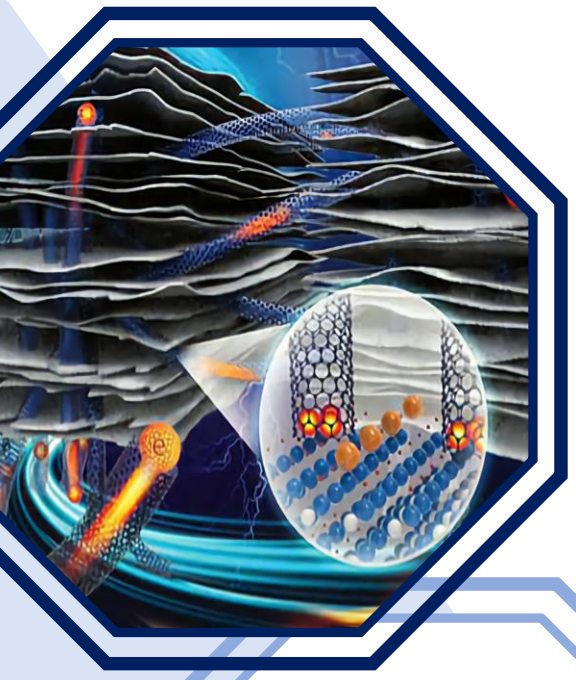
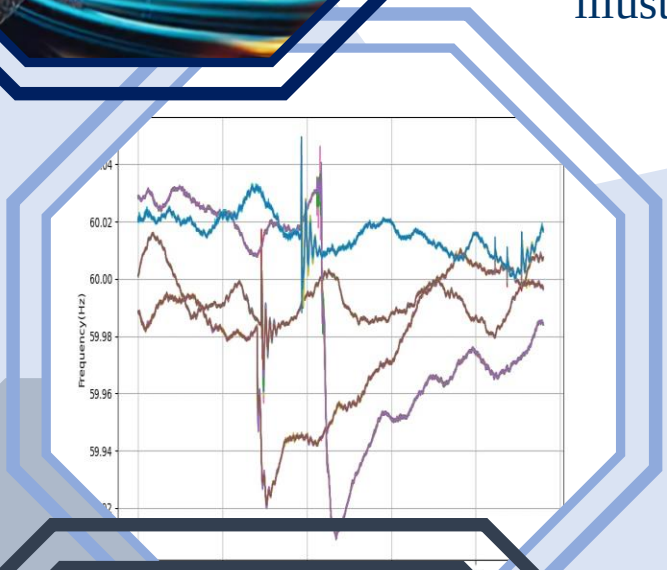
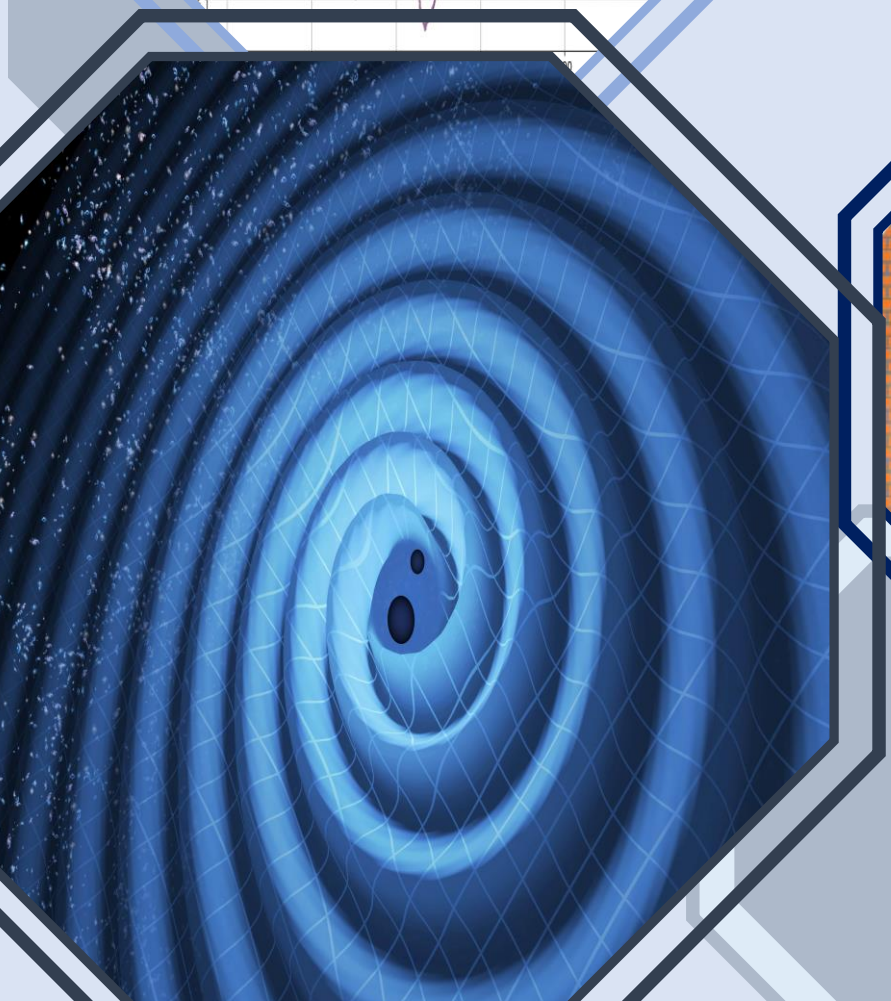


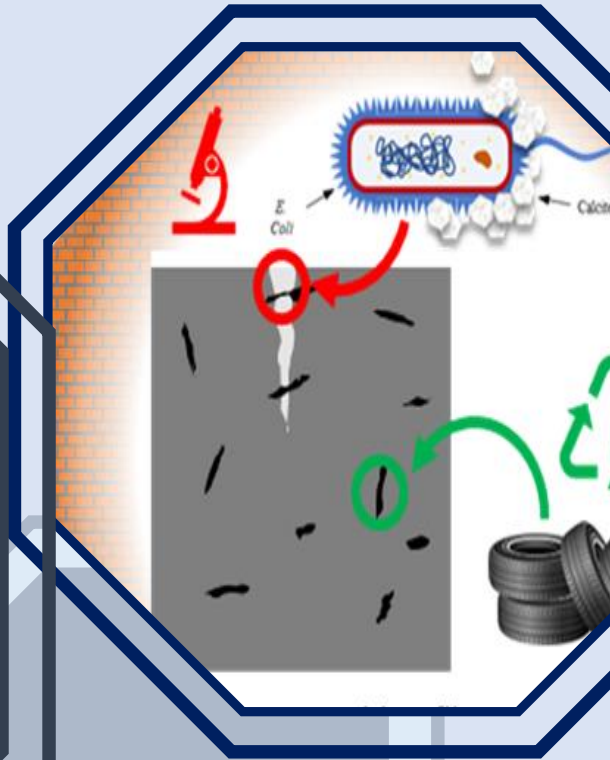
Research Spectrum

A compendium of Graphical Abstracts illustrating Research at IIT Indore



Volume 1, Issue 1
4 September 2023





Editors
Dr. Amit Skukla
Dr. Rupesh S. Devan
Prof. Sandeep Chaudhary
Prof. Trapti Jain

Research Spectrum

(A compendium of Graphical Abstracts illustrating Research at IIT Indore)

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Editors

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Prof. Sandeep Chaudhary, CE
Prof. Trapti Jain, EE

Director's Message

It gives me immense pleasure to write a foreword to the first volume of *Research Spectrum*. This publication will showcase high-quality research work, done by the faculty members and students of IIT Indore, in a graphical form. As we say '*a picture is worth a thousand words*,' we want to present a pictorial abstract of our complex research in a most simplified way through this endeavour of *Research Spectrum*.

