DEPARTMENT OF PHYSICS
TEZPUR UNIVERSITY
Napaam, Tezpur - 784 028
Sonitpur (Assam), India

☎ : 03712-267111
03712-267007-9(ext- 5551,5550)
Fax : 03712-267005, 267006
e-mail- hod_phy@tezu.ernet.in
website: www.tezu.ernet.in

A REPORT ON

Development of smartphone based diagnostic tool for early detection of cervical cancer

1. Name of the Collaborative Activity: Development of smartphone based diagnostic tool for early detection of cervical cancer
2. Nature of Activity: Collaborative research
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:PhotoSpIMeDx,
   Shikha Ahirwar
   CEO & Director
   PhotospimedxPvt. Ltd.
   Southern Labs-111, Academic Area,
   IIT Kanpur, Kalyanpur
   Kanpur-208016
   Email: ceo@photospimedx.com, aahirwar36@gmail.com
   Contact: +91-9651605272

4. Summary of collaboration:

   PhotoSpIMeDx is a young MedTech startup incubated at SIIC, IIT Kanpur primarily focusses on the development of medical diagnostics devices which have the potential to become real time biopsy directed screening devices in hospitals and clinics.

   The aforementioned startuphas developed a smartphone based diagnostic tool for early detection of cervical cancer. The team works under the guidance of Dr.Asima Pradhan, Professor at IIT Kanpur collaborated with Prof. Pabitra Nath, Professor at Tezpur University. The main objective of the project is to develop a smartphone-based device using fluorescence spectroscopic technique for early cervical cancer detection. We started with conceptualization of the working setup. The collaborating team comprising of Dr.Asima Pradhan, Shivam, Shikha & Amar worked with Dr. Pabitra Nath and his student DigantaHatiboruah to establish the table top experiments. In table top experiments, calibration of the developed device has been performed using different laser sources at IIT Kanpur lab. Different blocks of optical components were designed through 3D printing software and printed through 3D printing machine in the Pabitra Nath's Lab. In the next step, the 3D blocks were assembled together to complete the prototype design and was done by our team at IIT Kanpur. Final experimental validation was done through different fluorophores and whole cervix samples provided by the hospital in Kanpur. Now the prototype is ready for the clinical validation which will be done in the hospitals at Kanpur, Lucknow & Bhubaneswar.

   An Indian patent related to this inventive work has filed recently (*Indian Patent # 202111006127*). Also, a conference paper has been published and recently a manuscript has been submitted to a journal for publication

   With this successful collaboration, a prototype has been developed for early cervical detection which has the potential to become an effective biopsy guidance tool. This device will be compact, portable, minimally invasive, provide real time and objective results and has the ability reach to rural &far flung areas of the country.

5. List of year-wise activities under the collaboration:
   1st year activity: Conceptualization of the plan of the work and experimental investigations of the working of the proposed system in laboratory. 3Dprinted model design of the tool using computer aided design software. Development of the blocks in 3D printer.

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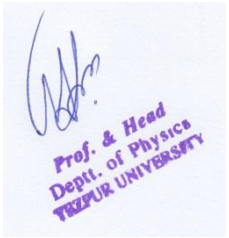
2nd year activity: Initial study with of the 3D printed diagnostic tool in the lab for standard lab samples. Validation of the device performance in nearby hospital in Kanpur.

6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
Name: Prof. P. Nath **Designation: Professor**	 **Name: Prof. M.K. Das** **Designation: HoD**

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website: www.tezu.ernet.in

A REPORT ON
Research Collaboration, Joint Supervision

1. Name of the Collaborative Activity: Research Collaboration, Joint Supervision
2. Nature of Activity: Research work
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details: Inter-University Centre for Astronomy & Astrophysics (IUCAA), Pune.
4. Summary of collaboration:Collaborative research work is going on with IUCAA, Pune since 2015. Few students of department of Physics, Tezpur University worked with IUCAA faculty members.
5. List of year-wise activities under the collaboration:

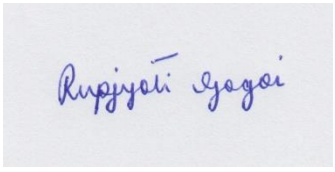
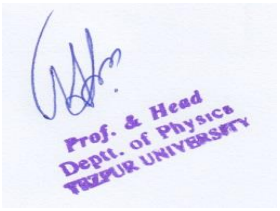
2015:

1. Dr GautamSaikia worked with Prof.Ranjan Gupta from IUCAA, Pune from 2015-2018. Prof.Ranjan Gupta was his Co-Supervisor. His thesis title was"Study of Dust characteristics in the Milky Way and nearby galaxies".

