



## Existence of Solutions to Non-Linear Quadratic Integral Equations via Measure of Non-Compactness

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**Abstract.** The objective of this manuscript is to enquire for the solvability of a specific type of non-linear quadratic integral equations via the interesting notion of measure of non-compactness. Firstly, we inquire into couple of exciting fixed point theorems involving a measure of non-compactness in the setting of a Banach space. Subsequently, bringing into play a suitable measure of non-compactness and the acquired results, we discuss the existence of solutions to the aforementioned kind of non-linear quadratic integral equations.

### 1. Introduction

The study on integral equations has drawn a huge amount of attention from the enthusiasts as it plays a decisive role in spelling out plenty of events and problems of real world. Utilizing several theories of functional analysis, topology and fixed point theory as the tools, the subject is growing fast with applications in applied mathematics, physics, engineering, economics, biological sciences and many other branches of science [1, 10, 15, 18, 27, 30]. Another crucial aspect of the study is the investigation of solvability conditions to integral equations as a whole, fixed point theory is one of the most vital and easiest of them. Mathematicians have explored a number of fixed point theorems and common fixed point theorems [3, 5, 19, 23, 28] to guarantee the existence of a solution or more to a certain type of integral equations. In the existing literature, there are a number of articles which deal with such scenarios via some suitable results from fixed point theory involving control functions while some others make use of findings in fixed point theory via measure of non-compactness. However, it is exciting to note that both of these approaches firstly enquire for existence of solutions and then look for solutions, and also are quite easy to handle.

In his research article, Kuratowski [22] put forward the concept of a measure of non-compactness (in short, MNC) and this gave a new wing to the research in this direction. Afterwards, Darbo [16] employed this concept and obtained the fixed points of  $\alpha$ -set contractions defined on a closed, bounded and convex subset of a Banach space. This result extends and generalizes the Schauder fixed point theorem remarkably, and is often brought into play as an essential tool to inspect the existence of a solution to a number of classes

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# Age-dependent potential health risk assessment due to radioactive radon-222 in the environs of highly populated Durgapur industrial zone and nearby Bakreswar hot spring, India

Saroj Khutia · Ankita Dawn · Kankana Seal · Hirok Chaudhuri · Chiranjit Maji · Suvashree Mukherjee

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**Abstract** It is well known that exposure to a high concentration of radon-222 causes severe health effects, including cancer. The present article includes a survey on radon-222 in the water bodies of the city Durgapur [non-geothermal area] and nearby Bakreswar hot spring [geothermal province], India. The possible sources of radon from natural radionuclides and industries have been discussed in the article. Durgapur is a densely populated [ $\sim 3680$  persons/ $\text{km}^2$ ] industrial city with a population of 0.57 million. On the other hand, many tourists and pilgrims usually visit Bakreswar throughout the year. Age-dependent potential health risk assessments of the dwellers at Durgapur and Bakreswar due to radon exposure were performed for the first time. The present work is the first attempt to estimate the mean ingestion /and inhalation dose per annum, total effective dose [TED] per

annum and the health risk assessment for cancer in adults, children and infants due to radon exposure at Durgapur and Bakreswar. In some cases, the values of TED exceed the permissible limit of 100 micro Sievert per year [ $\mu\text{Sv/y}$ ] as recommended by EUC and WHO. The radiation profile maps relating to radon concentration and associated contour maps of health risk factors [HRF] for the adults, children and infants were also prepared for the first time. Some areas were identified as high-risk zones, and the dwellers are prone to a high risk of cancer. The article also proposed several techniques to reduce radon in water and buildings. The authors also recommended banning some water sources to protect people from radon risk. This study will help scientists, policymakers, industrialists, farmers, government agencies and public health departments.

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# Cobalt-conjugated carbon quantum dots for in vivo monitoring of the pyruvate dehydrogenase kinase inhibitor drug dichloroacetic acid

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Jiko Raut, Md Majharul Islam, Shrabani Saha, Santi M. Mandal, Sukhendu Mandal, and Prithidipa Sahoo\*

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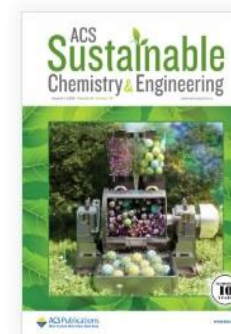
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NEW FIXED POINT RESULTS FOR ASYMPTOTIC  
CONTRACTIONS AND ITS APPLICATION TO CANTILEVER  
BEAM PROBLEMS

Surajit Karmakar, Hiranmoy Garai, Ankush Chanda and Lakshmi Kanta  
Dey

**Abstract.** In this article, we deal with some interesting variants of asymptotic contractions, namely Reich type and Chatterjea type weak asymptotic contractions defined on the usual metric spaces. We derive a couple of fixed point results concerning such contractions. Moreover, we look over the existence of solutions to a fourth-order two-point boundary value problem which is a particular type of cantilever beam problems. Furthermore, we construct numerical examples to justify our obtained results.

1. Introduction and preliminaries

The fixed point theory based on asymptotic contractions revolves about the assumptions on the iterations of the corresponding mapping. In fact, the notion of asymptotic contractions was originally proposed in connection with one of the initial extensions of Banach contraction principle due to Caccioppoli [5]. It states that for a self-map  $f$  defined on a complete metric space  $X$ , the Picard iteration converges to the unique fixed point of  $f$ , given that for each  $n \geq 1$ , there is a non-negative constant  $c_n$  such that  $d(f^n(x), f^n(y)) \leq c_n d(x, y)$ , holds for all  $x, y \in X$ , satisfying  $\sum_{n=1}^{\infty} c_n < \infty$ .


Now we recollect the definition of an asymptotic contraction due to Kirk [10], which constitutes a wider collection of mappings than the class of aforementioned mappings.

DEFINITION 1.1. Let  $\varphi : \mathbb{R}^+ \rightarrow \mathbb{R}^+$  be any contractive gauge function such that  $\varphi$  is continuous and  $\varphi(s) < s$  for  $s > 0$ . Let  $\Phi$  be the collection of all such contractive gauge functions  $\varphi$ . A self-map  $f$  defined on a metric space  $(X, d)$  is said to be an asymptotic contraction if for all  $n \in \mathbb{N}$ ,  $d(f^n(x), f^n(y)) \leq \varphi_n(d(x, y))$  holds for all

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Keywords and phrases: Asymptotic contractions; orbital continuity; cantilever beam problems; boundary value problems.

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## Origin of Sufism: A Discussion

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**Abstract:** 'Sufism' is Islamic mysticism. The concept of 'Sufism' is very complicated and there is a mass dispute about its actual origin. Various scholars have stated their different views regarding the origination of it. Some Sufis mentioned that the term '*Ṣūfī*' is derived from Arabic word '*Ṣafā*' (Purity). Some said that '*Ṣūfī*' is derived from '*Ṣūfah*', meaning an ancient tribe of Arabia who separated themselves from the world and engaged themselves only in the service of the Ka'ba of Mecca. According to some other scholars, '*Ṣūfī*' is derived from '*Ṣaff*' (their rank was first). Some other Sufis say that '*Ṣūfī*' is derived from '*Ṣaf*' (bench). Another system of Sufis claims that, '*Ṣūfī*' is derived from the Greek word '*Sophia*' (wisdom). The term '*Ṣūfī*' does not appear anywhere in Quran. Only some equal words for '*Ṣūfī*' such as *asmuqarrabin*(friends of God), *ṣābirīn*(patient men), *Abrār*(virtuous man) etc. are mentioned in it. It is believed by the Sufis that the original sources of *Ṣūfī* culture is the holy Quran and the Hadith but in later period, under the influence of other cultures and races, a considerable changes and modifications are noticed in *Ṣūfī* tradition. The present paper is an attempt to search the origin of Sufism and to discuss some of the movements and influences which molded it.