It may be noted that majority of the research works presented in the *Research Spectrum* have been bestowed with the Best Research and/or Best Technology awards of the Institute. It also includes some of the prominent research works that were considered for the award. Further, to recognise the professors who have won the awards in a year, they have been requested to be the editors of the periodic volumes of *Research Spectrum* coming out during the year.

We sincerely wish that the readers will find *Research Spectrum* containing graphical abstracts of the research work of IIT Indore faculty and students easy to understand, and will further help disseminate the novel research ideas depicted therein amongst the avid researchers and lovers of technology.

With best wishes,

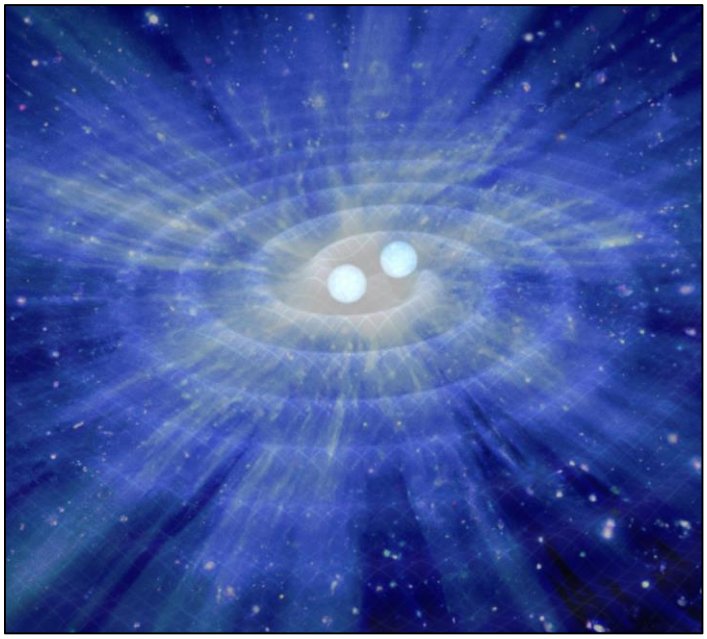
Prof. Suhas S Joshi
Director

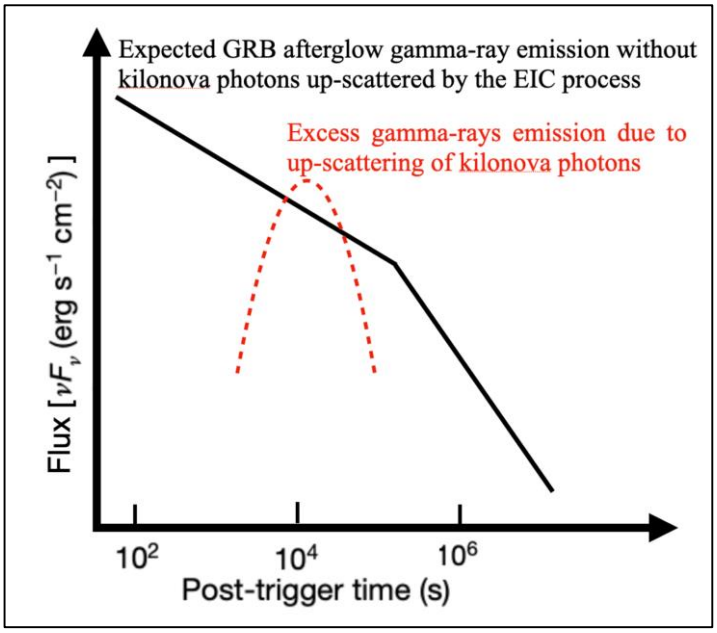
INDEX

Gigaelectronvolt Emission from a Compact Binary Merger

Alessio Mei[1,2], Biswajit Banerjee[1,2], Gor Oganesyan[1,2], Om Sharan Salafia[3,4,5], Stefano Giarratana[6,7], Marica Branchesi[1,2], Paolo D'Avanzo[5], Sergio Campana[5],Giancarlo Ghirlanda[4,5], Samuele Ronchini[1,2], Amit Shukla[8] & Pawan Tiwari[8]

[1]Gran Sasso Science Institute, L'Aquila, Italy. [2]INFN - Laboratori Nazionali del Gran Sasso, L'Aquila, Italy. [3]Università degli Studi di Milano-Bicocca, Milan, Italy. [4]INFN - Sezione di Milano-Bicocca, Milan, Italy. [5]INAF - Osservatorio Astronomico di Brera, Merate, Italy. [6]INAF - Istituto di Radioastronomia, Bologna, Italy. [7]Department of Physics and Astronomy, University of Bologna, Bologna, Italy. [8]Department of Astronomy, Astrophysics and Space Engineering, Indian Institute of Technology Indore, Indore, India.





Left Fig.: An artistic illustration of a GRB originating due to the Binary Neutron Star merger. **Right Fig.**: A representative light curve of an afterglow of a Gamma-Ray Burst.