2017:

1. Dr PranjupriyaGoswami worked with Prof.RanjeevMisra from IUCAA, Pune since 2017-2021. Prof.Misra was her Co-Supervisor.
   Thesis title: Broadband study of the spectral and temporal behaviour of blazars
2. Mr. AnshumanBorgohain is working with Prof. Kanak Saha from IUCAA Pune since 2017. Prof. Kanak Saha is Co-Supervisor of Mr. Anshuman. He is woking on Galaxy morphology.

6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
	
Name: Dr RupjyotiGogoi **Designation: Assistant Professor**	**Name: Prof. M.K. Das** **Designation: HoD**

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website: www.tezu.ernet.in

Supporting documents:

तेजपुर विश्वविद्यालय / TEZPUR UNIVERSITY
(केंद्रीय विश्वविद्यालय /A Central University)
• कुलाध्यक्ष का सर्वोत्तम विश्वविद्यालय पुरस्कार , 2016 और एनआईआरएफ भारत रैंकिंग 2016: नं. 05
• Visitor's Best University Award, 2016 and *NIRF India Rankings 2016: No. 05*
परीक्षा नियंत्रक का कार्यालय / OFFICE OF THE CONTROLLER OF EXAMINATIONS
तेजपुर-784028 :: असम / TEZPUR-784028 :: ASSAM

No.: F.13-16/1/2006(Acad)/ 1285-A Dated: 06/11/2017

To
Dr. Kanak Saha
Associate Professor (Scientist-F)
IUCAA, Pune

Sir,

I have great pleasure in informing you that you have been accorded recognition as a research co-supervisor of Mr. Anshuman Borgohain (Roll No.PHP17107), a PhD student, Dept. of Physics, Tezpur University as per resolution No. RC. 63/2017/2/2.1.7 of the 63rd meeting of the Research Committee held on 16.10.2017. Please take note that the supervision of research work is governed by the relevant rules of Tezpur University.

Yours sincerely,
6/11/17
(L. Boral)
Controller of Examinations

Copy of information to:-

1. The Chairperson, DRC, Dept. of Physics, Tezpur University.
2. Dr. Rupjyoti Gogoi , Dept. of Physics, Tezpur University.
3. Mr. Anshuman Borgohain (Roll No.PHP17107), a PhD student, Dept. of Physics, Tezpur University
4. Concerned file.

6/11/17
Controller of Examinations

Prof. & Head
Deptt. of Physics
TEZPUR UNIVERSITY

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website: www.tezu.ernet.in

TEZPUR UNIVERSITY

Certificate by the Co-Supervisor

This is to certify that the thesis entitled **"Broadband study of the spectral and temporal behaviour of Blazars"**, submitted to the School of Sciences, Tezpur University in partial fulfillment of the requirements for the award of the degree of **Doctor of Philosophy** in **Physics** is a record of original research work carried out by **Ms. Pranjupriya Goswami** under my supervision and guidance.

All help received by her from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for award of any other degree.

(Prof. Ranjeev Misra)
Co-Supervisor
Professor
Inter-University Centre for Astronomy
and Astrophysics (IUCAA)
Pune, India

Prof. & Head
Deptt. of Physics
TEZPUR UNIVERSITY

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TEZPUR UNIVERSITY

Certificate by the Co-Supervisor

This is to certify that the thesis entitled **"Study of dust characteristics in the Milky Way and nearby galaxies"**, submitted to the School of Sciences, Tezpur University in partial fulfillment of the requirements for the award of the degree of **Doctor of Philosophy** in **Physics** is a record of original research work carried out by **Mr. Gautam Saikia** under my supervision and guidance.