Mysticism is common to all religions. It is called "the great spiritual current which goes through all religions".<sup>1</sup> There is a characteristic in every religion which says to surrender one's finite-self to God by devotion of faith and Love. 'Sufism' is generally accepted term for the mysticism of Islam. It is an Anglo-Perso-Arabic word which indicates the system or the religion and profession of a Sufi. The Arabic word of it is '*Taṣawwuf*'.<sup>2</sup> Sufism is the immediate relation of man with the Divine which leads to an intuitive certainty of contact with the super-sensual world.<sup>3</sup> The term '*Ṣūfī*' comprises the philosophy and practices which aim at direct union of man with *Alāh* (God) and those who practice it are called Sufis. The aim of Sufism is same as that of the Mysticism of other religions.

The concept of 'Sufism' is very complicated and there is a mass dispute about its actual origin. Various scholars have stated their different views regarding the origination of it. Their opinions are far from satisfying the requirements of etymology, but they have articulated many subtle arguments. Hujwīrī had briefed the discussion as follows: "Some asserts that the *Ṣūfīs* so called because he wears a woolen garment (*jāma-i- ṣūf*); others that he is so called because he is in the first rank (*ṣaff-i-awwal*); others say it is because the *Ṣūfīs* claim to belong to the *Aṣḥāb-i-Ṣūffa*, with whom may God be well-pleased! Others, again, declare that the name is derived from





# Performance analysis of 5GMAKA: lightweight mutual authentication and key agreement scheme for 5G network

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## Abstract

In this paper, we have proposed a lightweight mutual authentication and key agreement scheme for 5G (5GMAKA) using the symmetric-key cryptographic framework. The proposed 5GMAKA protocol has been implemented to overcome the problem associated with the 5G authentication and key agreement (5G AKA) protocol suggested by the 3rd generation partnership project (3GPP). 5G AKA is exposed to various sorts of fatal network security attacks and takes excessive time to execute (~ 685.62 milliseconds) compared to other related authentication and key agreement schemes as per the literature survey. The stability and robustness of the proposed 5GMAKA under safety issues are ensured by the results obtained from the security analysis of the scheme using the well-known rubin logic and automatic validation of internet security protocol applications (AVISPA) simulation tool. The performance analysis of the proposed 5GMAKA shows that this scheme is superior compared to 5G AKA of 3GPP and other standard protocols with respect to enhanced security features, five communication rounds, and shorter execution time (~ 0.72 milliseconds) which is the lowest among all other related schemes.

**Keywords** 5G · AKA · Mobile communication · Security · AVISPA · Rubin logic

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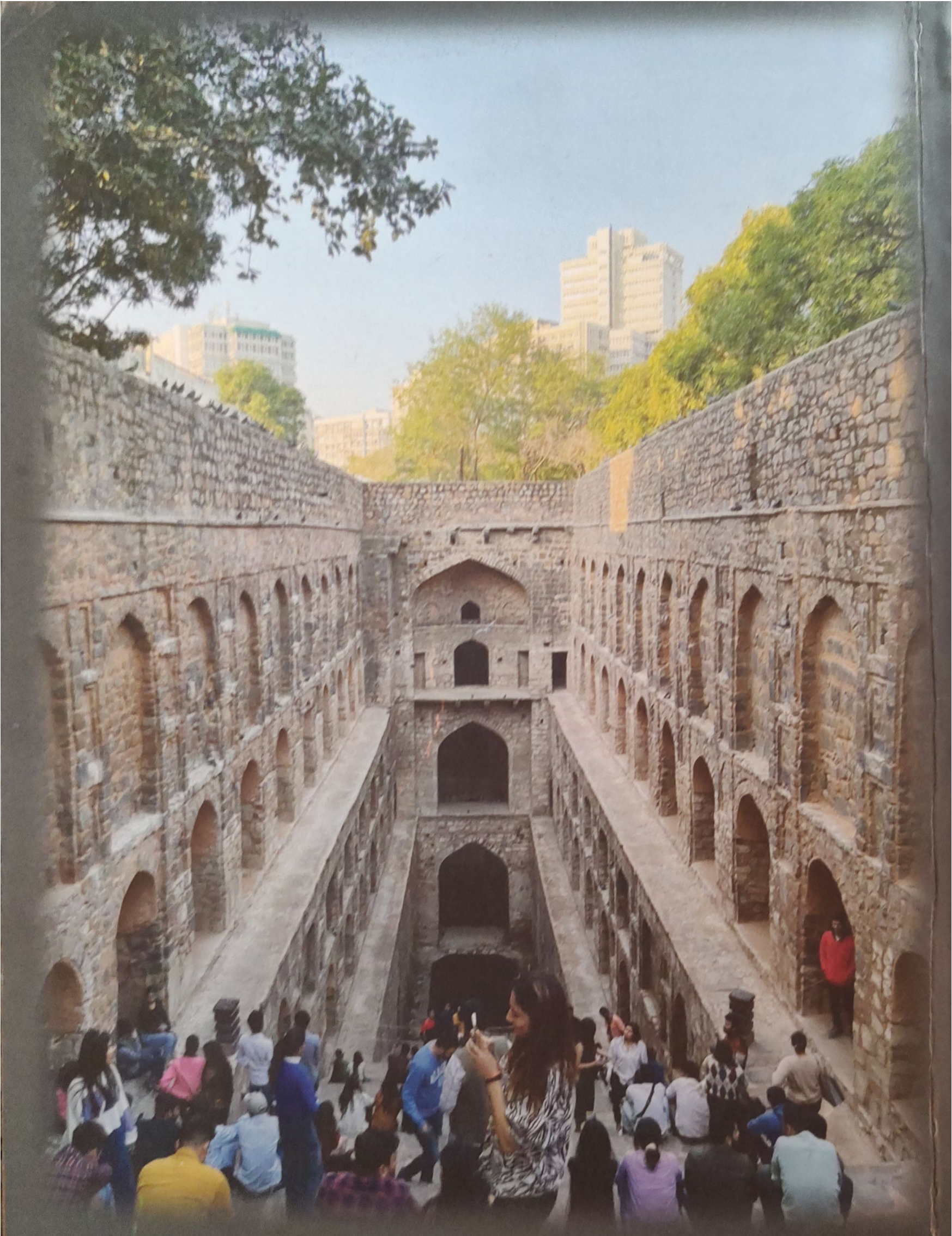
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*The Quiet Archway Within Words* by Vinayan Bhaskaran, New Delhi: Authorspress, 2021, Pp. 72, Rs. 295/-

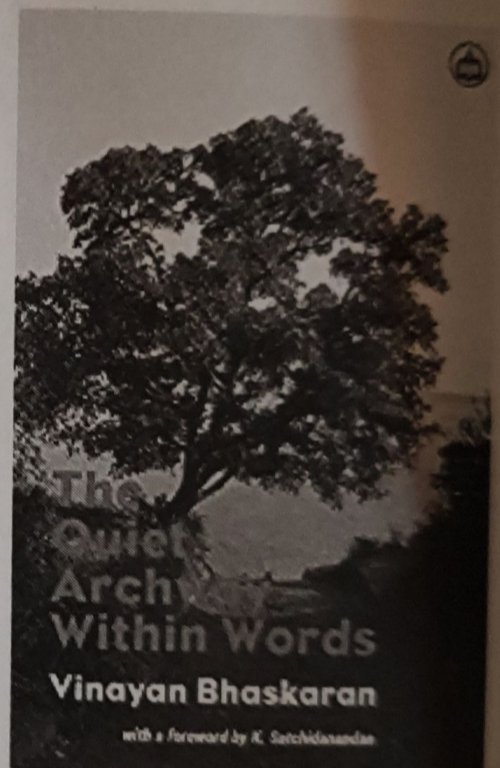
*On The High Wire* by Siddhartha Menon, Poetrywala, 2022. Pp. 111, Rs. 300/-

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Vinayan Bhaskaran's *The Quiet Archway within Words* is a debut collection of poems. K. Satchidanandan, in his "Foreword" to this book, calls it a "late debut" since Bhaskaran has been writing poems for a long time. Divided into three sections—"Poems of Exile," "Painting Pictures," and "The Quiet Archway within Words,"—this book consists of thirty-eight poems, which were published between 1982 and 2018.