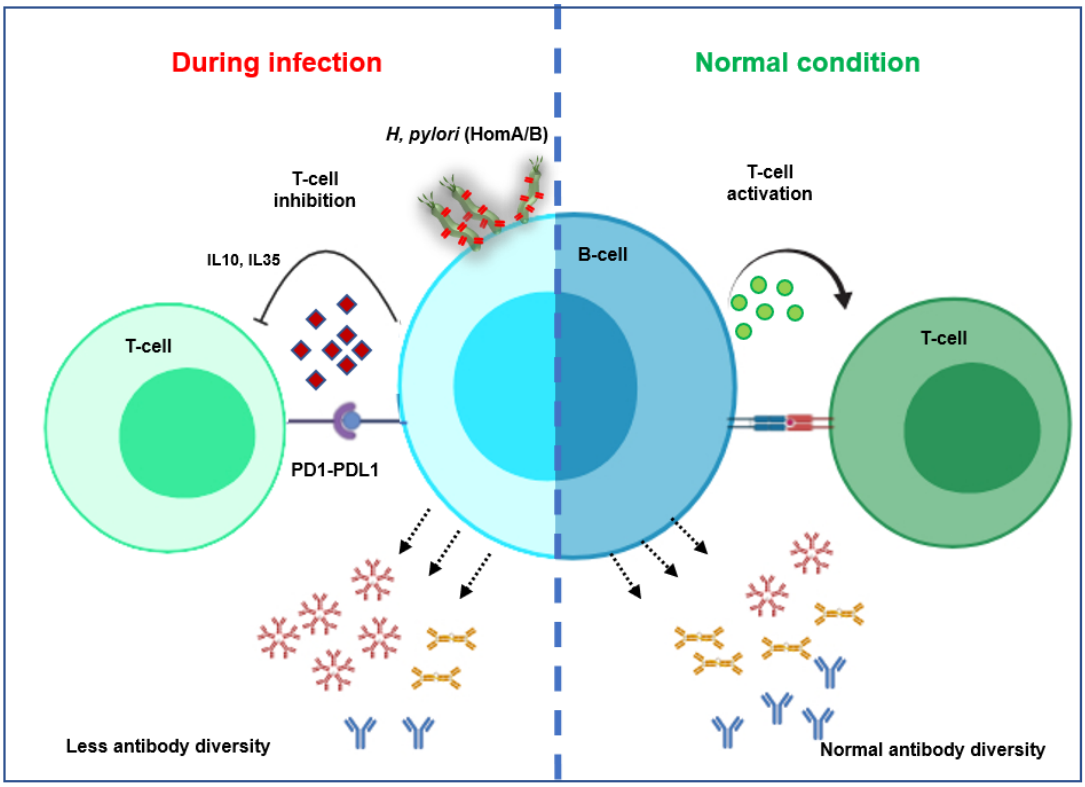
Gamma-ray bursts (GRBs) are the most luminous and highly energetic transient explosions detected in the universe. This work reports the discovery of a transient excess gamma-ray emission from a GRB 211211A caused by a Binary Neutron Star merger using the Fermi-Large area telescope for the first time. These observations open a new electromagnetic window to study stellar nucleosynthesis through Kilonova phenomena and open new perspectives to detect Binary Neutron Star mergers.

The work has been published in the Nature journal: Mei A. et al. Nature 612, (2022) 236–239.

HomA and HomB, outer membrane proteins of *Helicobacter pylori* down-regulate activation-induced cytidine deaminase (AID) and Ig switch germline transcription and thereby affect class switch recombination (CSR) of Ig genes in human B-cells.

Anubhav Tamrakar, Prashant Kodgire

Department of Biosciences and Biomedical Engineering, Indian Institute of Technology Indore, Indore, 453 552, Madhya Pradesh, India.



B-cell response to HomA and HomB, outer membrane proteins (OMPs) from *H. pylori*

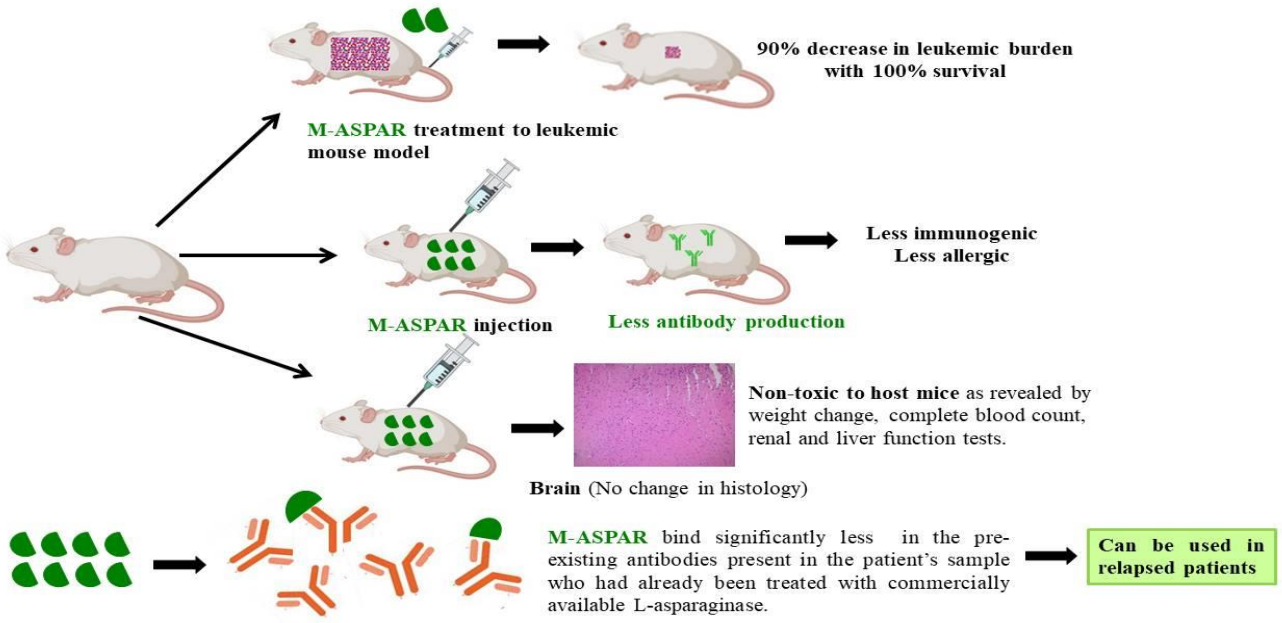
H. pylori is one of the major causes of chronic gastritis, peptic ulcer disease (PUD), gastric mucosa-associated lymphoid tissue lymphoma (MALT) and gastric carcinoma. *H. pylori* infected patients show reduced antibody response and its molecular mechanism is unknown yet. Interestingly, we observed that the interaction of HomB/HomA, outer membrane proteins (OMPs) from H. pylori, with B-cells transiently downregulates AID expression and Ig switch germline transcription. Downregulation of AID leads to impairment of class switch recombination (CSR), resulting in significantly reduced switching to IgG and IgA antibodies. Besides, we examined the immune-suppressive response of B-cells and observed that the cells stimulated with HomA/B show upregulation in the levels of IL10, IL35, as well as PDL1, a T-cell inhibition marker. Our study indicates a dual role of HomA and HomB, by suppressing B-cell antibody diversity as well as via Bregs cells polarisation to suppress the adaptive immune system by interfering with T-cell-B-cell communication.

The work has been published in Molecular Immunology 142 (2022) 37-49.