All help received by him from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for award of any other degree.

(Prof. Ranjan Gupta)
Co-Supervisor
Senior Professor, Scientist 'H'
Inter-University Centre for Astronomy and Astrophysics (IUCAA)
Pune, India

Prof. & Head
Dept. of Physics
TEZPUR UNIVERSITY

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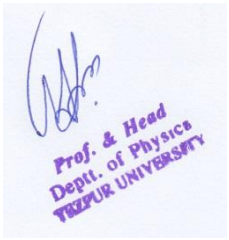
A REPORT ON

Scientific Inputs and assistance in drafting Bilateral Project

1. Name of the Collaborative Activity:**Scientific Inputs and assistance in drafting Bilateral Project**
2. Nature of Activity: **Joint Project**
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:
   Prof. Hiroshi Kawase, Kyoto University, Japan

   Email: kawase.hiroshi.6x@kyoto-u.ac.jp
4. Summary of collaboration:**Scientific Correspondence in relation to Indo Japan Bilateral Project duing 2019-20. However, the submitted project was not sanctioned**
5. List of year-wise activities under the collaboration: NA
6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
	
Name: Dr. R. Biswas **Designation: Assistant Professor**	**Name: Prof. M.K. Das** **Designation: HoD**

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A REPORT ON

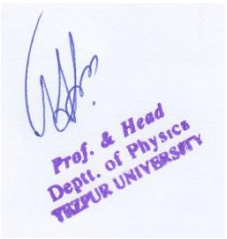
Scientific Inputs and assistance in drafting Bilateral Project

1. Name of the Collaborative Activity: **Scientific Inputs and assistance in drafting Bilateral Project**
2. Nature of Activity: **Joint Project, Paper and Book Chapter**
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:
   Dr. A. A. Dobrynina, Institute of Earths' Crust, Russia

   Email: anna.a.dobrynina@gmail.com
4. Summary of collaboration:**Scientific correspondence is going on till date. Starting from drafting joint projects to research works, the collaboration has been continuing form 2016.**
5. List of year-wise activities under the collaboration:

2017-18	One Joint Peer Reviewed Paper in Tectonophysics, Elsevier
2018-19	Joint Project Writing
2019-20	Joint Project Writing
2020-21	One Joint Book chapter accepted under Springer
2021-Till date	Manuscript under process

6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
	
Name:Dr. R. Biswas **Designation: Assistant Professor**	**Name: Prof. M.K. Das** **Designation: HoD**

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website: www.tezu.ernet.in

A REPORT ON

The Collaboration of Dr. Moon Moon Devi with Inter-University Centre for Astronomy and Astrophysics, Pune

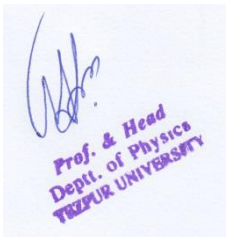
1. Name of the Collaborative Activity: Visiting Associate
2. Nature of Activity: Research (Detector and Astroparticle Physics)
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:

   Inter-University Centre for Astronomy and Astrophysics,
   Post Bag 4, Ganeshkhind,
   Savitribai Phule Pune University Campus,
   Pune 411 007, INDIA
   Tel: +912025604100
   Email Id: **samuel@iucaa.in**
4. Summary of collaboration:

   Dr. Moon Moon Devi is a visiting associate of the Inter University Centre for Astronomy and Astrophysics (IUCAA) which is located at Pune since 2019. The type of her association are as in the following:
   - Ongoing research work on SiPM detectors which are relevant for the Cherenkov Telescope Array experiment. It involves regular online discussions with peer members of IUCAA.
   - Attending as well as presenting in the online seminar sessions.
   - Attending various online meetings for the associates which focusses on refining IUCAA's activities to reach out more and more members.
5. List of year-wise activities under the collaboration:

Year	Activities
2019	• Received the Associateship.
2020	• Detector simulation work are ongoing.
2021	• Detector simulation work are ongoing.