The poems in the first section "Poems of Exile" represent a quarantine mood. His introspections on the bygone days represent the gradual transition of the middle-class Indian society from the folds of traditional set-up to a milieu of modernity. The changes that came over with the passage of time are conveyed through the speaker's ruminations on "Abandoned Home," "The Last Homestead" and "This Small Town." In poems such as "Goa" and "Fort Kochi," it is evident that colonial history finds a fixed place in the memory of a postcolonial subject. "Exile" implies a state of confinement, which makes one feel homesick, unhappy and anxious. It is a physical state as well as a psychological one.

In "Heat Wave" the sense of exile is represented through the description of an adverse environmental condition that bars people from going outdoors and makes both humans and animals exhausted: "Hard to tell/one face from another, /a dog from piled rubbish." In "Outsider" the speaker looks back at the lonely days of his childhood, when he felt alienated in school as well as at home. As an adolescent he showed defiance against





conservatism by being unconventional in his own way: "The younger crowd lit candles in their eyes and I shaved my head/ not in repentance but in quiet celebration" ("Outsider"). As suggested in the title "Painting a Picture," the poems in the second section evoke a plethora of images with which the speaker creates a picture gallery of people, places, seasons and objects. Though he draws on familiar subjects such as winter, the room at night, a well-known film-maker (John Abraham), mist, *ashram* etc., he defamiliarizes them by blending sensitivity with a critical outlook. This is apparent in "To Delhi, from a South Indian City," where the speaker inverts the centre-margin dynamics and affirms, "The differences could be discounted."

The title of the third section "The Quiet Archway within Words," which is named after the penultimate poem of the book, offers a thematic summary to the volume. It points out that in the maze of a mechanical existence, one can find "quiet" repose in memories and poetic musings. In this regard, "The Quiet Archway within Words" fits well as the title of the volume.

While Bhaskaran's work is a debut collection, Siddhartha Menon's *On The High Wire* is his fourth book of poems. It represents the poet's pensive thoughts on social and physiological maladies, human antagonism towards Nature and spatial significance of places. The title is inspired from the following lines of the American poet Lawrence Ferlinghetti: "the poet like an acrobat/ climbs on rime/ to a high wire of his own making." The image of a poet as an acrobat is thrilling in this context, but Menon uses it as an intertextual trope to represent a poet's apprehensions during calamitous situations. On being surrounded by disease and death during the Covid-19 pandemic, a poet's acrobatic jigs are slowed down: "How sickening that you step out/ no net no harness" ("On the High Wire"). The anxieties of living in an age of the "new normal" are recorded in "A Virus Diary March-April 2020," a sequence consisting of sixteen poems on the pandemic situation.



The norms of staying indoors, disinfecting the hands and donning masks are clearly reflected in poems such as "In the Dark" ("Fear is a mask



# অনুষ্ঠান

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## অনুবাদে বিপন্ন ভাষা এবং বাংলা অনুবাদ

দেবদীপ ধীবর

### সূচনা

ভাষার সংরক্ষণ, পুনরুজ্জীবন ও উত্তরাধিকার এই শব্দ তিনটি দীর্ঘ দু'দশক ধরে নানা ভাবে চর্চিত হয়ে আসছে। এই চর্চা বুঝিয়ে দেয় যদি একটা ভাষা অসংরক্ষিত, বিপন্ন তথা বিলুপ্তির পথে যায় তখন তার কারণগুলোকে দূর করা আশু প্রয়োজন। এগুলো দূর করতে পারলে ভাষা তার স্বাভাবিক রূপ ফিরে পাবে। কিন্তু আজকের জীবনে সে ভাবনা আরও কঠিন হয়ে পড়েছে। কারণ ভাষা ব্যবহারের গণ্ডী দিন দিন ক্ষুদ্র থেকে ক্ষুদ্রতর হয়ে আসা। এমতাবস্থায় ভাষার বিপন্নতা দূর করতে হলে, ছোটো থেকে বড়োর দিকে যেতে হবে। কিন্তু এই প্রক্রিয়াটি বাস্তবায়িত করা হলো স্বাভাবিকতার সঙ্গে যুদ্ধ করা বই কিছু নয়। বলা ভালো বিমূর্ত কিছুর সঙ্গে লড়াই করার শামিল। এরকম একটি সময়ে অনুবাদকে এই যুদ্ধের হাতিয়ার হিসেবে প্রতিষ্ঠিত করা যায় কিনা তারই একটা উদ্যোগ।

### অনুবাদে বিপন্ন ভাষা

অনুবাদ দুই ভাষার মধ্যে সম্পর্ক স্থাপন করে, আর এই দিয়ে নতুন সম্পর্কের প্রেক্ষাপট তৈরি হয়। তাছাড়া অনুবাদে ভাষার ব্যবহারের ক্ষেত্র প্রসারিত হয়। অন্যান্য বৈদ্যুতিন মাধ্যমেও তার প্রভাব পড়ে। কিন্তু অনুবাদে লক্ষ্য ভাষার পাঠকগোষ্ঠী স্বাভাবিক ভাবেই ভাষাটির ব্যবহারকারীর পরিসংখ্যান কিছু বাড়িয়ে তোলে। যন্ত্রে তা নাও হতে পারে। বিপন্ন ভাষার ব্যবহারের প্রয়োজনীয়তা উপেক্ষিত দু'ভাবে হতে পারে—মাতৃভাষা ব্যবহারে বাইরের থেকে বাধা প্রয়োগ আর ভাষা সম্প্রদায়ের মধ্যেই হীনমন্যতা বোধ বা উদাসীনতা। অনুবাদ বাইরের অজানা জগৎকে উন্মুক্ত করে। এই উন্মুক্তিকরণ



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## Abstract

Authentication plays a pivotal role for mobile users to provide security and privacy to their personal information while availing the roaming service in Global Mobility Network (GLOMONET). Most of the schemes offered to address authentication-related problems are built on the centralized semi-trusted server. In such type of server, the privacy and the security of mobile users may be compromised. To eradicate such a problem, here, we propose a user authentication scheme known as AUGChain for GLOMONET. The novelty of the work lies in proposing a scheme, to produce a peer-to-peer network, where each participant can directly interact with the information stored in the secure distributed ledger. Therefore, in this proposed scheme, the unnecessary forward of requisite data by a participant is reduced. Hence, not only minimization of communicational overhead is achieved, but also it minimizes the computational time of the whole scheme. The blockchain technology-based implementation is carried out on hyperledger composer along with hyperledger fabric. The security analysis of the proposed scheme has been done using Burrows–Abadi–Needham logic to ensure mutual authentication between the participants. Moreover, the proposed model, AUGChain, outperforms the other existing schemes by resisting different network security attacks like compromised server attacks, DOS, DDOS attacks, reducing communicational costs as well as computational time a significant amount. This has been done by reducing the execution time of the order of 7.5 ms.