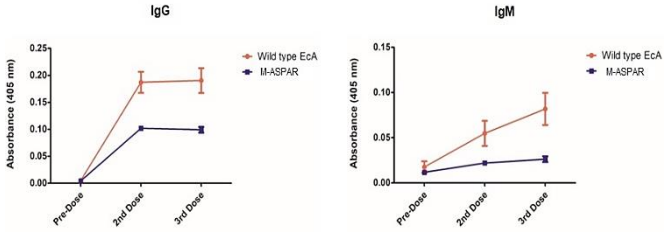
Novel M-ASPAR to improve the treatment of Acute Lymphoblastic Leukemia (ALL)- a type of blood cancer

Mainak Biswas, Soumika Sengupta, Vikram Gota & Avinash Sonawane

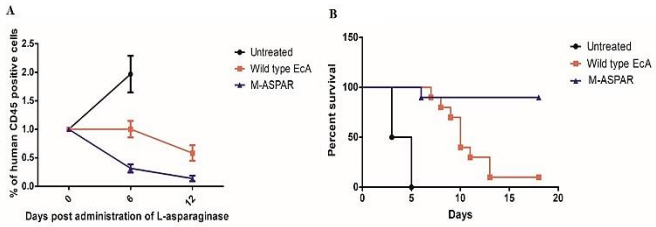
Disease Biology and Cellular Immunology Lab, Department of Biosciences and Biomedical Engineering (BSBE), IIT Indore, Madhya Pradesh-453552, India. Email: asonawane@iiti.ac.in



Pre-existing antibody binding in ALL patients receiving EcA therapy



In-vivo immunogenicity in Balb/c mice



Efficacy in leukemia xenograft mice model

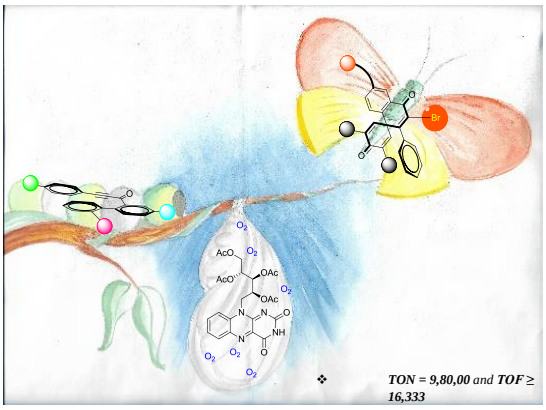
Acute Lymphoblastic Leukemia (ALL), the most common form of blood cancer, is treated using a combination of drugs that includes L-asparaginase as a major component. However, administration of L-asparaginase causes serious side effects such as- allergic reactions, neurotoxicity, blood clot formation, and toxicity to liver, pancreas and spleen in ALL patients. Moreover, the therapeutic efficacy of L-asparaginase is significantly reduced in relapse ALL patients. To overcome above therapeutic limitations, we have developed novel M-ASPAR drug which is more stable, less neurotoxic, less immunogenic, better pharmacokinetic properties, nontoxic to kidney, liver, spleen, brain, bone. M-ASPAR killed 90% cancerous cells and 100% survival of cancerous mice was observed

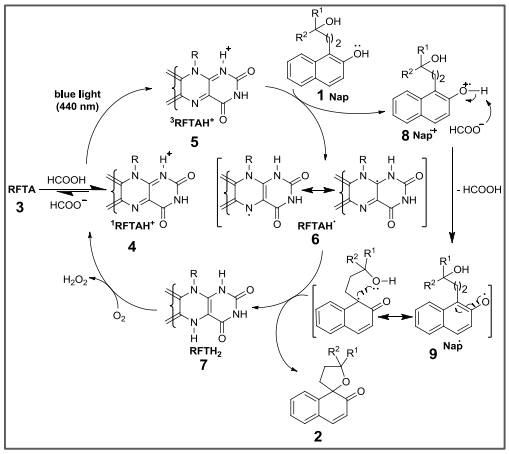
Technology currently under PhaseI/II clinical trial.

Visible Light Promoted Brominative Dearomatization of Biaryl Ynones To Spirocycles

Barnali Roy,[a] Puspendu Kuila,[a] Debayan Sarkar*, [b]

[a]Department of Chemistry, National Institute of Technology, Rourkela. [b]Organic Synthesis and Molecular Engineering Laboratory, Department of Chemistry, IIT Indore, Madhya Pradesh, India-453552. E-mail: sarkard@iiti.ac.in





Mechanistic Explanation of Visible Light Redox Catalysis

Vitamin – Organic Photocatalyst

Visible Light Reaction Set ups

A step-economic photo-oxidative brominative carbannulation of biaryl ynones employing ammonium bromide and riboflavin tetraacetate (RFTA) have been developed.

We have achieved the first visible-light-driven, metal-free brominative dearomatization of biaryl ynones using inexpensive RFTA as a photocatalyst, which allows straightforward access to ipso-annulated spiro compounds as well as dibenzocycloheptene-5-ones, depending on the molecular architecture. The method is mild, operationally simple, tolerant of several functional groups and exhibit excellent scalability. We believe this methodology provides practitioners with an alternative tool that will permit the scrutiny of unexplored chemical space and find useful applications in organic synthesis.

The work has been published in American Chemical Society - J. Org. Chem. 2023, 88, 15, 10925–10945

Micro and macro-structural properties of waste tyre rubber fibre-reinforced bacterial self-healing mortar

Akshay Anil Thakare[a], Trilok Gupta[b], Roshni Deewan[a], Sandeep Chaudhary[a,c]

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bDepartment of Civil Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture & Technology, Udaipur 313001, India

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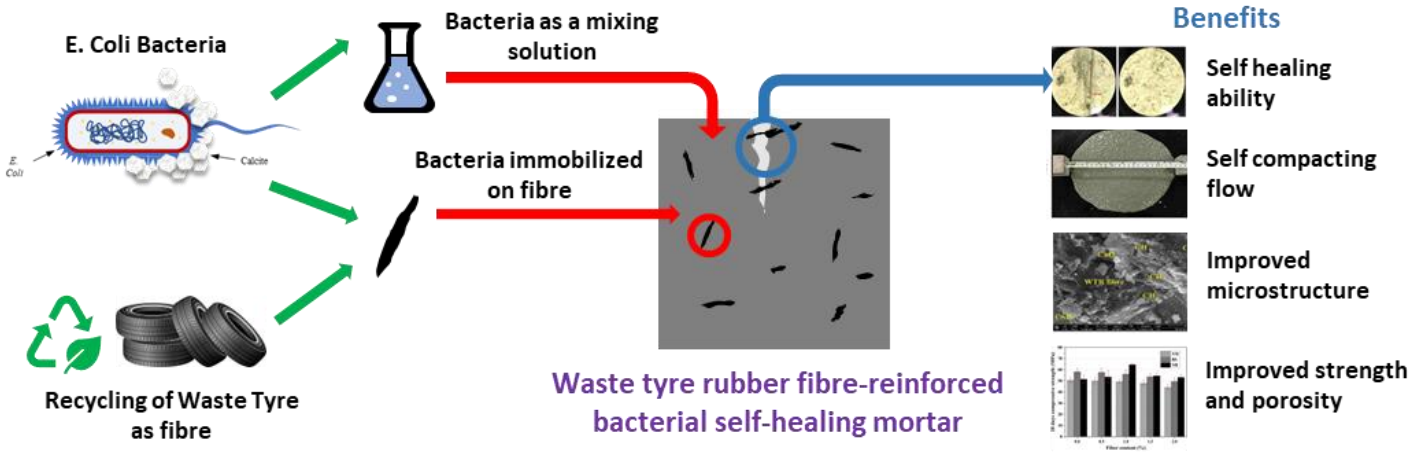


Waste tyre rubber fire-reinforced bacterial self-healing mortar (L to R: 1. incorporation of waste tyre and bacteria; 2. prepared mortar; 3. improved properties)

The article investigates the development of rubber fibre-reinforced bacterial self-healing mortar for environmentally safe disposal of waste tyre rubber. Direct utilization of waste-originated fibre leads to reduced flow and strength properties in mortar and limits their application. The article adopts bio-cementation from bacteria for improved recycling of waste tyre fibre for the development of bacterial self-healing mortars. The resulting bacterial mortar shows high flowability, conforming with the properties of self-compacting mortars. The mortar shows improved microstructure, strength and porosity. The mortar also shows self-healing ability, which improves sustainability. The result shows that the proposed strategy is technically viable for recycling waste tyre fibres as bacteria carriers in mortar.

