was able to block infection, most likely by blocking viral entry. When cells were sequentially exposed to viruses and GF19, the infection was attenuated but not arrested, supporting the contention that the GF19 mode of action was to block viral entry. Encapsulation into silica nanoparticles allowed a more sustained release of GF19, enhancing its activity. GF19 is most likely suitable as a prevention rather than a virucidal treatment.**

The cornea is the clear window at the front of the eye which plays a crucial role in vision by directing light onto the retina. Severe infections or injuries causing permanent opacity in the cornea may result in blindness. Herpes Simplex Virus serotype 1 (HSV-1) is a DNA virus, approximately 125 nm in diameter, that has evolved to replicate mainly in epithelial cells and neurons,[1] such as those of the cornea. HSV-1 corneal infection is the leading cause of infectious blindness worldwide in both developed and developing regions, with 1 to 1.5 million new cases and 9 million recurrent ones annually[2]. Once a cornea is infected, the virus can be transported retrogradely through the cornea nerves to the trigeminal ganglia where it establishes latency[3]. Initial or primary infections commonly affect only the epithelium with minimal or no requirement for medical intervention. Viruses are cleared from the eye by effective antiviral drugs. However, these drugs do not prevent viral reactivation, which in turn causes an inflammatory cascade (keratitis) that can result in tissue damage.

Structurally, HSV-1 comprises a nucleocapsid containing viral DNA, a surrounding proteinaceous tegument layer, and an outermost lipid envelope with surface glycoproteins[4,5]. The capsid is involved in the retrograde transport of the virus in neurons and release of the viral genome into the host cell nucleus. It also facilitates the release of nascent virus from the host cell nucleus[6]. The tegument comprises over 20 proteins with essential roles in viral transport and maturation[7]. The outermost lipid coat is derived from the internal membrane of the infected host cells, where the membrane cholesterol is needed for critical fusion with host cells to enable viral

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RESEARCH PAPER

# Solar Photocatalytic and Biodegradation of Polymer–Semiconductor Composite Film in Series: Characterization and Kinetic Modelling

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## Abstract

Once hailed as a 'wonder material'' for its low cost, durability, lightweight, flexibility, and water resistance, plastics have now become one of the potent threats to human civilization. Imperatively, light and microbes could play significant roles in plastic degradation. Plastic–semiconductor composites enhance photodegradation, whereas the presence of biodegradable compound in composites may facilitate their degradation by soil microbes. In this work, composite films of polyvinyl chloride (PVC) and zinc oxide semiconductor (ZnO) are synthesized in various combinations and subjected to sequential photo- and biodegradation. The photodegradation was exclusively solar, whereas polycaprolactone (PCL) was apprehensively added to the composite for enhancing the biodegradability. The process sequence was also altered to investigate the possible effects. Sequential photocatalytic degradation under sunlight and biodegradation by bacteria isolated from soil could decrease the original weight of a photo-bio degradable polymer composite film comprising of PVC, PCL and ZnO in less than a month. The isolated microbe was later identified as *Bacillus altitudinis* by 16S rRNA gene sequencing. Identification and isolation of enzymes involved in PVC degradation by the isolated strain may be included in future work. Maximum 26.8 w% degradation was observed within 25 days in case of PVC–ZnO composite. The role of PCL was found to be insignificant in biodegradation especially in presence of ZnO. The solar photodegradation was modelled based on a proposed mechanism that finally led to two parallel reaction pathways following first- and zero-order kinetics, respectively. Biodegradation, on the other hand, was noted to be fairly consistent with the Michaelis–Menten kinetics.

## Article Highlights

- **Polymer composite is degraded by sunlight and microbes.**
- **Sequences of photo and bio degradation are altered**
- **Kinetic data are modelled for both photo and bio degradation**
- **Natural degradation of polymer composite is enhanced**

**Keywords** Polymer–semiconductor composite · Zinc oxide · Sequential · Solar photocatalytic · Biodegradation · Rate model

## Introduction

The literal meaning of the word 'Plastic' is 'easily mouldable'. Synthetic polymers were named 'plastics', since most of them were strong, light, and flexible. For their application versatility and their lightweight together with waterproof characteristics and affordable price, plastics were hailed as wonder materials, since the first semi-synthetic polymer (Celluloid) was invented in 1869 by Hyatt. The first fully synthetic plastic, Bakelite was patented by Leo Baekeland in 1907. Thereafter, over time, several plastics like polyethene,

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ORIGINAL PAPER

# Impedance spectroscopic investigation of chiral additive induced wide range blue phases

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**Abstract:** Impedance spectroscopic investigation has been performed for a chiral additive (10%wt) doped biphenyl derivative possessing two successive wide ranges blue phases (BP) viz. cubic BP and BPIII. Experimental attention is focused in BPIII along with two BPIII related phase transitions, i.e., cubic BP-BPIII and BPIII-Isotropic phase (I). Dielectric pre-transitional effect has been observed in the vicinity of I-BPIII transition exhibiting convex-shaped anomaly (CSA). Anomalous DC bias field dependences are observed in frequency-dependent real part and imaginary part of complex dielectric permittivity profile in pre-transitional BPIII, BPIII and cubic BP phases considered being signatures of respective phases. Temperature and DC bias field dependent relaxation frequency indicates bias field induced enhancement of domain size in BPIII. Also a noticeable change of activation energy is observed from its estimated values in BPIII and pre-transitional BPIII region by Arrhenius equations.