**Keywords** User authentication scheme · Burrows–Abadi–Needham (BAN) logic · Network security attacks · Blockchain · Hyperledger fabric

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Research Paper

# Syntheses of flower and tube-like MoSe<sub>2</sub> nanostructures for ultrafast piezocatalytic degradation of organic dyes on cotton fabrics

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## ABSTRACT

The synthesis of few-layered transition metal dichalcogenides (TMDCs) with abundant exposure of the active site, viz., is an important key to achieve excellent dye degradation performance. Here, we have reported synthesis and ultrafast dye degradation performance of flowers-like MoSe<sub>2</sub> nanostructure (FMN) with ~230 nm in diameter and its transformation to tube-like MoSe<sub>2</sub> microstructure (~1 μm in length) by tuning the solvothermal reaction time. The piezoelectric devices are developed using the FMNs delivers the highest open-circuit voltage of ~2.12 V, which is ~21 times higher than that of the developed device with the tube-like MoSe<sub>2</sub> microstructure. The piezoelectric property of the synthesized samples has been judiciously utilized further for ultrafast degradation of organic dyes within 60–120 s only under the low-frequency (40 kHz) ultrasonication vibration in the dark. The estimated dye degradation efficiencies of the FMNs-based piezocatalyst are found to be ~86% and 85% for degradation of Rhodamine B (RhB) and methylene blue (MB) dye within the 60 s, respectively. Also, the FMN has exhibited an excellent piezocatalytic dye degradation capability for RhB-MB dye mixture and dye loaded on a cotton fabric with an efficiency of ~98% (60 s) and 84% (120 s), respectively. The piezocatalytic dye degradation mechanism of FMNs has also been explained theoretically.

## 1. Introduction

The existing water is being polluted gradually by different toxic dyes coming from the different textiles industries and environmental pollutants. Therefore, the treatment of organic dyes present in wastewater has fascinated significant and long-term consideration (Borgarello et al., 1981; Kabra et al., 2004). The wastewater treatment is also a major problem area in energy research (Borgarello et al., 1981; Kabra et al., 2004). Recently, researchers are extensively utilizing semiconductor nanoparticle-based photocatalysts to degrade organic pollutants by creating strong oxidizing free species under light illumination (Sharma et al., 2009; Xiao et al., 2021). But due to the limitation of the band gap matching of the semiconductor photocatalysts with the illuminated light irradiation, the photocatalytic dye degradation is not applicable at all times. Additionally, for fast degradation, the semiconductor nanomaterial must show a high capability to generate and separate electron-hole (e<sup>-</sup>-h<sup>+</sup>) pairs under optical irradiation. So far, a number of strategies such as doping, use of high reaction temperature, and

designing of heterostructured materials have been tried to enhance photocatalytic dye degradation (Ajmal et al., 2014). However, these materials and methods are also limited due to their low solar energy conversion efficiency (<20%), and low light transmission in intensely dyed toxins (Banin et al., 2021). Therefore, novel environment-friendly, recyclable, highly efficient methods and materials are necessary for forthcoming wastewater purification techniques. Mechanical energy is a sustainable abundant natural energy that can be harvested by employing piezoelectric materials (Wu et al., 2018, 2016, 2017; Mushtaq et al., 2018; Lan et al., 2017; Lin et al., 2017). Piezoelectric materials can produce an electric field in reaction to an external force. A built-in electric field powerfully increases the separation of free carriers (Wu et al., 2018, 2016, 2017; Mushtaq et al., 2018; Lan et al., 2017; Lin et al., 2017). Thus, piezoelectric materials have been widely used in photocatalytic dye degradation. Thus, the innovative studies associated to piezoelectric water treatment are paid significant attention (Wu et al., 2018, 2016, 2017; Mushtaq et al., 2018; Lan et al., 2017; Lin et al., 2017). Recently, researchers have investigated the piezocatalytic

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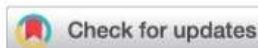
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## Palladium(0)-catalysed regioselective cyclisations of 2-amino(tosyl) benzamides/sulphonamides: the stereoselective synthesis of 3-ylidene-[1,4]benzodiazepin-5-ones/benzo[*f*][1,2,5]thiadiazepine-1,1-dioxides†

Debasmita Mondal, Gargi Pal and Chinmay Chowdhury \*

The Pd(0) catalysed cyclisation reactions between *tert*-butyl propargyl carbonates and 2-aminotosyl benzamides or sulphonamides deliver 1,4-benzodiazepin-5-ones or sultam derivatives, key components of many biologically active compounds. But 2-amino benzamides/sulphonamides require propargyl carbonates substituted at acetylenic carbon to undergo the reaction resulting in the stereoselective formation of the said products.

The preparation of seven, eight, and larger membered heterocycles exhibiting wide and ever evolving biological properties is a challenging task.<sup>1</sup> Among the seven-membered heterocycles, 1,4-benzodiazepin-5-ones (**I**, Fig. S1 in the ESI†) are considered as privileged<sup>2</sup> structures in medicinal chemistry, contributing to the development of many drugs.<sup>3</sup> Besides, bicyclic 1,4-benzodiazepin-5-ones are considered as potential precursors of their tricyclic fused analogs, many of which have been translated into potent drugs, *viz.* *anthramycin*,<sup>4a</sup> *flumazenil*<sup>4b</sup> and its <sup>18</sup>F-labelled derivative,<sup>4c</sup> and *fuligocandin B*<sup>4d</sup> (Fig. S1 in the ESI†). But there are a limited number of methods for the general synthesis of 1,4-benzodiazepin-5-ones, mostly employing either traditional reactions<sup>5</sup> or metal-catalysed heteroannulations<sup>6</sup> including palladium.<sup>6c–e</sup> Therefore the development of methodologies to provide easy access to this scaffold (*i.e.*, **I**) specially those involving the simultaneous formation of the C–C and C–N bonds in one pot and using simple substrates would be worthwhile.

Sultams (*i.e.*, cyclic sulphonamides) display activities against a wide variety of biological targets.<sup>7</sup> Benzo[*f*][1,2,5]thiadiazepine-1,1-dioxides (**II**, Fig. S1 in the ESI†), a subclass of sultams, have emerged as important pharmacophores with potential biological activities.<sup>8</sup> For example, pyrrolo[1,2-*b*][1,2,5]benzothiadiazepine-5-

5-dioxides<sup>8a</sup> (PBTDs) are anti-cancer agents, while compound **X**<sup>8b</sup> (see Fig. S1 in the ESI†) has anti-HIV activity. However, reports<sup>9</sup> on the synthesis of benzo[*f*][1,2,5]thiadiazepine-1,1-dioxides (*i.e.*, **II**, Fig. S1 in the ESI†) are few, calling for straightforward and practical methods for their general synthesis.

In continuation of our work<sup>10</sup> on palladium-catalysed reactions, we envisioned that simple 2-amino benzamides or their sulphonamide analogs could be employed as bis-nucleophiles in reactions with propargylic carbonates for the formations of two C–N bonds (*i.e.*, 1,2 and 3,4) in one pot, thereby offering a facile and general synthetic route to 1,4-benzodiazepine-5-ones or their sulphur analogues. The concept appeared viable upon choosing the appropriate palladium catalyst and reaction conditions as depicted in Scheme 1.