This work has been published in Construction & Building Materials, Vol. 322 (2022)

A Hybrid Deep Neural Network for Multimodal Personalized Hashtag Recommendation

Shubhi Bansal, Kushaan Gowda, and Nagendra Kumar

Indian Institute of Technology, Indore

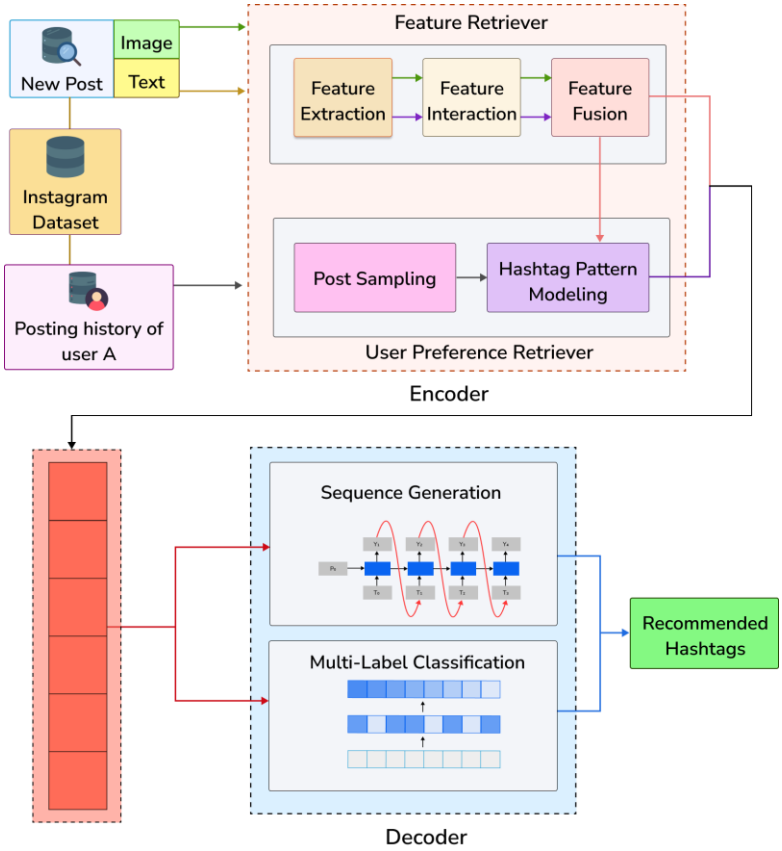


Fig. 1: Proposed Work

Fig. 2: Qualitative Analysis

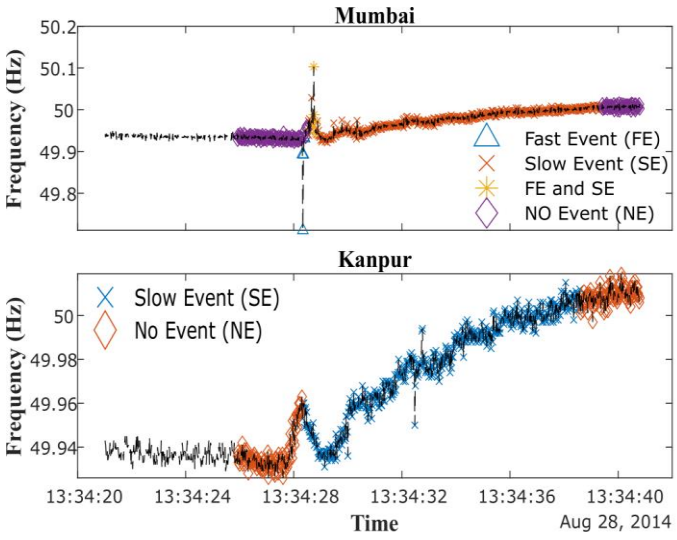
Hashtags are words preceded by hash symbols that facilitate content categorization, organization, navigation, and query expansion. Fig. 1 shows the overview of the proposed multimodal personalized hashtag recommendation system (DESIGN). We first extract features from visual and textual modalities and model their interaction using a word-level parallel co-attention mechanism. User habits are learned to get a post-feature vector influenced by the user's tagging behavior. Hashtags are predicted from post features using Multi-Label Classification and Sequence Generation procedures. The predicted hashtags are then effectively sampled and ranked to recommend relevant hashtags. Fig. 2 shows a user's post depicting hashtags recommended by DESIGN.

This work has been published in IEEE Transactions on Computational Social Systems (2022) 9806458.

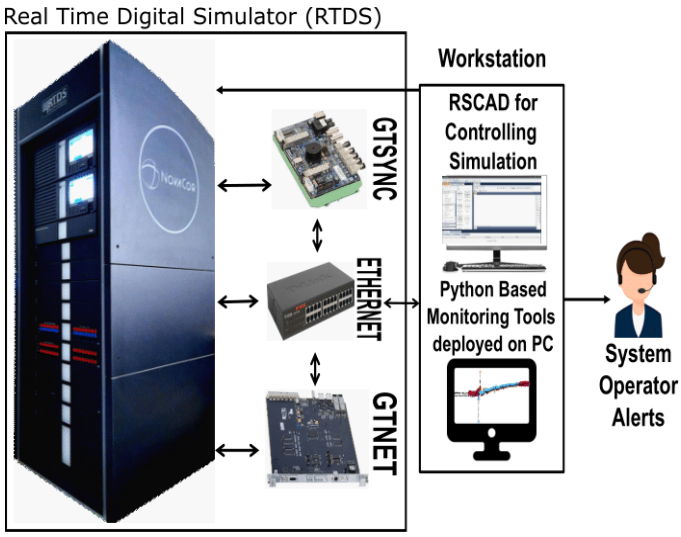
Real-Time Event Detection Based on Weibull Distribution Using Synchrophasor Measurements for Enhanced Situational Awareness

Adnan Iqbal and Trapti Jain

Indian Institute of Technology Indore



Event monitoring using the proposed methodology



Software in loop using RTDS at Smart Grid Research Laboratory

The increasing use of Phasor Measurement Units for closely monitoring power grids (10–100 samples/sec) has created a new approach to situational awareness. This paper introduces a novel method, named Weibull-based Excursion Transient and Oscillatory method, which utilizes wide-area frequency measurements to detect events with both fast and slow dynamics. Using a single parameter called variability, WETO identifies event timing, location, and severity within a 5-cycle window. The method's effectiveness is demonstrated on Indian and North American grids, thereby enhancing system operators' ability to perceive true grid situations.