**Keywords:** Liquid crystals; Blue phases and other defect-phases; Dielectric properties; Phase transitions

## 1. Introduction

Blue phase liquid crystals (BPLC) have established their application potential in display and photonic devices for ultra-fast response time, spontaneous appearance of optically isotropic phase devoid of any alignment layer, cell gap insensitive electro-optic properties and very large Kerr constant [1, 2]. Hence, extensive applications of BPLCs are observed in beam splitters, [3] light modulators, [4] optical communications [5] and beam steering devices [6]. The structure of such important material viz. BPLC is quite complex. Nematic LC doped with chiral molecules can show stable chiral nematic (N*) LC phases with one-dimensional helical structure. Unlike N* phase, the LC molecules may also exhibit helical order in more than one dimension. But topological constraints suggest that it is not possible to construct a state with helical order in more than one dimension without introducing defects or disclination lines into the structure. These defects are lines between double twist cylinders (DTC) where the orientational order goes to zero and the direction of preferred orientation is unified. Self-assembly of DTCs in cubic symmetry results in BPLC. Thus, BPLCs are very exciting because their fluid lattices are indeed stabilized by lattice defects. These disclination lines have high free energy and hence in general the thermal stability of BPs occurs in a narrow temperature range [7]. Usually, blue phases appear between $N_*$ and isotropic phase. Three distinct thermodynamically stable blue phases are recognized till date viz. BPI, BPII and BPIII, having body centered cubic, simple cubic and amorphous structures, respectively [8–12]. The imposed chirality within the helical nematics judges whether they will appear singly or in a compilation. It is some time likely that there will be all three blue phases within a very narrow temperature range $\sim$ 1 °C.

However, practical applications of BPLC require much wider temperature regions of BPLC phases. Kikuchi et al. successfully achieved a wide BP temperature range of 60 K including room temperature by polymer stabilization and referred this phase as "polymer stabilized blue phase

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# Electro-optic Stabilization and Control for a Polymer Stabilized Ferroelectric Liquid Crystal

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**Abstract.** The ferroelectric liquid crystal viz. 2-butyloxyethyl(R)-2-[4-(4''-decyloxybiphenyl-4'-carbonyloxy) phenyloxy] propionate and 8wt% polymethyl methacrylet (PMMA) composite has been synthesized using the consolidation of solvent and thermally prompted phase separation techniques. The optical texture and scanning electron microscopic studies assure formation of the polymer stabilized ferroelectric liquid crystal (PSFLC) film. The electro optic characteristics of pure FLC in the surface stabilized (SSFLC) geometry have also been presented along with polymer stabilized counterpart for comparison. PSFLC is found to show much greater gray-level capability, ~ 44% faster response in fall time and ~ 17% slower rise time compared to the corresponding SSFLC.

**Keywords**: Ferroelectricity, Defects in liquid crystals, Switching phenomena, phase transitions, Phase separation and segregation in polymer blends.
PACS: 77.80.-e, 61.30.Jf, 77.80.Fm, 77.80.B-, 64.75.Va



## INTRODUCTION

During the last couple of decades, ferroelectric liquid crystals (FLC) attracted considerable attraction as a possible high performance alternative for the typical nematic liquid crystals used in liquid crystal displays (LCDs) and in numerous other electro-optic devices. The wide application potential of the FLC system is due to its rapid response time [1], acute bistability and broad viewing angle [2-4] in the pair of distinct molecular alignments observed in surface stabilized FLC (SSFLC) configuration. Though passive matrix addressing displays requires the bistability, it however imposes primary obstacles to exhibit full colour or analog gray scale. Additional significant limitation in using FLC display is the trouble in attaining high quality alignment of FLC molecules, which requires to be resistive to mechanical shocks. Polymer stabilized ferroelectric liquid crystal (PSFLC) is first fabricated by Hikmet and Lub at Philips in the year 1995 [5]. The test samples were synthesized by polymerizing ferroelectric (SmC*) phase in presence of applied electric field strong enough to preserve the preferred orientation of sample in one of its stable switching states; and an aligned network formation along the smectic layer normal was observed. It has been reported that the network embedded in the FLC layer improves its mechanical shock absorbing capability [6]. The general idea of PSFLC is stabilization of the alignment of low-molar mass LC by elastic interaction between the network and LC. Interestingly, process of fabrication of PSFLC strongly influences their properties. The fabrication implies comprehending of the relationship between experimental conditions to be imposed in the method of polymerization, and network structure and their electro-optic performance. Hence the fundamental research interest lies in the process of polymerization, conveying LC orientation at different phases onto network of polymer etc. It is to be noted that the choice of LC as well as polymer are immensely important in the formation of PSFLC. We have chosen low molar mass (~12000), transparent polymer polymethyl methacrylet (PMMA) having refractive index ~1.49 (quite close to the refractive indices of common FLC materials) to disperse in the FLC material capable of showing hysteresis free switching near room temperature [7].

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# Report On The Precursors Of Great Turkey-Syria Earthquake On 6th February, 2023

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***Abstract:***

A devastating earthquake of Mw 7.8 struck Southern and Central Turkey and Northern and Western Syria on 6th February, 2023, at 01:17:35 UTC, followed by an aftershock of Mw 7.7 at 10:24 UT. The epicenter was Gaziantep (37.166° N, 37.032° E) at a depth of 10km. To investigate about some precursor of the quake, variation of Vertical Total Electron Content (VTEC) is observed 17 days prior to the earthquake day ( 20th January to 05th February, 2023) taking the observed data recorded at IGS ( International GNSS Station), TUBI, Turkey (40.787°N, 29.451°E). Atmospheric total Ozone and Surface air temperature are also analysed during January-February, 2023 to find evidence of Lithosphere Atmosphere Ionosphere Coupling (LAIC) phenomena associated to this earthquake. It is found that few days (3 to 9 days) prior to earthquake, Total Electron Content value is far outside the error bar, showing its precursory nature. Some relationships between the ozone and surface pressure is found also relating to this earthquake event. Geomagnetic Dst, Kp indexes and solar flux data during these days are also analyzed to make sure that, these observed variations are not related to geomagnetic or solar activity.