At the outset, we performed an optimisation study for the model synthesis of 1,4-benzodiazepin-5-one **4a** as shown in Table 1. Initially, the exposure of the reactants to 10 mol% Pd(OAc)<sub>2</sub> and 20 mol% PPh<sub>3</sub> in refluxing acetonitrile afforded **4a** after 18 h albeit in a low yield (Table 1, entry 1). When PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> was used a comparable result was observed (entry 2, Table 1). We therefore switched to Pd(0) catalysts. But the use of Pd<sub>2</sub>(dba)<sub>3</sub>, Pd<sub>2</sub>(dba)<sub>3</sub>CHCl<sub>3</sub> or Pd(PPh<sub>3</sub>)<sub>4</sub> afforded **4a** only in moderate (22–45%) yields (Table 1, entries 3–5). Pleasingly, the use of Pd(dba)<sub>2</sub> together with Xantphos as the ligand afforded **4a** within 4 h with a 92% yield (Table 1, entry 6). Thereafter, we continued with Pd(dba)<sub>2</sub> but used different ligands like *t*-butyl Xantphos/DPEphos/dppf/dppe (Table 1, entries 7–10); these reactions furnished **4a** in 18 h with moderate (15–40%) yields.

Even changing the solvent system (Table 1, entries 11–13) by including both high (*i.e.*, DCE, DMSO) and low polar (*i.e.*, toluene) ones did not succeed well except in the case of DCE that produced **4a** in 7 h with a 89% yield. Next, decreasing the catalyst loading from 10 mol% to 5 mol% produced **4a** in 93% yield though entailing a slightly longer reaction time (Table 1, entry 14 *vs.* entry 6). We therefore considered the conditions used in entry 14 of Table 1 as the preferred ones to explore the scope of this reaction (Table 2).

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## SOLUTION TO SECOND ORDER DIFFERENTIAL EQUATIONS VIA $F_w$ -CONTRACTIONS

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**Abstract.** In this article, we introduce the notions of  $F$ -contractions and Hardy-Rogers type  $F$ -contractions via  $w$ -distances in the backdrop of an orthogonal metric space. After this, we prove some fixed point results concerning the said kind of contractions by taking a weaker version of completeness of the underlying space instead of completeness. Further, we employ the results to obtain some existence and uniqueness criteria of the solution(s) to a certain type of second order initial value and boundary value problems. Along with these, we illustrate some numerical examples to interpret our achieved fixed point results.

**Key Words and Phrases:**  $F$ -contractions,  $w$ -distances, orthogonal metric spaces, second order differential equations.

**2020 Mathematics Subject Classification:** 47H10, 54H25, 34A12, 34B15.

### 1. TECHNICAL PRELIMINARIES

The metric fixed point theory has inspired many researchers since the emergence of *Banach Contraction Principle* in 1922. Therefore, many interesting works are there in existing literature involving various types of contractive conditions and abstract spaces, see [2, 3, 4, 5, 7, 8, 10, 12, 18]. Of late, a very novel generalization of the above-mentioned principle is proposed by Gordji et al. [9]. They firstly came up with the notion of an orthogonal set and further, obtained the extension of Banach fixed point result for such kind of sets. We here put down the formal definition of an orthogonal set.

**Definition 2.1.** Suppose that  $X$  is a non-empty set and  $\perp$  is a binary relation on  $X$ . If there exists  $x_0 \in X$  such that

$$(\forall y \in X)x_0 \perp y \vee (\forall y \in X)y \perp x_0,$$

**“More Last Words”: John Gay’s *Polly* and the Radical  
Re-writing of the Margins of the Empire**

Chandrima Das

Do not some by honour mean good nature and humanity, which weak minds call virtue? How then! Must we deny it to the great, the brave, the noble, to the sackers of towns, the plunderers of provinces, and the conquerors of kingdoms? Were not these men of honour? And they scorn those pitiful qualities I have mentioned. Again, some few (or I am mistaken) include the idea of honesty in their honour. And shall we then say that no man who withholds from another what law- or justice perhaps, calls his own—or who greatly and boldly deprives him of such property, is a man of honour? Heaven forbid I should say so in this, or, indeed, in any other good company!

Henry Fielding, *Jonathan Wild the Great*

Pohetohee: Honour, and honesty, are not those distinguish'd?

Morano: As incapacities and follies. How ignorant are these Indians! But indeed I think honour is of some use; it serves to swear upon.

John Gay, *Polly*

Henry Fielding’s knowledge of the Classical language implies that he would most certainly have been aware of the etymological connection between the words “Honour” and “Honesty”. However, as the narrator/biographer of Jonathan Wild’s earthly exploits wryly mentions, it is a common human fallacy to associate “greatness” with “goodness”, or “honour” with “honesty”, for that matter. The relationship between these

Chandrima Das





## On Some Non-Linear Contractions in Modular Metric Spaces

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**Abstract.** Motivated by the exciting notion of modular metric spaces, in this manuscript, we positively answer an open question posed by Mitrović et al. [Ital. J. Pure Appl. Math., 41 (2019), 679-690] on the existence of fixed points of Hardy-Rogers contractions. Moreover, in the said setting, we conceive the common fixed point theorem of Jungck. As consequences of our findings, we deduce a few fixed point and common fixed point results which authenticate the novelty of the obtained theories. Finally, we construct numerical examples to validate our study.

### 1. Introduction

The fascinating and intensive development on the study of modulars on various linear spaces is due to Nakano [26, 27] and some of his fellow mathematicians from his school. As the modular type hypotheses involved in the theories can be comfortably verified than that of their norm or metric counterparts, such assumptions arise quite naturally in the study of integral equations, approximation theories, the electrorheological fluids, economics and in many other courses. Therefore in recent times, the notion of modulars and modular spaces are thoroughly investigated, particularly in a variety of Orlicz spaces which has a huge applicability in diversified fields [19, 20, 24, 25, 28, 29].

In recent past, Chistyakov [11, 12] coined the idea of a new kind of modular which is not too restrictive and is also consistent with the classical concept of it. Further, this construction of a novel modular notion is more functional in complying with the questions of description of multi-valued superposition operators. One of the major motivation at the back of this newly defined modular by Chistyakov is the physical interpretation of it. Precisely, while a metric defined on a non-empty set stands for the finite distances between any two points of the set, a modular on a set associates a non-negative, at times infinite valued, field of velocities with the elements. Informally, one can correspond an average velocity  $\omega_\lambda(x, y)$  to any arbitrary time  $\lambda > 0$  so that it takes  $\lambda$  time to travel the distance between points  $x, y \in X$ . In the wake of such modification by Chistyakov, plenty of impressive and compelling results are done in the setting of modular metric spaces [2, 3, 5, 6, 9, 15, 21, 23].