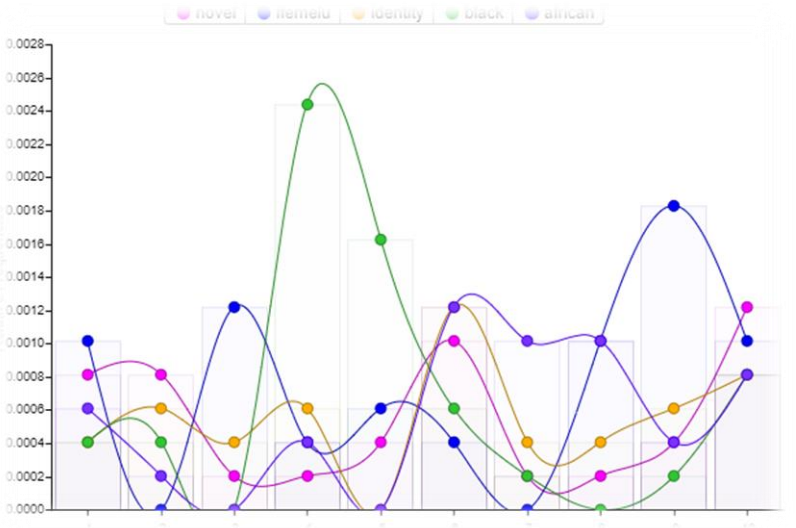
This work has been published in IEEE Transactions on Power Systems, vol. 37, no. 2, (2022) 1425-1436.

Enumerating Identities in the Certitude of African Indigeneity in Chimamanda Ngozi Adichie's Americanah

Justy Joseph and Nirmala Menon

Digital Humanities and Publishing Studies Research Lab, School of Humanities and Social Sciences, , IIT Indore, Madhya Pradesh, India-453552. Email: nmenon@iiti.ac.in

Topic modelling Results



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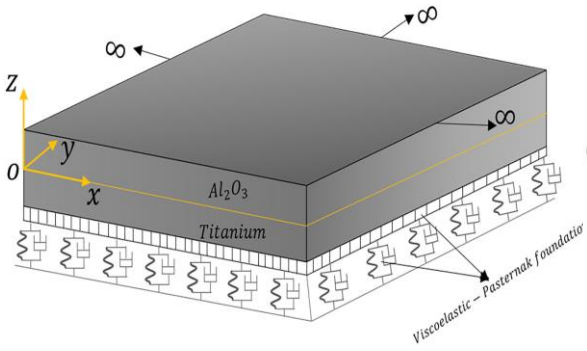
African immigrants across the world are identified with their ancestors who were oppressed. They create anti-racist racism for themselves with the fear of corresponding to the stereotypes set by the dominant culture. But they end up perceiving their hybrid identities in the certitude of being black in an active state of kinship. The novel Americanah by Chimamanda Ngozi Adichie is a tale about being a black immigrant in the 21st century. This paper analyses the entangled cultural experience associated with dislocation, redefinition of indigenous identity through black consciousness, formation of a hybrid identity through afropolitanism and the 'wound of return' while settling back in the native space in the novel Americanah.

This work has been published in IUP J. of English Studies, IJES020322, (2022)

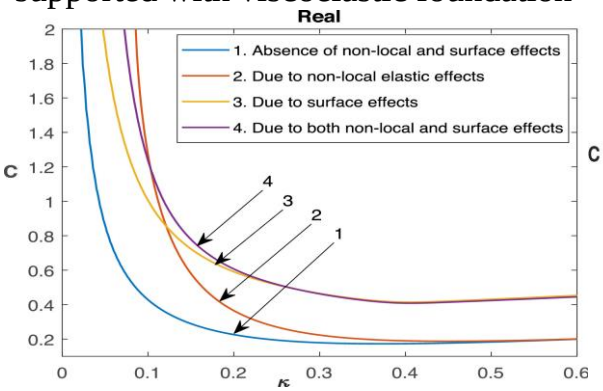
Edge wave for a non-destructive testing technology on an FGM plate supported by a semi-infinite viscoelastic Pasternak foundation

Rahul Som and Santanu Manna

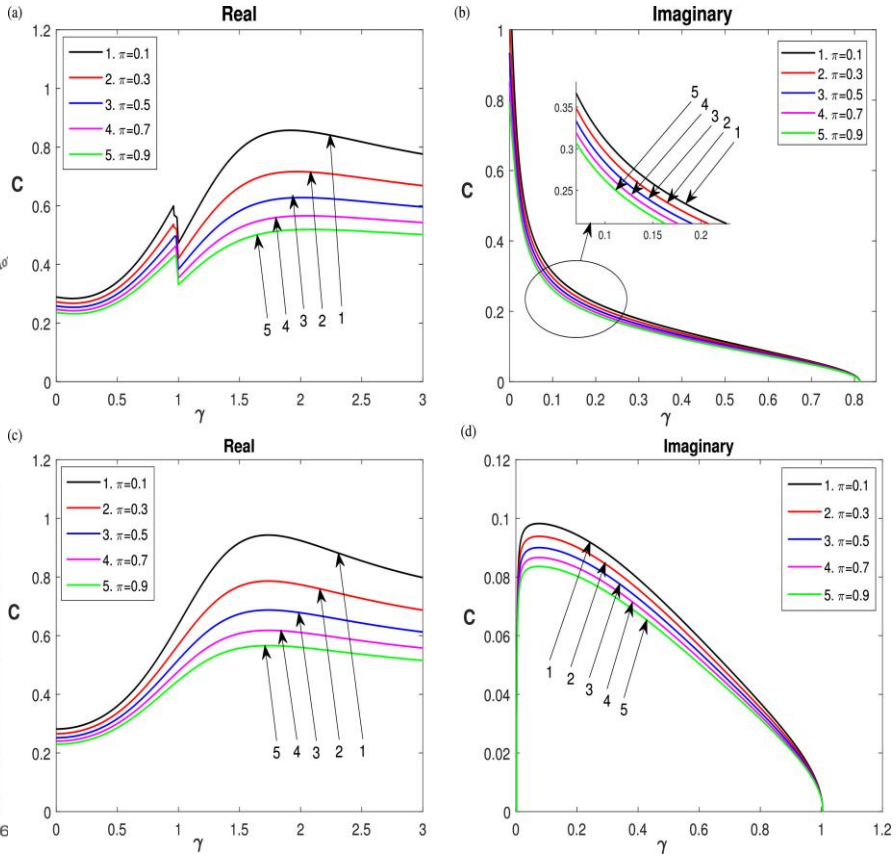
Applied Mathematics and Geomechanics Lab, Department of Mathematics, IIT Indore, MP, India-453552 Email: santanu@iiti.ac.in



Functionally graded thin plate supported with viscoelastic foundation



Variation in edge wave dispersion with different microstructure effects



Phase velocity vs. attenuation coefficient for different density ratio

This study explores the dynamic behaviour of a semi-infinite transversely isotropic thin plate supported by a viscoelastic foundation under the bending edge wave propagation within the framework of Kirchhoff plate theory and quadratic grading material properties. Additionally, the microstructure impact on the dispersion is analyzed by incorporating the non-local elasticity theory with surface effect.