6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
Moon Moon Devi **Name: Dr. MOON MOON DEVI** **Designation: ASSISTANT PROFESSOR**	 **Name: Prof. M.K. Das** **Designation: HoD**

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A REPORT ON

The Research Collaboration of Dr. Moon Moon Devi with Hyper-Kamiokande Neutrino Experiemnt in Japan

1. Name of the Collaborative Activity: Collaboration Member
2. Nature of Activity: Research (Detector Simulation and Machine Learning)
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:

   Hyper-Kamiokande,
   Kamioka Observatory,
   Institute for Cosmic Ray Research
   University of Tokyo Kashiwa Campus
   5 Chome-1-5 Kashiwanoha, Kashiwa, Chiba 277-8582, JAPAN
   Email Id: **hk-public@km.icrr.u-tokyo.ac.jp**
4. Summary of collaboration:

   Dr. Moon Moon Devi has been a member of the Hyper-Kamiokande (HK) neutrino experiment (http://www.hyper-k.org/en/), which is located at Japan and being contributed by an International Collaboration, since 2019. The types of association Dr. Devi and her research group have with Hyper-Kamiokande are as in the following:

   (i) Dr. Devi is a member of the India-HK collaboration group. The name of Tezpur University appears in the list of the collaborating institutes of HK (http://www.hyper-k.org/en/organization/member.html).

   (ii) Dr. Devi's research group has been contributing to the detector simulation work. They regularly attend and present their work status in the collaboration meetings and weekly working group meetings via online mode (bluejeans platform).

   (iii) Dr. Devi's group has been contributing to the Machine Learning activities related to HK and hosted by TRIUMF, Canada.

   (iv) Dr. Devi and her group members are co authors of recent HK collaboration publication K. Abe et al 2021 ApJ 916 15 (DOI 10.3847/1538-4357/abf7c4) and Letter of Intent (arXiv:2009.00794).
5. List of year-wise activities under the collaboration:

Year	Activities
2019	• Preliminary discussions and submission of Expression of Interest to Hyper-Kamiokande. • Joined simulation working group activities.
2020	• Contributed to the simulation framework and analysis. • Joined the Machine Learning working Group.
2021	• Contributed to the simulation framework and analysis.* • Contributed to the Machine Learning working group activities.*

* All these activities are still ongoing.

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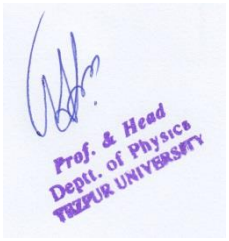
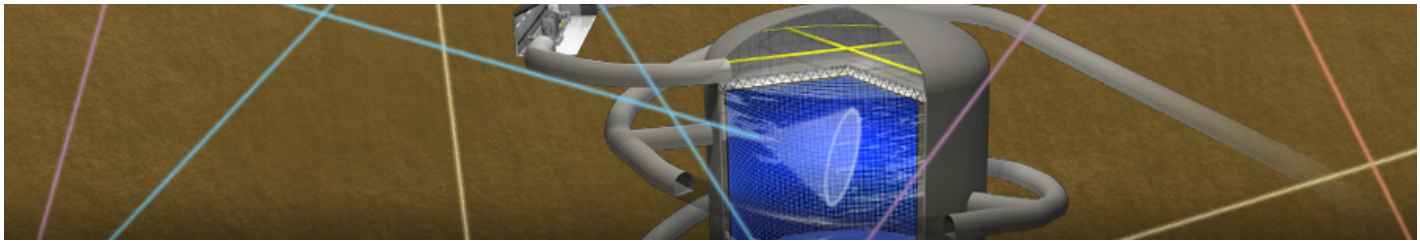
6.