***Keywords:*** *Earthquake, GNSS, Ozone, Precursor, IGS, Vertical Total Electron Content (VTEC)*

***Introduction:***

A large number of observations have been done over the past few decades to detect precursors of earthquakes. In addition to the ground based observation such as ground radon emission, remote sensing techniques are also applied for the prediction of earthquake phenomena. Litosphere-Atmosphere-Ionosphere-Coupling (LAIC) model can explain different ground surface, atmospheric and ionospheric processes and anomalus variations which are usuall y named as short term earthquake precursors [1]. Electromagnetic (EM) and ionospheric perturbations associated with seismic activity from satellite observation has been reported in many cases [2-4]. Prasad et al., [5], Zing and Singh[6] observed the changes in atmospheric Ozone before strong earthquakes. Changes in Total Electron Content (TEC) and ionospheric disturbances before earthquake has been reported by Liu et al [7], Pulinets et. al., [8]. Sharma et al.,[9] found variation of Total Electron Content (TEC) while observing the TEC (Total Electron Content) from GNSS (Global Navigation Satellite System) data recorded during some Himalayan earthquake events. Guha Bose et al.,[10] also observed TEC variation from GPS data during Nepal earthquake, 2015 along with the variation of soil radon concentration. Liu et al. [11],[12] observed anomalies in TEC before earthquake, observing TEC from GPS and Global Ionospheric Map respectively. From the ground to ionosphere at different altitudes, Adil et al.,[12] analysed different data sets like surface air temperature, relative humidity, total column water vapor, air pressure, Outgoing Longwave Radiations (OLR), and the Total Electron Content of the Global Ionosphere Maps (GIM-TEC) during Jamaica earthquake,2020 and found collocated synchronized atmospheric and ionospheric anomalies which supports LAIC model. In this paper observation data collected from GNSS satellites recorded at Tubi *(40.787°N, 29.451°E),* Turkey 17 days *before the February 6, 2023 earthquake event* are processed to calculate Vertcal Total Electron Content (TEC) and this VTEC are analysed to find presence of anomalous variation of VTEC before the earthquake. In support of this data, Surface Pressure and Total Atmospheric Ozone data are also analysed for the same period.

***Data and Analysis:***

ISG (International GNSS Service) observation data recorded at the station Tubi (*40.787°N, 29.451°E),* Turkey is downloaded from the site https://data.unavco.org/archive/gnss/rinex/ Then this observation data is used as input of a computer program (Version 3.03) developed by Dr. Gopi Srimala and VTEC data is obtained. This diurnal Vertical TEC (VTEC) data is plotted from 20th January 20 to 05th February, 2023, during 17 days before the seismic event. Standard deviation (±1σ) of the VTEC (Vertical Total Electron) values of all these days are calculated for each minute and a diurnal variation of standard deviation on both sides og Mean TEC is obtained. This (±1σ) level is considered as upper and lower boundary level, VTEC values above or below this level can be considered as anomalous in nature. As the VTEC in the ionosphere is also influenced by Solar and Geomagnetic activity, so for the investigation of the precursor to the earthquake, Dst values, Kp index and Solar Flux for these days have been observed. Dst and Kp data can be downloaded from https://wdc.kugi.kyoto-u.ac.jp/ , where as the solar flux data is available in https://www.ngdc.noaa.gov/stp/solar/solarradio.html.

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# A study of some research work on soil radon concentration and ionospheric total electron content as earthquake precursors

**Saheli Chowdhury[1] · Arpita Guha Bose[2,3] · Aditi Das[2,3] · Argha Deb[4]**

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**Abstract**
This review discusses some research on two earthquake precursors—soil radon concentration, a geochemical precursor; and Total Electron Content (TEC), an atmospheric one, studied in some earthquake-prone regions in the world. These two precursors were chosen because their generation mechanisms are interlinked. The selected soil radon studies focused on establishing anomalous radon fluctuations as a robust precursory signal for medium to high-magnitude earthquakes, including determination and removal of meteorological effects from soil radon time series, and identification of genuine pre-seismic anomalies. For the seismic precursory property of TEC, studies on detecting seismogenic TEC fluctuations and their formation mechanisms were discussed.

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## Introduction

Earthquake is one of the most disastrous natural phenomena for human society and all living beings. Every year earthquakes of considerable magnitude cause widespread devastation and grievous loss of life and property. Therefore, prediction of earthquakes is considered important to minimise large scale losses and for disaster management. Efforts are being made all over the world to determine probable precursors of an impending earthquake. However, the only "prediction" mechanism for seismic hazard mitigation available at present are the earthquake early warning systems (some tens of seconds) functioning in a number of countries [39, 133, 135]. The status of short-term prediction, focusing on days to weeks prior to earthquakes, that may be useful for disaster management is still obscure.