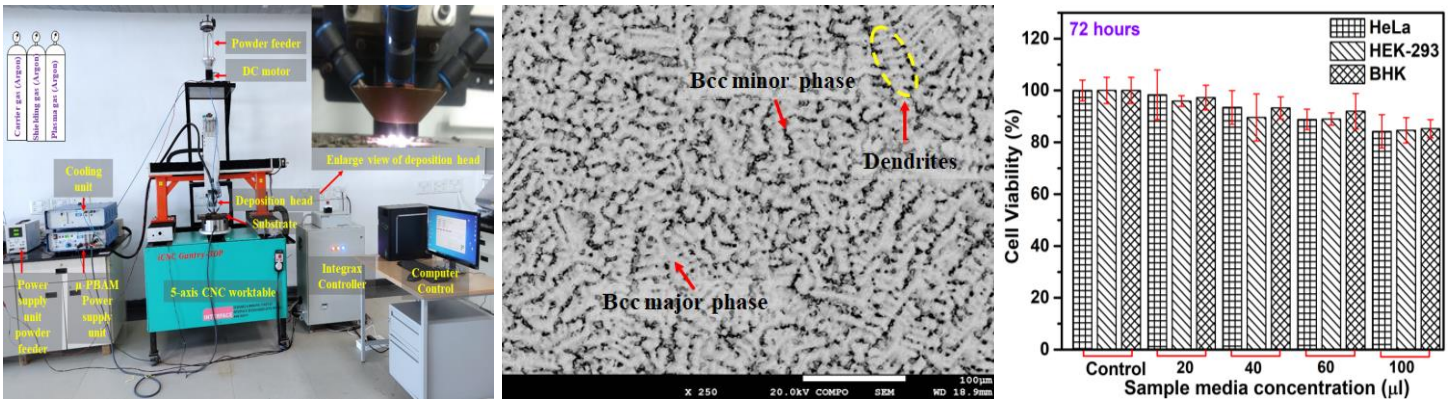
Due to the microstructure effect, phase velocity slowly decreases in viscoelastic plates while it increases with increasing residual stress and density. The dispersive and localization characteristic of the edge wave makes it an ideal candidate for non-destructive testing to identify structural damage. This study holds utility in detecting pavement cracks, inclusions, or any irregularities on highway and airport runways.

This work has been published in Published in Applied Mathematical Modelling, 119 (2023) 338-353.

Development of Ti-Ta-Nb-Mo-Zr high entropy alloy by μ-plasma arc additive manufacturing process for knee implant applications and its biocompatibility evaluation

Pankaj Kumar[1], Neelesh Kumar Jain[1@], Saumya Jaiswal[2], Sharad Gupta[2]

[1]Mechanical Engineering, Indian Institute of Technology Indore, India; [2]Biosciences and Biomedical Engineering, Indian Institute of Technology Indore, India



(a) (b) (c)

(a) Developed machine for μ-plasma arc additive manufacturing process, (b) microstructure of the developed Ti-Ta-Mo-Nb-Zr bio-HEA, and (c) avg. viability of HeLa, HEK-293, and BHK cells in it

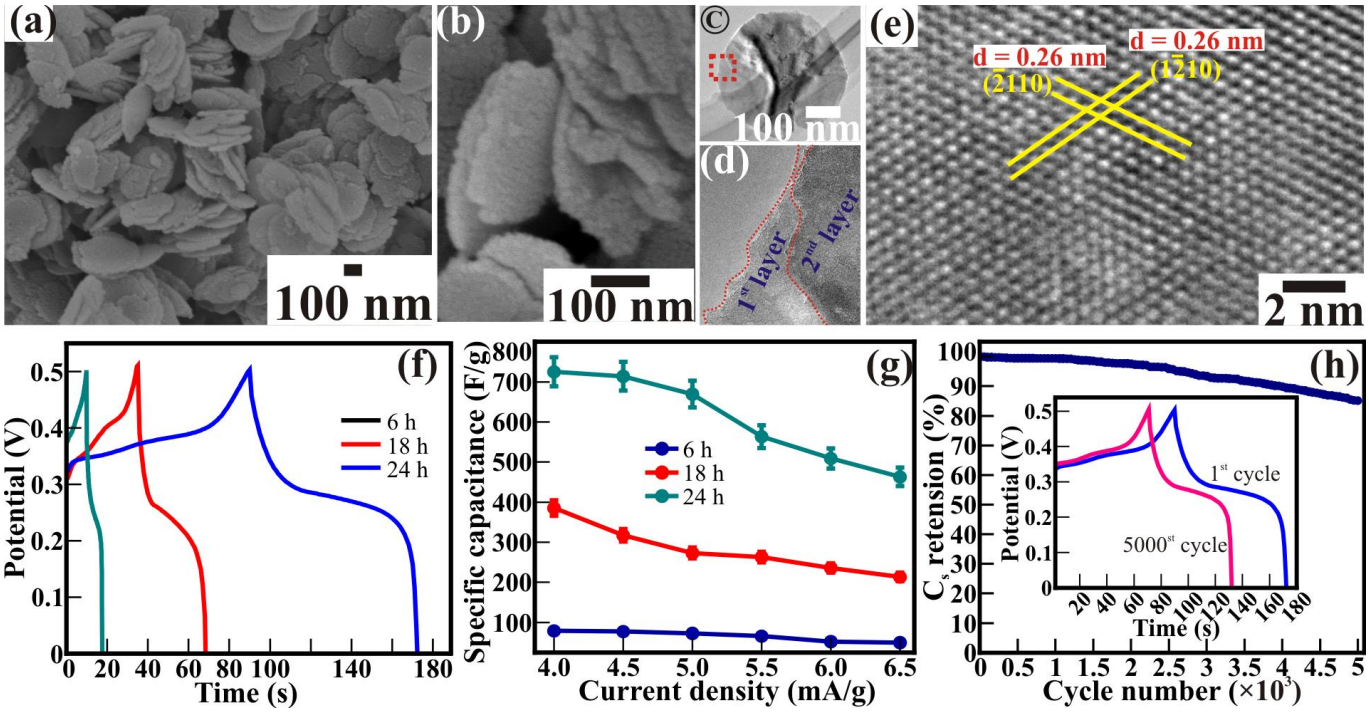
This work describes development of equiatomic Ti-Ta-Nb-Mo-Zr as high entropy alloy (HEA) by μ-plasma arc additive manufacturing process for knee implant applications by studying its microstructure and *in-vitro* biocompatibility using viability of HeLa, HEK-293, and BHK cells, release of metallic ions, and corrosion behavior in simulated biofluids (SBF) of 4.4; 5.4; and 7.4 pH value at 37^0C. The developed HEA showed avg viability for HeLa, HEK-293, BHK cells as 90%, 88%, and 92%, and released avg. amounts of Ti, Ta, Nb, Mo, and Zr ions as 37, 26, 57, 38, and 28 ppb, and better corrosion resistance in SBF without causing any pitting. Its constituents impart it excellent tribological characteristics needed for knee implant applications. It can overcome limitations of the presently used knee implant materials. *In-vivo* biocompatibility study is in progress to study interactions of Ti-Ta-Nb-Mo-Zr HEA with the human bones and tissues.