Signature of Faculty	**Signature and Seal of Head of Department/ Centre/ Cell**
Moon Moon Devi **Name: Dr. MOON MOON DEVI** **Designation: ASSISTANT PROFESSOR**	 **Name: Prof. M.K. Das** **Designation: HoD**



Collaborating Institutes (November, 2021)

- Institute for Theoretical Physics and Modeling (Armenia)
- Pontificia Universidade Catolica do Rio de Janeiro (Brazil)
- British Columbia Institute of Technology (Canada)
- Carleton University (Canada)
- University of Regina (Canada)
- University of Toronto (Canada)
- TRIUMF (Canada)
- University of Victoria(Canada)
- University of Winnipeg (Canada)
- York University (Canada)
- Charles University (Czech)
- Laboratoire Leprince-Ringuet, Ecole Polytechnique (France)
- LPNHE Paris (France)
- IRFU, CEA Saclay (France)
- RWTH Aachen University (Germany)
- Indian Institute of Technology - Kharagpur (India)
- Tezpur University (India)
- Indian Institute of Technology - Guwahati (India)
- Indian Institute of Technology - Jodhpur (India)
- Vishwakarma Institute of Information Technology (India)
- INFN (Italy)
- INFN-LNL (Italy)
- Università Federico II di Napoli (Italy)
- INFN Sezione di Napoli (Italy)
- Università degli Studi di Salerno (Italy)
- INFN Sezione di Padova (Italy)
- Università Sapienza (Italy)
- Earthquake Research Institute (Japan)
- ISEE/KMI. Nagoya University (Japan)
- Kamioka Observatory, ICRR, Univ. of Tokyo (Japan)
- Kavli IPMU/Utokyo (Japan)
- KEK/J-PARC (Japan)
- Keio University (Japan)
- Kobe University (Japan)
- Kyoto University (Japan)
- Kyoto Sangyo University (Japan)
- Miyagi University of Education (Japan)
- Okayama University (Japan)
- Osaka City University (Japan)
- Research Center for Cosmic Neutrinos, ICRR, Univ. of Tokyo (Japan)
- Tokyo Institute of Technology (Japan)

- Tokyo Metropolitan University (Japan)
- University of Tokyo (Japan)
- RCNS, Tohoku University (Japan)
- Tohoku University (Japan)
- Tokyo University of Science (Japan)
- Yokohama National University (Japan)
- Chonnam National University (Korea)
- Dongshin University (Korea)
- Gwangju Institute of Science and Technology (Korea)
- KAIST (Korea)
- Kyungpook National University (Korea)
- Ulsan National Institute of Science and Technology (Korea)
- Sungkyunkwan University (Korea)
- Instituto Tecnologico de Estudios Superiores de Monterrey, Campus Guadalajara (Mexico)
- Universidad de Guadalajara (Mexico)
- Universidad Autonoma Sinaloa (Mexico)

- Faculty of Sciences, Hassan II, Casablanca (Morocco)
- Faculty of Sciences, Ibn-Tofail University, Kenitra (Morocco)
- Faculty of Sciences, Mohammed V University, Rabat (Morocco)
- Mohammed VI Polytechnic University, Ben Guerir (Morocco)
- AGH University of Science and Technology (Poland)
- Jagiellonian University (Poland)
- The Henryk Niewodniczański Institute of Nuclear Physics (Poland)
- National Centre for Nuclear Research (Poland)
- University of Warsaw (Poland)
- Warsaw University of Technology (Poland)
- University of Silesia (Poland)
- Wroclaw University (Poland)
- Institute for Nuclear Research (Russia)
- Moscow State University (Russia)
- P.N.Lebedev Physical Institute of the Russian Academy of Science (Russia)
- Canfranc Underground Laboratory (LSC) (Spain)
- Donostia International Physics Center (DIPC) (Spain)
- IFAE (Spain)
- University Autonoma Madrid (Spain)
- University of Oviedo (Spain)
- Universitat Politècnica de València (Spain)
- Instituto Galego de Física de Altas Enerxias (Spain)
- University of Zaragoza (Spain)
- KTH Royal Institute of Technology (Sweden)
- Stockholm University (Sweden)
- Uppsala University (Sweden)
- Eidgenössische Technische Hochschule Zürich (Switzerland)
- Universite de Geneve (Switzerland)
- The University of Edinburgh (UK)
- Imperial College London (UK)
- University of Glasgow (UK)
- Lancaster University (UK)
- University of Liverpool (UK)
- Oxford University (UK)
- King's College London (UK)
- UKRI/STFC Rutherford Appleton Laboratory (UK)
- University of Sheffield (UK)
- University of Warwick (UK)
- Kyiv National University (Ukraine)
- Louisiana State University (USA)