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‘এবং মছয়া’-বিশ্ববিদ্যালয় মঞ্জুরী আয়োগ (U.G.C.- CARE List) অনুমোদিত  
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# স্বাধীনতা-উত্তর বর্ধমান জেলায় জনস্বাস্থ্য উন্নয়নে এনজিওগুলির ভূমিকা সেখ ওয়াদেকার রহমান

সারসংক্ষেপ :

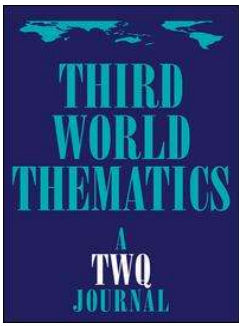
স্বাধীনতার পর থেকে, বর্ধমান জেলার জনস্বাস্থ্যের উন্নয়নে এনজিওগুলির ভূমিকা অত্যন্ত গুরুত্বপূর্ণ ছিল। এনজিওগুলো সব একরকম ছিল না। তাদের উৎপত্তি এবং কাজের পদ্ধতিতেও বেশ কিছু পার্থক্য লক্ষ্য করা যায়। কিছু এনজিও চিকিৎসা সেবা প্রদানের পাশাপাশি প্রতিরোধমূলক পরিষেবা প্রদান করে। প্রতিরোধমূলক পরিষেবা হিসাবে তারা জেলার বিভিন্ন স্থানে বিভিন্ন সচেতনতামূলক অনুষ্ঠানের আয়োজন করে। তাদের প্রাথমিক লক্ষ্য ছিল সাধারণ মানুষের সচেতনতা বৃদ্ধি করা। রক্তদান শিবির আয়োজন, বিনামূল্যে চক্ষু পরীক্ষা শিবির, টিকাদান শিবির এবং অ্যাম্বুলেন্স সেবা প্রদান ছিল তাদের উল্লেখযোগ্য কিছু কার্যক্রম। তারপর থেকে তারা সরকারের কাছ থেকে জনস্বাস্থ্য সম্পর্কিত বিভিন্ন ধরনের প্রকল্প পেয়ে আসছে। জনস্বাস্থ্যের ক্ষেত্রে তাদের সাফল্য খুবই উল্লেখযোগ্য।

সূচক শব্দ :

জনস্বাস্থ্য, স্বেচ্ছাসেবী সংস্থা, চিকিৎসা, পরিষেবা, সেবা, নিরাময়, প্রতিষেধক, সচেতনতা শিবির, ভ্রাম্যমান হাসপাতাল।

প্রতিপাদ্য বিষয় :

বর্ধমান জেলায় এনজিওগুলি জনস্বাস্থ্যের উন্নয়নে যুক্ত হয়েছে। তারা নিরাময়মূলক, প্রতিরোধমূলক এবং পুনর্বাসন পরিষেবা প্রদান করে আসছে। কখনও কখনও তারা লক্ষ্যযুক্ত সম্প্রদায়ের কাছে তাদের পরিষেবা সরবরাহ করে। তারা সরকারের কাছ থেকে পাওয়া স্কিম বা প্রকল্পগুলিও পরিচালনা করে। এটা লক্ষ্য করা গেছে যে তারা স্বাস্থ্য সচেতনতা কর্মসূচি, কমিউনিটি পর্যায়ের ক্যাম্পে রোগ সনাক্তকরণ কর্মসূচিতে সবচেয়ে বেশি সাফল্য পেয়েছে। এছাড়াও বেশ কয়েকটি এনজিও হাসপাতাল পরিষেবা সরবরাহ করছে। যাইহোক, জনস্বাস্থ্য



## The culinary as 'border': perspectives on food and femininity in the Indian subcontinent

Shyamasri Maji

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## The culinary as 'border': perspectives on food and femininity in the Indian subcontinent

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### ABSTRACT

The word 'border' usually refers to the dividing line between two distinct territories. Geo-political borders not only protect the sovereignty of the nation but also preserve the cultural and the religious identities of the people inhabiting the nation. 'Food,' an important signifier of cultural identity, is an effective tool for drawing lines between the South Asian ethnic and sub-ethnic groups. Women play a crucial role in sustaining such borderlines. For them, kitchen is the fortress, where traditional food items are prepared and the secrets of cooking are handed down the generations through daughters and daughters-in-law. The performative roles associated with the production of food are strictly reserved for women. In the Indian subcontinent, food can be studied as a discursive domain of feminine rituals observed in social and religious ceremonies. In this article, I have analysed this connection between food and femininity by examining the gendered kitchen rituals. I have also examined the kitchen space as the cultural borderline that protects and preserves the traditions of a community and nation. I have explored the culinary practices as a site of patriarchal surveillance and feminine resistance in the literary narratives of Bulbul Sharma, Monica Ali and Tahira Naqvi.

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'Gender roles continue to be implicated in the scripts of women's nationalisms and "cultural identities," particularly as they take root in the culinary realm.'<sup>1</sup>

This article looks into the concept of 'border,' the political line of division between territories and nations, through the microscope of culinary tradition in the home (*ghar*) and the diaspora (*bahir/away*). Since conventions of femininity drive women to practise and preserve the culinary activities of a family and a community, it is necessary to analyse the gender roles that operate in the culinary realm. In this context, it becomes obvious to relate the geopolitical interpretations of 'border' with the politics of gender in a patriarchal society. Certain customs such as the women members in the family should eat after the male members have eaten their meals and a Hindu woman should give up meat and fish from her diet after the death of her husband are examples that point out the secondary status of women in the family and the community. This article will analyse the relationship between food and femininity among the Hindus and the Muslims in the homeland and the hostland. It will examine the ways in which the culinary code of a community controls the lives of its

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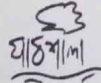


আন্তর্জাতিক  
পাঠশালা

জুলাই-সেপ্টেম্বর, ২০১৯

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অমিত রায়

যুগ্ম সম্পাদক  
কপোতাক্ষী সুর  
শুভেন্দু দাশমুন্দী



পাঠশালা প্রোডাকসন্স

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সর্বস্বত্ব সংরক্ষিত

প্রকাশক এবং স্বত্বাধিকারীর লিখিত অনুমতি ছাড়া এই পত্রিকার কোনো অংশেরই কোনো রূপ পুনরুৎপাদন বা প্রতিলিপি করা যাবে না এবং কোনো বাস্তবিক উপায়ের (গ্রাফিক, ইলেকট্রনিক বা অন্য কোনও মাধ্যম, যেমন ফটোকপি, ডিস্ক, টেপ, পারফোরেটেড মিডিয়া বা পুনরুদ্ধারের সুযোগ সংবলিত তথ্য-সঞ্চয় করে রাখার কোনো পদ্ধতি) মাধ্যমেও প্রতিলিপি করা যাবে না। এই পত্রিকায় প্রকাশিত যে কোনো লেখা অন্যত্র বই আকারে প্রকাশ করতে হলে লেখকদেরও স্বত্বাধিকারী বা প্রকাশকের লিখিত অনুমতি নেওয়া বাধ্যতামূলক। এই শর্ত লঙ্ঘিত হলে উপযুক্ত আইনি ব্যবস্থা গ্রহণ করা হবে।

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অক্ষরবিন্যাস ও মুদ্রণ : সুরত সরকার

'পাঠশালা প্রোডাকসন্স'-এর পক্ষে অমিত রায় কর্তৃক শ্যামা প্রেস, ৩৫/২, কৈলাস রোস স্ট্রিট, কলকাতা-৭০০ ০০৬ থেকে মুদ্রিত ও দি টলি রেসিডেন্সি, ফ্ল্যাট এবি, ৩৩৮, এন. এস. সি. রোস রোড, কলকাতা-৭০০ ০৪৭ থেকে প্রকাশিত।

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## লোক সাংস্কৃতি চর্চা

বাঁকুড়া জেলার প্রচলিত সাঁওতালি ধাঁধা :  
প্রান্তবাসীর ও প্রান্তবাসের জীবন ইতিবৃত্ত

কুদুম। প্রান্তিক বাংলার জনগোষ্ঠীর কাছে এটাই  
ধাঁধার প্রতিশব্দ। এই কুদুম-এর ভিতরেও প্রচ্ছন্ন  
হয়ে আছে সমকাল আর পারিপার্শ্বিক জনজীবন।  
এই ধাঁধার খেলায় এক নতুন পাঠ খুঁজে দেখলেন  
অনুপ কুমার মাজি।