A wide variety of geophysical and geochemical phenomena have been studied as potential precursors, such as geophysical precursors like seismicity-induced changes in terrestrial electric and magnetic fields [132], changes in levels of wells, ponds and other waterbodies [150], geochemical precursors like changes in gas emissions from the crust [142], concentration changes of dissolved ions in wells and springs [93], atmospheric precursors like changes in atmospheric total electron content (TEC [13, 70, 77], ionospheric disturbances [108, 127, 128], emissions of ultra-low frequency (ULF) and very low frequency (VLF) signals in the atmosphere [19], and biophysical precursors like unusual animal behaviour [34]. Although each of these phenomena has been observed prior to certain earthquakes, such observations have been mostly by chance [18]. In no earthquake has all the precursors been observed, however, in no case was anyone searching for all the precursors, and precursor activity is known to depend on the type of the earthquake and the geology of the epicentral region as well as that of the monitoring centre. Moreover, for a precursor to be authentic and useful, the information provided by it should be reproducible and amenable to formal testing [28]. Herein lies one of the biggest challenges of earthquake precursor study, as all earthquakes are not same and do not arise from the same conditions, due to which observed precursors may be different and all precursors may not be manifested in all earthquakes.

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# A study of some research work on soil radon concentration and ionospheric total electron content as earthquake precursors

Saheli Chowdhury[1] · Arpita Guha Bose[2,3] · Aditi Das[2,3] · Argha Deb[4]

Received: 11 August 2023 / Accepted: 1 February 2024


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One promising geochemical precursor is fluctuation in concentration of $^{222}$Rn in soil, given that crustal fluid systems (soil gas and groundwater) are affected extensively by faulting processes (formation of faults, cracks, etc. in the crustal rock mass) and hence there exists a probability of detecting signals of faulting related to earthquake

## Radon as earthquake precursor

Radon is a naturally occurring radioactive noble gas, generated by the decay of radium which is present in variable quantities in all types of rocks and soils in the earth's crust. Of the 39 known isotopes of radon,

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# Weyl formula and thermodynamics of geometric flow

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We study the Weyl formula for the asymptotic number of eigenvalues of the Laplace-Beltrami operator with Dirichlet boundary condition on a Riemannian manifold in the context of geometric flows. Assuming the eigenvalues to be the energies of some associated statistical system, we show that geometric flows are directly related with the direction of increasing entropy chosen. For a closed Riemannian manifold we obtain a volume preserving flow of geometry being equivalent to the increment of Gibbs entropy function derived from the spectrum of Laplace-Beltrami operator. Resemblance with Arnowitt-Deser-Misner formalism of gravity is also noted by considering open Riemannian manifolds, directly equating the geometric flow parameter and the direction of increasing entropy as time direction.

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## I. INTRODUCTION: WEYL ASYMPTOTIC FORMULA AND ENTROPY FUNCTION

In the early 20th century, Hermann-Weyl proved a formula for the asymptotic number of eigenvalues of the Laplace-Beltrami operator acting on space of functions satisfying Dirichlet boundary conditions on the boundary of a bounded domain $\mathbb{R}^d$ [1]. In particular he proved that if $N(E)$ are the number of eigenvalues of such an operator up to some value $E$, then

$$\lim_{E\to\infty}\frac{N(E)}{E^{\frac{d}{2}}}=\frac{\omega_d \mathrm{Vol}\, M}{(2\pi)^d}, \tag{1}$$

with $\mathrm{Vol}\, M$ being the $d$-dimensional volume of $M$ and $\omega_d$ is the volume of the unit sphere in $\mathbb{R}^d$. He also conjectured the two-term asymptotics of $N(E)$ in [2], which was later proved by [3]. This can be stated as follows; given the $d$-dimensional Laplace-Beltrami operator, the two-term asymptotic formula for the number of eigenvalues $N(E)$ lying up to a given energy level $E$ is given by the following relation:

$$N(E)\sim c_0 E^{\frac{d}{2}}\pm c_1 E^{\frac{d-1}{2}}, \tag{2}$$

with $M$ being a region in Euclidean space $\mathbb{R}^d$ and "+" or "−" depends on the choice of Dirichlet or Neumann boundary conditions, respectively. The constants in this case are

$$c_0=\frac{1}{(2\pi)^d}\omega_d \mathrm{Vol}\, M, \qquad c_1=-\frac{1}{4(2\pi)^{d-1}}\omega_{d-1}\mathrm{Vol}\,\partial M, \tag{3}$$

with $\mathrm{Vol}\,\partial M$ being the $(d-1)$-dimensional volume of the boundary $\partial M$ and $\omega_d, \omega_{d-1}$ are the volume of unit spheres in $\mathbb{R}^d$ and $\mathbb{R}^{d-1}$, respectively. One can consult [4] for an excellent review with further references on this topic. Kac [5] and Pleijel [6] investigated this matter further to ask if it is possible for an observer to decipher the shape of a membrane by listening to its vibrations.[1] It turned out that to some extent this is indeed possible as pointed out by Mckean and Singer [7]. They proved the following result. Let $\Delta$ be the Laplace-Beltrami operator on a $d$-dimensional Riemannian manifold $M$ without boundaries, equipped with a metric[2] $g_{ij}$, then the partition function (heat kernel) is given by

$$Z=\sum_n e^{-\frac{\gamma_n}{T}}=\frac{T^{\frac{d}{2}}\mathrm{Vol}\,\mathrm{M}}{(4\pi)^{\frac{d}{2}}}+\frac{T^{\frac{d}{2}-1}\int\sqrt{g}dx^d R}{6(4\pi)^{\frac{d}{2}}}+\frac{T^{\frac{d}{2}-2}}{180(4\pi)^{\frac{d}{2}}}\int\sqrt{g}dx^d Q+\mathcal{O}(T^{\frac{d}{2}-3}). \tag{4}$$

Where $\gamma_n$ are the eigenvalues of $-\Delta$, and $Q=10A-B+2C$, with $A$, $B$, and $C$ being particular quadratic polynomials in the Riemann tensor [7], on which we will

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[1]The work of Kac in [5] is interestingly titled; *Can one hear the shape of a drum?*

[2]$\Delta\equiv\frac{1}{\sqrt{|g|}}\partial_i(\sqrt{|g|}g^{ij}\partial_j)$.