- University of California, Irvine (USA)
- Virginia Tech (USA)

February, 2020

Subject: [hyperk:00175] Re: Virtual Hyper-K collaboration meeting - Plenary meetings starting and updates of the agenda.
From: hyperk@suketto.icrr.u-tokyo.ac.jp
Date: Fri, March 5, 2021 12:53 pm
To: "hyperk@suketto.icrr.u-tokyo.ac.jp" <hyperk@suketto.icrr.u-tokyo.ac.jp>
Priority: Normal
Options: View Full Header | View Printable Version | Download this as a file | View as HTML | Add to Address Book | Bounce

Dear all,
We have already arrived at the plenary talks!
https://indico.ipmu.jp/event/386/overview<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Findico.ipmu.jp%2Fevent%2F386%2Foverview

A couple of notes:

* We will start our plenary sessions at 22:0JST today (Fri, March 5), in a bit less than 6h. This time we will use Zoom to connect. The link is on the front page (it is https://u-tokyo-ac-jp.zoom.us/j/96994612217?pwd=OUJMd1U3MkJyYndSNXpRamhNcWY2dz09).
* Please add you pictures on the Zoom profile and also be ready to have the camera off for the Zoom picture at the end of the session today!
* We may finish 20” earlier today due to a talk being postponed. A confirmation will be sent out soon.
* We will continue our excellent collaboration meeting with a final session (actually a pre-meeting, but it is after the plenaries this time) on hadron production measurements for Hyper-K March 16th (Tue) 22:00-24:00JST. It will be added soon to the agenda on the web.

Best wishes,
Francesca

--
Prof. Francesca Di Lodovico
Experimental Particle and Astroparticle Physics Group | Department of Physics
King's College London
S7.26 | Strand Building | Strand | London | WC2R 2LS
Phone: +44 (0)20 784 89695
Email: francesca.di_lodovico@kcl.ac.uk<mailto:francesca.di_lodovico@kcl.ac.uk>
<mailto:francesca.di_lodovico@kcl.ac.uk>

From: "Di Lodovico, Francesca" <francesca.di_lodovico@kcl.ac.uk>
Date: Tuesday, 16 February 2021 at 22:30
To: "hyperk@suketto.icrr.u-tokyo.ac.jp" <hyperk@suketto.icrr.u-tokyo.ac.jp>
Subject: Re: [hyperk:00142] Virtual Hyper-K collaboration meeting 1->12 March

Dear All,
The access to the web pages requires the usual code:

2
5
y
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a

to be written horizontally.
Best wishes
Francesca

--
Prof. Francesca Di Lodovico
Experimental Particle and Astroparticle Physics Group | Department of Physics
King's College London
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Reply to: "Di Lodovico, Francesca" <francesca.di_lodovico@kcl.ac.uk>
Date: Tuesday, 16 February 2021 at 22:05
To: "hyperk@suketto.icrr.u-tokyo.ac.jp" <hyperk@suketto.icrr.u-tokyo.ac.jp>
Subject: [hyperk:00142] Virtual Hyper-K collaboration meeting 1->12 March

Dear All,

The Hyper-K collaboration will be held virtually during the first two weeks of March:

https://indico.ipmu.jp/event/386/overview<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Findico.ipmu.jp%2Fevent%2F386%2Foverview

The conveners are currently setting up the agenda for the parallel sessions, which will be held during the period 1-2-3-4 March and then March 10. The times when the sessions will run is not fixed but chosen by the relevant conveners.

The plenary sessions will be held from 22:00-> 24:00 JST on March 5-8-9-11-12.

Please start to register:

https://indico.ipmu.jp/event/386/<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Findico.ipmu.jp%2Fevent%2F386%2F&data=04%7C01%7

It will help to organise the agenda knowing who is available.