লোকসাহিত্যের অন্যতম একটি গুরুত্বপূর্ণ শাখা হল ধাঁধা। ধাঁধার ব্যবহার অত্যন্ত প্রাচীন, প্রত্যেক দেশের প্রাচীন সাহিত্যেই ধাঁধার পরিচয় পাওয়া যায়। বিশ্বের অপরাপর ভাষায় প্রচলিত ধাঁধার মতোই সাঁওতাল সমাজেও অজস্র ধাঁধা প্রচলিত রয়েছে। এই সমস্ত সাঁওতালি ধাঁধাতে একদিকে যেমন প্রাকৃতিক রহস্যময়তা কুটে উঠেছে, তেমনি প্রকৃতিতে সৃষ্ট জীব-জগৎ, উদ্ভিদ-জগতের সঙ্গে লোকসাধারণের বিশেষ সংস্পর্শের দিকটিও উন্মোচিত হয়েছে। বিকল্প-বৈচিত্র্যের দিক দিয়ে মানবদেশের গঠন, তার চারিত্রিক বৈশিষ্ট্য, দেবদেবী প্রসঙ্গ যেমন ধরা পড়েছে তেমনি পরিচিত পশুপাখি ও কীটপতঙ্গও ধাঁধার বিষয় হয়েছে। রয়েছে গাছপালাবন বিষয়ক ধাঁধা যার মধ্যে উল্লেখ করা যায় তৈজসপত্র, খাদ্য-পানীয়, আচার-অনুষ্ঠান ইত্যাদি প্রসঙ্গ। সাঁওতালি ভাষায় ধাঁধাকে 'কুদুম' বলা হয়। বাংলা ভাষায় ধাঁধার বিভিন্ন আঞ্চলিক প্রতিশব্দ পাওয়া গেলেও সাঁওতালিতে 'কুদুম' নামটিই প্রচলিত।

একসময় গোষ্ঠীবদ্ধ জীবনে গোষ্ঠীকেন্দ্রিক স্বাতন্ত্র্য বজায় রাখতে বা নিজ গোষ্ঠীর পালনীয় আচার-অনুষ্ঠান, বিধি-সংস্কারকে গুণমাত্র নিজেদের মধ্যেই সীমাবদ্ধ রাখতে সাঁওতাল সমাজেও ধাঁধার প্রচলন হওয়া স্বাভাবিক। বিভিন্ন লোকউৎসব, বিবাহ অনুষ্ঠান অথবা অস্বাভাবিক ক্রিয়াক্রমে সাঁওতাল সমাজে ধাঁধার ব্যবহার এখনও লক্ষ করা যায়। বাঁকুড়া জেলার দক্ষিণ-পশ্চিম অঞ্চলের সাঁওতাল জনগোষ্ঠীর দৈনন্দিন আলাপচারিতায়, প্রবচনে ধাঁধা বা হেয়ালির ব্যবহার ধরা পড়ে। সন্তান ভূমিষ্ঠ হওয়ার পর সোটি পুত্র সন্তান না কন্যা সন্তান তা যেমন হেয়ালির মাধ্যমে তারা প্রকাশ করে, তেমনি মৃত্যুর বিষয়টিও তারা সরাসরি না বলে হেয়ালির আশ্রয় নেয়। সাঁওতাল সমাজে কোনো ব্যক্তির মৃত্যু হলে বা কেউ মারা গেলে লোকসাধারণ একপ সত্যকে প্রকাশ করতে সুন্দর একটি বাগধারার সাহায্যে হেয়ালি করে বলে থাকে 'জমরাজঠেন মুনিস ঢালাঃ আ' অর্থাৎ

## Problematizing 'Indigeneity' through Hansda Sowvendra Shekhar's *The Mysterious Ailment of Rupi Baskey*

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### Abstract


The article problematizes dominant discourses on 'indigeneity' (within the context of India) through an analysis of the novel *The Mysterious Ailment of Rupi Baskey* (2014) written by Hansda Sowvendra Shekhar (1983—). Those discourses are predicated on colonial and neocolonial ethnic stereotypes: at times 'the indigenous' denotes a reluctant subject of the nation-state, a primitive mindlessly opposing the 'modernising' corporate projects; at times, it constitutes a pristine innocence, an antithesis of the 'corrupting' urban life. Santhals, among various other indigenous communities in India, have been a victim of such reductivism. The article argues that Hansda's novel offers a nuanced depiction of a Santhal community in India which is fraught with internal conflicts as well as external threats undercutting the grand narrative in which the adivasi is a cultural imaginary, either an embodiment of atavism and wildness to be curbed or vulnerable artefacts to be preserved. The tale of Rupi appears to be a critical departure from the monolithic images of adivasis as it blends the magical with the real.

**Keywords:** indigeneity, Santhal, adivasi, tribe, magical realism, subaltern, Hansda Sowvendra Shekhar.

### Introduction

The ontology of adivasis or indigenes is a fault line in the Indian nation-state's narrative of teleological progress. Definitions and representations of the so-called indigenous people are fraught with semantic ambiguity and power politics. Sometimes 'the indigenous' denotes a recalcitrant subject of nation-state mindlessly opposing the 'modernising' corporate projects; sometimes it constitutes a prehistoric innocence, diametrically opposed to the 'corrupting' urban life. From the colonial era, or even before that, the large heterogeneous communities, who are presently clubbed together in India as 'Scheduled Tribes', have been suffering from essentialisation and reductivism. They have been tagged as animist 'tribes' (as opposed to Hindu 'castes') naturally prone to criminality and bestiality, on the one hand. On the other hand, they have been championed as an embodiment of autochthony and innocence. Neither colonial nor nationalist epistemological attempts seem capable of addressing the actual ontological crises of the so-called indigenous population. The more recent transnational interest in the rights of





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## Trauma and Transformation: An Exploration of Mahasweta Devi's *Mother of 1084* through the Lens of Trauma Theory

Amitayu Chakraborty

**Abstract** ■ The paper deals with the play *Mother of 1084* written by Mahasweta Devi, and explores the text within the framework of trauma theory. It focuses the journey of the protagonist Sujata from the state of a helpless and sad mother in search of the true self of her deceased son to that of a politically subversive individual who reorients herself for social change in an aim to contend that Sujata's trauma in the wake of the aftermath of Naxalite movement has myriad ramifications. In so doing, the paper offers a praxis-oriented critical inquiry foregrounding the complex interaction among history, literature and trauma.

**Keywords:** Trauma, Naxalite Movement, violence, psychoanalysis, anti-establishment.

### Introduction

Trauma can be defined as a response or a series of responses to intense events which disrupt cognitive or emotional functioning (Vickroy 142). Trauma theory centres on an eclectic intellectual pursuit that investigates cultural texts that deal with such psychological disruption. It emerged in the 1990s in the western academia, when the humanities took a so-called ethical turn (Craps 45). Apart from encompassing intense emotional and cognitive disruptions caused by large-scale catastrophic events like wars, the Holocaust, the 9/11 and Partitions, trauma theory also engages in "ongoing and sustained dynamics of social injury and deprivation" that affect the lives of disenfranchised groups due to prevailing "racism, mysogyny, homophobia and economic exploitation" (Moglen 151, 159). This paper aims at a critical reading of Mahasweta Devi's play *Mother of 1084*, as a trauma narrative. It argues that Sujata, the eponymous character of the play, a middle-class, urban, genteel, Bengali, aged wife of the corrupt but socially respectable Dibyanath Chatterjee, undergoes and copes with the trauma of the untimely death of her youngest son, Brati. Written against the backdrop of the cycles of violence in the aftermath of Naxalite uprising of 1970s, the play, as it would be presented in the paper, dramatises Sujata's transformation from a bereaved mother living in an individualistic insularity to an active, sentient, politically aware belligerent who fulminates against structural violence and the repressive state apparatus. In so doing, the paper explores the politically subversive dimension of the play in a