Parikshit Dutta

 

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# Understanding the Xenoestrogenic Activity of BPA Involves Molecular Docking Study with a few Chosen Nuclear Receptors and Toxicodynamics Analysis: An *In Silico* Research

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**Abstract:** Bisphenol A (BPA) is predominantly synthesized on a massive scale for use in polycarbonate plastic manufacturing. Because it resembles a hormone, BPA functions as a xenoestrogen, imitating the effects of estrogen in the human reproductive system. Employing the Docking Wizard program on The Molegro virtual Docker system, we molecularly docked BPA onto the 1A52, 1GS4, 2GPU, 5TOA, and 7XTB in order to compare binding energies and gain insight into the toxicodynamics and estrogenic activity of BPA in biological systems. Our investigation clearly shows that BPA's biggest possibility for coupling is with the estrogen receptor alpha 1A52 (-8.4 Kcal/mol), and then with the ERR-γ receptor 2GPU (-8.4 Kcal/mol). BPA is categorized as an Endocrine Disrupting Chemical (EDC) that can imitate internal hormones and hence, increase the effects they have, or it may hinder with and keep natural hormones from attaching to their targets.

**Keywords:** Bisphenol A, Xenoestrogen, Toxicodynamics, Endocrine Disrupting Chemical, Biological systems

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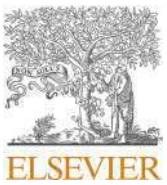

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# Structural control on formation of polygonal rims of impact craters in Thaumasia Minor, Mars

Dipayan Dasgupta [a], Abhik Kundu [a,*], Rwiti Basu [a], Nilanjan Dasgupta [b], Diptangshu Ghosh [a,b], Aindrila Roy [a,c]

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ABSTRACT

It has been known for almost a century that the surfaces of rocky planets contain polygonal-shaped, circular, or elliptical craters. Researchers have hypothesized that pre-existing structurally weak planes, such as faults or fractures, in the vicinity of the impact, are responsible for polygonal patterns of the crater rims. Thaumasia Minor, Mars, which is a heavily deformed late-Noachian terrain with craters of various morphologies, including polygonal impact craters (PICs), is the present area of study to understand the geological control behind the polygonal shapes of the crater rims. A population of 45 carefully chosen polygonal craters are mapped and compared with morphotectonic structures such as graben, wrinkle ridges, and dykes. To discern the relationship between the features, the study uses trends, statistical and spatial analyses of orientation data, and other parameters such as crater diameter and crater excavation depth. Also, to understand the factors affecting PIC formation, 12 earlier studied craters in East Coprates Planum, a region adjacent to the Thaumasia Minor, are studied again. The study proposes two possible geological controls on PIC formation. The study also suggests that graben have more control over smaller PICs while larger PICs are controlled by wrinkle ridges.

## 1. Introduction

Polygonal Impact Craters (PICs) are impact craters, which have rims with at least two adjoining rectilinear segments with a distinct angle in between (Öhman et al., 2008). Geographical orientations of these rectilinear PIC rim segments are used to correlate the evolution of geometry of PICs with fracture planes in the vicinity and also to identify trends of pre-existing weak fracture planes that are not exposed (Fulmer and Roberts, 1963; Öhman et al., 2008; De et al., 2018; Dasgupta et al., 2019; Baby et al., 2024). Impact craters have also been discovered on the Earth, such as the Meteor Crater (Shoemaker, 1960), that have polygonal shapes with arms on the rim parallel to the previously existing weak planes (Öhman et al., 2008). According to Eppler et al. (1983) and Öhman et al. (2006), the rectilinear segments of simple PICs may form during the cratering process' excavation phase and are guided by the pre-existing fault planes. In the modification stage slide of rocky substances from the rim occurs along the pre-existing planes of weaknesses (Eppler et al., 1983). The polygonality of the craters can also be brought on by erosion, flooding, and lava intrusion (Schultz, 1976), however, some authors have argued that these external agents can have a negligible effect on the polygonality of a crater (Eppler et al., 1983) and, therefore, not taken into account in the present study.

The Martian PICs can be broadly classified into two categories:

I) Simple PICs: Craters on the Martian surface with diameters <7 km are referred to as simple craters (Pike, 1980; Garvin et al., 2003). These simple craters, when polygonal, commonly have square rims, where each arm is at an angle of ~$45^0$ to an already existing fault plane in the excavation stage. This occurs when along the pre-existing fractures, the excavation flow is expanded quickly, resulting in straight rim segments that bisect the fracture trends (Eppler et al., 1983; Öhman et al., 2006). More recent studies on PICs of both Mars and Moon, however, have shown that this relation of 45° is not applicable everywhere and the rectilinear edges of simple PIC rims are often parallel to the fault planes' strikes (Öhman et al., 2008; Basu et al., 2022; Thapa et al.,

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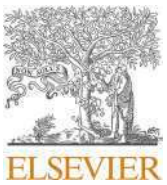

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# Cancer stem cell–immune cell crosstalk in breast tumor microenvironment: a determinant of therapeutic facet