Best wishes,
Francesca

--
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Attachments:

cid: 438DEA66A26C04479B25E4314D6FEBAB@eurprd03.prod.outlook.com.html

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Subject: [hyperk:00558] Re: Software and Analysis Workshops January 2022 and Summer 2022
From: hyperk@suketto.icrr.u-tokyo.ac.jp
Date: Thu, January 20, 2022 11:24 am
To: hyperk@suketto.icrr.u-tokyo.ac.jp
Priority: Normal
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Dear Hyper-K,

This is a reminder of our analysis workshop starting next Monday at 22:00
JST.

You can access the workshop online via:
Indico Page <https://indico-sk.icrr.u-tokyo.ac.jp/event/6973/> (account:
hk)
Bluejeans HK-103 <https://bluejeans.com/410054102> (all days)

There has been a slight shift in the schedule, so the new agenda is as
follows.
Monday 1/24, 22:00 JST: Astrophysics and ATMPD
Tuesday 1/25, 22:00 JST: Long-baseline and Near Detector
Thursday 1/27, 22:00 JST: Computing, Software, and Reconstruction

Looking forward to "seeing" you there,
Roger and PSC Conveners

2021年12月16日(木) 20:55 Roger Alexandre WENDELL <wendell.roger.4s@kyoto-u.ac.jp
>:

> Dear Hyper-K,
>
> The Physics, Software, and Computing group will hold two workshops to
> introduce people, both new and seasoned, to the details of our analysis
> environment.
>
> The first workshop will focus on higher level presentations about *how*
> we perform various Hyper-K analyses and discuss plans going forward. We
> will hold three online meetings as follows:
>
> 1/24, 22:00 JST: Astrophysics and ATMPD
> 1/25, 22:00 JST: Computing, Software, and Reconstruction
> 1/27, 22:00 JST: Long-baseline and Near Detector
>
> Agenda and connection information will be circulated later, but please
> mark your calendars.
>
> The second workshop will be held sometime in the summer next year and will
> be more hands-on, with coding tutorials and presentation of rather
> low-level analysis details.
>
> We hope to see you there,
> Roger
> (For PSC Conveners)
>
>

Attachments:

untitled-[2].html	**2.5 k**	[text/html]	Download | View

The Astrophysical Journal, 916:15 (17pp), 2021 July 20 https://doi.org/10.3847/1538-4357/abf7c4

Supernova Model Discrimination with Hyper-Kamiokande

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Abstract

Core-collapse supernovae are among the most magnificent events in the observable universe. They produce many of the chemical elements necessary for life to exist and their remnants—neutron stars and black holes—are interesting astrophysical objects in their own right. However, despite millennia of observations and almost a century of astrophysical study, the explosion mechanism of core-collapse supernovae is not yet well understood. Hyper-Kamiokande is a next-generation neutrino detector that will be able to observe the neutrino flux from the next galactic core-collapse supernova in unprecedented detail. We focus on the first 500 ms of the neutrino burst, corresponding to the accretion phase, and use a newly-developed, high-precision supernova event generator to simulate Hyper-Kamiokande's response to five different supernova models. We show that Hyper-Kamiokande will be able to distinguish between these models with high accuracy for a supernova at a distance of up to 100 kpc. Once the next galactic supernova happens, this ability will be a powerful tool for guiding simulations toward a precise reproduction of the explosion mechanism observed in nature.

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The Hyper-Kamiokande Experiment - Snowmass LOI

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(Dated: September 3, 2020)

Hyper-Kamiokande is the next generation underground water Cherenkov detector that builds on the highly successful Super-Kamiokande experiment. The detector which has an 8.4 times larger effective volume than its predecessor will be located along the T2K neutrino beamline and utilize an upgraded J-PARC beam with 2.6 times beam power. Hyper-K's low energy threshold combined with the very large fiducial volume make the detector unique, that is expected to acquire an unprecedented exposure of 3.8 Mton·year over a period of 20 years of operation. Hyper-Kamiokande combines an extremely diverse science program including nucleon decays, long-baseline neutrino oscillations, atmospheric neutrinos, and neutrinos from astrophysical origins. The scientific scope of this program is highly complementary to liquid-argon detectors for example in sensitivity to nucleon decay channels or supernova detection modes.