## Accepted Manuscript

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# In-situ synthesis of rGO-ZnO nanocomposite for demonstration of sunlight driven enhanced photocatalytic and self-cleaning of organic dyes and tea stains of cotton fabrics

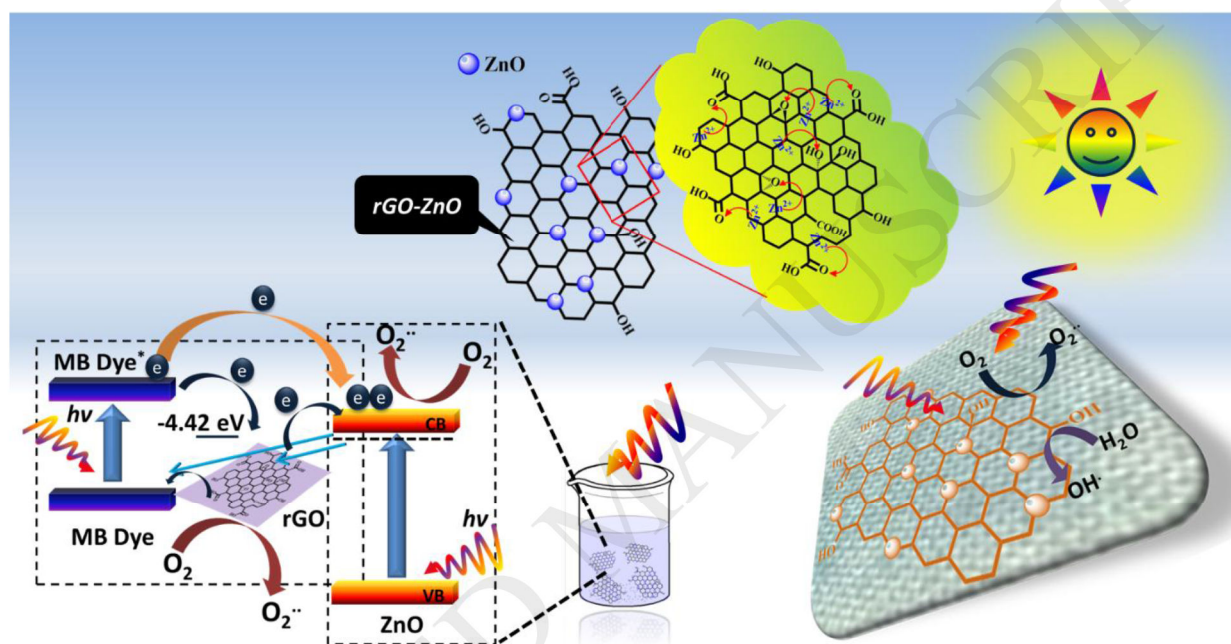
Partha Kumbhakar<sup>1</sup>, Ashim Pramanik<sup>1</sup>, Subrata Biswas<sup>1</sup>, Arup Kanti Kole<sup>2</sup>, Rajat Sarkar<sup>1</sup> and Pathik Kumbhakar<sup>1\*</sup>

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Graphical Abstract



## Highlights

- A two-step synthesis approach is proposed to synthesize 2D rGO-ZnO (rGZn) nanocomposites.
- Cotton smart fabrics have been prepared with the synthesized rGZn nanocomposites.
- Synthesized nanocomposites show high photocatalytic and self-cleaning properties.
- The amount of ZnO is varied in nanocomposites to achieved high photo-catalytic efficiency.
- Methylene blue dye degradation of ~91% is achieved only within 60 min.

## Abstract

Recently, research activities are focused on development of 2D reduced graphene oxide (rGO) based semiconductor nanocomposite materials for boosting up its catalytic applications. In this work, a rarely reported green synthesis approach has been envisioned to synthesize in-situ 2D rGO-ZnO (rGZn) nanocomposites from Apple juice and zinc acetate. Also the composition of the samples has been optimized to achieve high photocatalytic and self-cleaning properties by





# Role of Reactive Oxygen Species in Cotyledon Senescence During Early Seedling Stage of Mung Bean [*Vigna radiata* (L.) Wilczek]

Lily Pal<sup>1</sup> · Rup Kumar Kar<sup>1</sup>

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## Abstract

Reactive oxygen species (ROS) plays an important role in senescence, which was studied for cotyledon senescence in mung bean (*Vigna radiata*) seeds following germination in the present work. Morphology and chlorophyll content analysis revealed that cotyledons undergo a short developmental stage followed by senescence when attached with axis while detachment prolonged such developmental changes and delayed senescence. Histolocalization and spectrophotometric analysis of ROS revealed a positive correlation between the total chlorophyll content and extracellular superoxide ( $O_2^{\bullet-}$ ) level that accumulated around chlorophyllous regions, whereas hydrogen peroxide ( $H_2O_2$ ) was mainly localized in the peripheral cells, wherefrom storage mobilization started for both intact and isolated cotyledons. Among the antioxidant enzymes, catalase (CAT, EC 1.11.1.6) and ascorbate peroxidase (APX, EC 1.11.1.11) activity declines when peroxidase (POX, EC 1.11.1.7) and superoxide dismutase (SOD, EC 1.15.1.1) activity was maintained during cotyledon senescence. POX activity, which was mainly localized in the cell wall, showed a positive correlation with total chlorophyll content for both intact and isolated cotyledons, whereas CAT activity showed positive and negative correlation with total chlorophyll content for intact and isolated cotyledons, respectively. On the other hand, a clear negative correlation was shown by APX activity of both intact and isolated cotyledons, whereas a highly positive correlation was established for SOD activity with total chlorophyll content of intact cotyledons only. Possible association of  $O_2^{\bullet-}$  with cotyledon development and  $H_2O_2$  with storage mobilization followed by senescence has been proposed.

**Keywords** Antioxidant enzymes · Chlorophyll · Cotyledon senescence · Hydrogen peroxide · Mung bean · Superoxide

## Introduction

Reactive oxygen species (ROS) are partially reduced or activated derivatives of oxygen, highly reactive, and toxic and can be generated by the direct transfer of excitation energy from chlorophyll to produce singlet oxygen or by oxygen reduction in the Mehler reaction (Meloni et al. 2003). ROS are also the byproducts of various cellular redox processes. These are mainly responsible for the development of symptoms of oxidative damages when ROS production exceeds

the capacity of the cellular ROS scavenging machinery (Schopfer et al. 2001). Evidence suggests that superoxide ( $O_2^{\bullet-}$ ) and hydrogen peroxide ( $H_2O_2$ ) can also act as components for the signaling circuit of programmed cell death in plants (Jabs 1999).

Senescence, a well-regulated developmental process, plays an important role in recycling of cell nutrients and metabolites. It is almost universally accepted that ROS are actively involved in inducing senescence-associated degradative processes. In the case of leaf senescence, the reaction centers of photosystem I and II of chloroplast thylakoids are the major generation site of ROS (Foyer and Noctor 2003; Asada 2006; Waszczak et al. 2018) that may be involved in the dismantling of chloroplasts. Cotyledons are the storage organs of most dicotyledonous seeds and undergo senescence at the end of functional life. However, developmental changes that occur in the cotyledons of epigeously germinating seeds, for example, seeds of legumes (like mung bean seeds used in the present study) are very complex, starting

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