Aishwarya Guha[1†], Kuntal Kanti Goswami[2†], Jasmine Sultana[1], Nilanjan Ganguly[1], Pritha Roy Choudhury[1], Mohona Chakravarti[1], Avishek Bhuniya[1], Anirban Sarkar[1], Saurav Bera[1], Sukanya Dhar[1], Junina Das[1], Tapasi Das[1], Rathindranath Baral[1], Anumika Bose[1] and Saptak Banerjee[1*]

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Breast cancer (BC) is globally one of the leading killers among women. Within a breast tumor, a minor population of transformed cells accountable for drug resistance, survival, and metastasis is known as breast cancer stem cells (BCSCs). Several experimental lines of evidence have indicated that BCSCs influence the functionality of immune cells. They evade immune surveillance by altering the characteristics of immune cells and modulate the tumor landscape to an immune-suppressive type. They are proficient in switching from a quiescent phase (slowly cycling) to an actively proliferating phenotype with a high degree of plasticity. This review confers the relevance and impact of crosstalk between immune cells and BCSCs as a fate determinant for BC prognosis. It also focuses on current strategies for targeting these aberrant BCSCs that could open avenues for the treatment of breast carcinoma.

KEYWORDS
breast cancer (BC), breast cancer stem cells (BCSCs), tumor microenvironment (TME), innate immune cells, adaptive immune cells

**Abbreviations:** ALDH1, alcohol dehydrogenase 1; APCs, antigen-presenting cells; BC, breast cancer; BRCA, breast cancer gene; BCSCs, breast cancer stem cells; CD, cluster of differentiation; CTCs, circulating tumor cells; CSF, colony-stimulating factor; DCs, dendritic cells; ECM, extracellular matrix; EMT, epithelial to mesenchymal transition; Id1, inhibitor of DNA binding 1; IL, interleukin; iDCs, immature DCs; MDSCs, myeloid-derived suppressor cells; MFG, milk fat globule; MHC, major histocompatibility complex; MIC, MHC-I chain-related protein; MMPs, matrix metalloproteinases; M-DCs, mature DCs; NK, natural killer cells; NKG2D, NK-activating receptor; PGE2, prostaglandin E2; ROS, reactive oxygen species; RNS, reactive nitrogen species; TME, tumor microenvironment; TAMs, tumor-associated macrophages; Tregs, T regulatory cells; TILs, tumor-infiltrating lymphocytes; TINs, tumor-infiltrating neutrophils.

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# AMELIORATIVE EFFECT OF *ARTHROSPIRA PLATENSIS* (SPIRULINA) DIETARY SUPPLEMENTATION AGAINST FLUORIDE TOXICITY IN THE FRESHWATER FISH, COMMON CARP (*CYPRINUS CARPIO* L)

Ram Krishna Das,[a,*] Nilay Ray[b]

Kolkata and Cooch Behar, India

**ABSTRACT: Aim of the present study was to investigate the ameliorative effect of cyanobacteria, *Arthrospira platensis* (Spirulina) dietary supplementation against the fluoride (F) toxicity in the freshwater fish, common carp (*Cyprinus carpio* L) with reference to growth performance, digestive enzyme activities, haematological parameters, and F accumulation in muscular tissues. The study parameters were studied after 30 days of supplementation. For the study, fingerlings of *C. carpio* L were purchased from a local fish market, and then acclimatized for a total period of 28 days. A total of 120 acclimatized fingerlings were allocated into five experimental groups (GI, II, III, IV, and V) each with 24 fingerlings. Each group was further divided into three replicates containing 8 fingerlings each. Group I and II were provided control diet and served as control and toxic control, respectively, whereas group III, IV, and V were provided with 5 gm, 7.5 gm, and 10 gm of *A. platensis* /kg of supplemented diet, respectively. All groups except for Group I were exposed to 5% of the $LC_{50}$ of F (NaF @ 33.75 mg/L). The results revealed that, exposure of sub-lethal concentration of F (33.75 mg/L) adversely affected the growth and feed utilization parameters, inhibited the digestive enzyme activities, altered the haematological parameters, and increased the accumulation of F in the muscular tissues of group II (GII) compared to control. However, *A. platensis* dietary supplementation significantly ($p<0.05$) improved F induced alterations of growth and feed utilization parameters, digestive enzyme activities, haematological parameters, and reduced the accumulation of F in the muscular tissues in group III, IV, and V compared to group II (GII). In conclusion, *A. platensis* dietary supplementation restored the F induced alterations and thus mitigated the F toxicity. Fish fed 10 gm of *A. platensis* /kg supplemented diet showed the best response; hence it is the optimum dose.**

***Keywords:*** Amelioration; *Arthrospira platensis* (Spirulina); Common carp (*Cyprinus carpio* L); Dietary supplements; Fluoride; Freshwater fish; Toxicity

## INTRODUCTION

Fluoride (F) is ubiquitously present in the soil, air, and aquatic environments in varying amounts. The maximum permissible limit of F in drinking water for humans is 1.5 mg/L as per guidelines of the World Health Organization.[1] In India, except in few eastern states, almost all the ground-drinking water sources of 23, out of 37 states and union territories are contaminated with F and most of them have F beyond the threshold level 1.0 or 1.5 mg/L.[2] Presence of abnormally high F concentration in groundwater in the country is due to natural cause of higher abundance of F-bearing minerals in the host rocks and sediments.[3] F in non-polluted surface water is almost negligible or present in fractions or traces (0.01–0.3 ppm).[1,4] If the humans and domestic animals drink a water having F more than this level for long time, then it becomes toxic and harmful for health and causes a serious disease called fluorosis in them. Most of the studies on chronic F toxicosis have been conducted in man[5-6] and