The work has been published in J. of Materials Research and Technology, 22, (2022) 541-555

Theory abide experimental investigations on morphology driven enhancement of electrochemical energy storage performance for manganese titanate perovskite electrodes

Narasimharao Kitchamsetti[a1], Manopriya Samtham[a1], Pravin N. Didwal[b,c,2], Dhirendra Kumar[b,2], Diwakar Singh[a], Santosh Bimli[a], Parameshwar R. Chikate[a,e], Dudekula Althaf Basha[a], Sunil Kumar[a], Chan-Jin Park[c], Sudip Chakraborty[d], and Rupesh S. Devan[a,*]

[a]Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Indore, Simrol, Indore 453552, India, [b]Department of Materials, University of Oxford, Parks Road, Oxford OX1 3PH, United Kingdom, [c]Department of Materials Science and Engineering, Chonnam National University, 77, Yongbongro, Bukgu, Gwangju, 61186, South Korea, [d]Materials Theory for Energy Scavenging (MATES) Lab., Harish-Chandra Research Institute (HRI) Allahabad, HBNI, Chhatnag Road, Jhunsi, Prayagraj, 211019 India, [e]School of Advanced Materials Science and Engineering, Sungkyunkwan University, 2066, Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, 16419, Republic of Korea



Surface morphological and structural analysis of morphology driven 2D ultra thin MTO nanodiscs delivering stable electrochemical energy storage performance

This work was carried out to study the effect of morphological transformation from nanoparticles to ultrathin nanodiscs of $MnTiO_3$ (MTO) perovskites as an efficient electrode for electrochemical supercapacitor, delivered the remarkable specific capacitance of 1513.7 F/g, specific capacity of 103.2 mAh/g, specific power of 1351.9 W/kg, and specific energy of 52.2 Wh/kg with a greater retentivity of ~85.2 % for a continuous 5000 cycles in 2M aq. KOH electrolyte. This study paves the path for efficient utility as an electrode material for environmentally friendly electrochemical supercapacitor.

The work has been published in J. of Power Sources 538, 231525 (2022)

DNN based estimator for elliptic flow in heavy-ion collisions

Neelkamal Mallick[1], Suraj Prasad[1], Aditya Nath Mishra[2], Raghunath Sahoo[1] and Gergely Gábor Barnaföldi[3]

[1]Department of Physics, Indian Institute of Technology Indore, Simrol, Indore 453552, India
[2]Department of Physics, University Centre For Research & Development (UCRD), Chandigarh University, Mohali, Punjab 140413, India
[3]Wigner Research Center for Physics, 29-33 Konkoly-Thege Miklós Str., H-1121 Budapest, Hungary

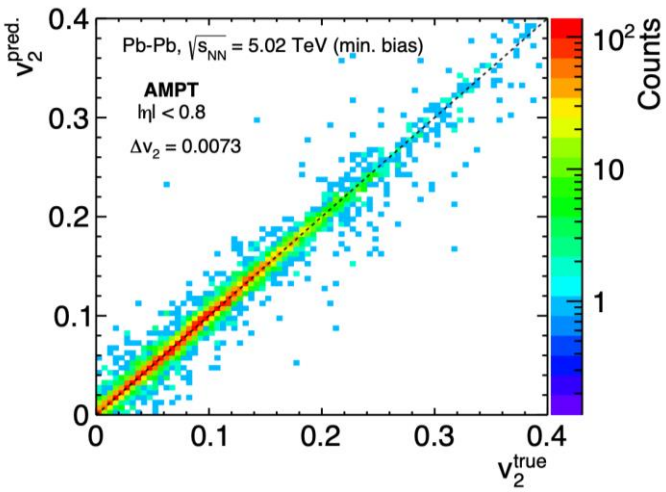


Figure 1: DNN predictions versus the true values of elliptic flow in Pb-Pb collisions $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV

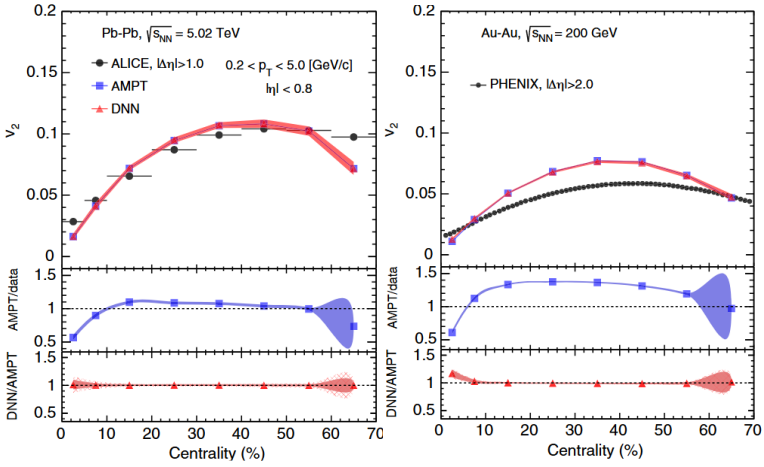


Figure 2: DNN predictions for Centrality and $\sqrt{s_{\mathrm{NN}}}$ dependence of v_2 compared with AMPT, ALICE and PHENIX results.

This work explores a novel method of using a deep neural network (DNN) based machine learning (ML) model to estimate elliptic flow (v_2) in heavy-ion collisions. DNN used in this work has four hidden layers each having 128, 256, 256 and 256 nodes, respectively, which takes mass, transverse momentum (p_{T}) and collision energy as the input. The DNN predictions have minimal loss as $v_2^{\mathrm{true}} = v_2^{\mathrm{pred}}$ line in Fig. 1 is well populated. In addition, the DNN model retains the collision centrality and p_{T}, $\sqrt{s_{\mathrm{NN}}}$, particle mass, and collision system dependence, a few of which is shown in Fig. 2. Furthermore, the model is found to be robust against event simulations with additional noise.

This is one of the first ML applications in heavy-ion collisions at the LHC energies.

This work has been published in Phys. Rev. D. 105, (2022) 114022

Indian Institute of Technology Indore

ISBN: 978-93-5967-954-9