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# Taxonomy and conservation status of swamp eels (Synbranchiformes: Synbranchidae) of West Bengal, India

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**Abstract:** In a comprehensive study spanning January 2019 to April 2023 within the state of West Bengal, the research focused on elucidating the taxonomy and conservation status of swamp eels in the state. Swamp eels were harvested using traditional fishing techniques, and sampling sites were randomly selected across nine districts: Cooch Behar, Alipurduar, Jalpaiguri, Uttar Dinajpur, Purba Bardhaman, North Purba Medinipore, North 24 Parganas, and South 24 Parganas, accounting for variations in climatic zones and topography. Through meticulous examination involving X-ray radiographs and morphometric measurements, two distinct swamp eel species, *Ophichthys cuchia* (Hamilton, 1822) and *Ophisternon bengalense* McClelland, 1844, were identified, both falling under the 'Least Concern' category according to the IUCN Red List of Threatened Species. Rapid population decline of swamp eels in West Bengal is primarily attributed to habitat degradation and the indiscriminate use of pesticides and chemical fertilisers.

**Keywords:** Bengal Mud Eel, diagnosis and description, Gangetic Mud Eel, *Ophichthys cuchia*, *Ophisternon bengalense*, Synbranchiform fishes.

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Original Article

# A Comprehensive Analyses of Affective Health and Sex Differences in Adolescents as a Function of Peer Pressure and Internet Addiction

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Sage

Jhuma Mukhopadhyay[1] and Arinjoy Bhattacharjee[2]

## Abstract

**Introduction:** Existing research literature has shown that the dynamics of depressive traits in adolescents are influenced heavily by various psycho-social factors such as peer pressure and addictive tendencies.

**Purpose:** The study was conducted to investigate the interrelationship between internet addiction and peer pressure on adolescent depression.

**Methodology:** The sample of adolescents ($N$ = 94) in the age range of 13–18 years was collected using a stratified random sampling design. Three major psychometric tools were administered to the sample, namely, Internet Addiction Test, Peer Pressure Inventory, and Hamilton Depression Rating Scale. Correlation and inferential analyses were done on the acquired data.

**Findings:** The sample reflected moderate tendencies to have peer pressure, internet addiction and depression. It also showed a significant positive correlation between internet addiction and depression, an insignificant positive relationship between peer pressure and depression along with a significant effect of sex on adolescent depression but insignificant sex differences on peer pressure and internet addiction.

**Limitations:** The descriptive nature of the study reveals less about the causal relationships between the variables.

**Implications:** The study encourages parents to redefine their roles and parenting styles while dealing with adolescents.

## Keywords

Depression, sex, internet addiction, peer pressure

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## Introduction

The field of adolescent psychology is currently developing a new definition of adolescent mental health that is based on the description of a wide range of patterns of adaptation to the biological, psychological, and social challenges of adolescence. This article's main focus is on how psychologists currently comprehend the extent and variety of these developmental routes, aptitudes, and adaption profiles.[1] It is common for adolescents to experience significant mood swings, depression, and excitement back-to-back. Explosive arguments with relatives, friends, and the law are regarded as usual. This widely held opinion is largely based on theoretical work done by the psychiatric clinical community in the 1950s and early 1960s.[2–4]

In the simplest of terms, adolescence can be defined as the transitional phase in a person's life that is characterized by

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# Value of Mistakes in Human Life

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Human life is a very rare life. According to Vedic Scriptures, this human body is obtained after many lives. From the birth of human beings, extended through a mysterious environment. People tend to learn nothing else. And through the flame, there is a different mistake of the wrong error. Non-experience experience people learn a lot of time. Life is for learning. So it is heard that as long as you live. People have many different languages in this learning, that is, people learn to learn in different ways and awakened its values. Many people are not only increasing the knowledge of people because of learning something like a lot of time, some of the wrong errors happening in human life. After the mistake of life, the teaching of the people who guides in the heart of the people may have been treated some right now, but later the education that the misunderstanding is about to strengthen people. That is, the conscience of people who are awake from the wrong error, the courage of the conscience and the courage of the conscience. If the human life may not be wrong, then the education is not correct. There is no matter of mistakes because it is wrong to be the potential of the wrongdoing of the person in the beginning of the career and the mistakes of the people were awakened from that mistake.

Freedom is freed and frees to the people, but if the heart of the heart is hidden in that independence, then the external independence is not just the names of the names. So people have to be independent from both outward and inner degeneration. The independence cooperatives to move people to much improvement. So human feelings and duties need to reflect in reality images, then there is a free person. But in the way of our life, we are wrongly understood in knowledge. And from the thought of this wrong error, we have to warn the underlying instructions in the monkonism. We can not get independent from inside of the wrong error. That's why the Bapinchandra falt forgot the pordent that the slave can not be free from the heart. But if the Chaitanya and Vivek can be set up in the measure of the right consideration, then it will be seen that if any of them can not consume any kind of substance, he will be able to replace an unknown freedom.

We have to think about a time that the wrong error will be in life and to hold them in the way of life, some unconsciousness identity. The wrong error is a part of the career, but without giving them serious importance or not in the world, if they are able to bring the mental stability to the new way after the new way of the new way, then it can be able to become a lot of work. We have a way to remember human life, remember us this while reminding them. People can not be right in a life, like that one way to walk in the life of a way that he is to take myself out of the miscarriage of the wrong life through a free manner of the human life and accepting yourself from the mentality of the wrong life. And for this is the need for independence. That is, if there is no mistake in mind, if a person does not think that he does not think anybody freely, but if he is not able to do anything independently, then he will lose himself inside. Therefore, the mischief of the misunderstanding of the wrong error in human life is abusive.

One of the creatures of the society and the possibility of the Chaitanya is the people. Even if it is increased in human life, everyone has a basic entity. He does not turn away from the basic entity that the situation is not in his life. And this policy is to use the standard of one of the most valuable people of human life. Bhabbinda Shrikrishna's musical message is that many of the clear obligations are found in the basic entity of the human life from Srimat Bhagavati Gita. It is also seen that people are looking for miserable situations in many unfavorable situations, but inside the inner basis is never responding to the move.

When people lend himself on his way, they make themselves in the absolute disorder and adversity in the absolute disorder, but ignores all the adversity, leads to the basis of the basis of the basis of the basis of the basis of the basis of the basis of the basis. If people do not forget the mistakes in his life, he does not have to hide himself with everything, and that is behind the back, never is the reason. The real language of the people is to be the prince to be a great deal of mistakes from the wrong error, and the courage to get a way to go on the coming day. Therefore, if you do not forget the wrong way

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# Environmental Consciousness Reflected in Kumarasambhava

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Kalidasa is one of the greatest poets not only of India but of the world. His work transcends the boundaries of time and occupies an eternal place in the world literature. He has given several poems to the world of Sanskrit poetry - Ritusamghara, Kumarasambhava, Meghdut and Raghuvansh. Kalidasa's identity as a poet of nature is well known. The essential role of nature and environment can be noticed in his poetry and plays. The epic Kumarasambhava is the work of Kalidasa's youth. This epic is divided into seventeen sargas. Fear of the gods due to Taraksura's oppression, Parvati's birth as the daughter of Himalayas, Mahadeva's penance, Mahadeva and Parvati's union, the birth of Kartika, the killing of Taraksura by Kartika, etc. The subject matter is the Himalayas described in Kumarasambha's first sarga. The Himalayas are situated in the north of India. He is the soul of the gods and the king of mountains. The Himalayas stand as the benchmark of the world, overlooking the eastern and western seas.

**अस्त्युत्तरस्यां दिशि देवतात्मा हिमालयो नाम नगाधिराजः।**
**पूर्वापरौ तयोनिधी वगाह्य स्थितः पृथिव्या इव मानदण्डः।। (कुमारसम्भवम् 1/1)**

There is no dearth of benu forests or bamboo forests in Himgiri. The sound of the flute was created by blowing the wind in that wind. The sound of that flute sounded like the music of the Kinnars like the music of the Himalayas.

**यः पूरयन्कीचकरन्ध्रभागान्दरीमुखोत्थेन समीरणेन।**
**उद्गास्यतामिच्छति किंनराणां तानप्रदायित्वमिवोपगन्तुम् ।। (कुमारसम्भवम् 1/8)**

Plain snow ridges in the Himalayas. A cedar tree is seen there. Cedar is one of the sacred trees in the Himalayas of India. It is a tree loved by the gods. He-is noble in the family of trees. The cedar trees trembled in the cool Himalayan air. A peacock's tail gracefully adorns, The weary banker's troop Enjoys this wind-

**भागीरथीनिर्झरसीकराणां वोढा मुहुः कम्पितदेवदारुः ।**
**यद्वापुरन्विष्टमृगैः किरातैरासेव्यते भिन्नशिशण्डिबर्हः ।। (कुमारसम्भवम् 1/15)**

The lotus has a lot of place in Kalidasa's nature kingdom. Kalidasa's kabo says that land lotuses are like water lotuses.

**अभ्युन्नताङ्गुष्ठनखप्रभाभिर्निक्षेपणाद्रागमिवोद्विरन्तौ ।**
**आजह्नतुस्तच्चरणौ पृथिव्यां स्थलारविन्दश्रियमव्यवस्थाम् ।। (कुमारसम्भवम् 1/33)**

Kalidasa's Kumarsambhava material came into great neglect. But even though it arrived prematurely, the arrangements for that spring were more than adequate. In the third sarga of this poem, Kalidasa sings of that spring. The appearance of new leaves growing on the branches of the mango tree in spring, Tilak flower has bloomed in the forest (3/30). Pial trees are also full of manjari (3/31). Nibid embrace of vines and trees in spring forest captured (3/39). In the fourth heaven, there is a mention of the fact that the water of rivers etc. has dried up due to the heat of the sun. The rivers etc. which take full form again in the course of monsoons are mentioned-

**रविपीतजला तपात्यये पुनरोघेन हि युज्यते नदी। (4/44)**

In the fifth heaven, the small trees of the Ashram are seen to grow in the water of the children of Parvati lovingly. The drowsy efforts of the mother to take care of the child are seen, Parvati's efforts are also seen to take care of the small trees. Even after the birth of Karthik, Parvati's love for the small trees did not diminish

**अतन्द्रिता सा स्वयमेव वृक्षकान् घट-स्तन-प्रस्रवणैर्व्यवर्धयेत्।**
**गुहोऽपि येषां प्रथमा प्रथमाप्तजन्मनां न पुत्रवात्सल्यम पाकरिष्यति।। (कुमारसम्भवम् 5/14)**

It is as if the love of Kalidasa's heart has blossomed through this son's love of Parvati in the plant world. In the sixth heaven there is a description of the medicinal city of the Himalayas. We notice the lovely presence of clouds there (6/40). Outside the city of Oshadhiprastha there was a sub-forest named Gandhamadana. The smell of that abundance would have