Hyper-Kamiokande construction has started in early 2020 and the experiment is expected to start operations in 2027. The Hyper-Kamiokande collaboration is presently being formed amongst groups from 19 countries including the United States, whose community has a long history of making significant contributions to the neutrino physics program in Japan. US physicists have played leading roles in the Kamiokande, Super-Kamiokande, EGADS, K2K, and T2K programs.

अंतर-विश्वविद्यालय केंद्र : खगोलविज्ञान और खगोलभौतिकी

IUCAA

Inter-University Centre For Astronomy And Astrophysics

An Autonomous Institution of the University Grants Commission

Prof. Kandaswamy Subramanian
Dean, Visitor Academic Programmes

August 5, 2019

By Speed-Post

Dr. Moon Moon Devi
Assistant Professor,
Department of Physics,
Tezpur University,
Napaam,
Sonitpur -784 028,
Assam.

Dear Dr. Devi,

It gives me great pleasure to invite you, on behalf of the Governing Board and Director of IUCAA to become a Visiting Associate of IUCAA from August 1, 2019 for a period of three years. I hope that you will be able to accept this invitation.

The purpose of the Associateship Programme is to help university and college faculty members in their research projects and to encourage interaction between them and the IUCAA faculty. Those selected as Visiting Associates are encouraged to visit IUCAA regularly and to actively participate in the Centre's programmes.

I am enclosing along with this letter of invitation (1) a copy of the letter I have sent to the Vice-Chancellor of your University, explaining the programme and requesting him/her to treat your visits to IUCAA under this programme as "*on duty*", (2) a copy of a letter sent in September 2, 2004 to the Vice-Chancellors of different universities by Professor Arun Nigavekar, the then Chairman of the University Grants Commission (UGC). You may use these letters when you apply for leave for visits to IUCAA, if you find that necessary.

I shall look forward to your response to this letter of invitation and hope that IUCAA will benefit from your regular visits, participation and advice. The Terms and Conditions of the Associateship Programme are enclosed along with this letter.

With kind regards,

Sincerely,

Kandaswamy Subramanian

Professor Kandaswamy Subramanian

Encl : (1) Copy of the letter sent to the Vice-Chancellor of your University; (2) Copy of the letter sent by UGC; (3) Terms and Conditions of the Associateship Programme.

Mailing Address : IUCAA, Post Bag 4, Ganeshkhind, Pune - 411 007, India.

अंतर-विश्वविद्यालय केंद्र : खगोलविज्ञान और खगोलभौतिकी

IUCAA

Inter-University Centre For Astronomy And Astrophysics

An Autonomous Institution of the University Grants Commission

Prof. Kandaswamy Subramanian
Dean, Visitor Academic Programmes

August 5, 2019.

The Vice-Chancellor,
Tezpur University,
Napaam, Sonitpur,
Tezpur - 784 028

Dear Sir / Madam,

As you are aware, the Inter-University Centre for Astronomy and Astrophysics (IUCAA) has been set up by the University Grants Commission (UGC) to promote and nucleate astronomy and astrophysics in the universities and affiliated colleges. To this end, IUCAA has launched a number of programmes on its campus at Pune and also on the campuses of various universities and colleges. In particular, arrangements have been made to facilitate the usage by interested students and faculty of universities and colleges of centralized facilities at Pune, such as an advanced Computer Centre with High Performance Computing facility, a state-of-the-art library, the Instrumentation Laboratory and observational facilities including the South African Large Telescope (SALT) at Sutherland. IUCAA is also involved in a number of large projects of national and international importance like ASTROSAT, LIGO-India, the Thirty Metre Telescope, etc.

One major activity in this context is the **Associateship Programme.** Under this programme, faculty members of universities and colleges, who are made **Visiting Associates of IUCAA**, can make visits to IUCAA for specified periods to participate in the teaching research and development activities in astronomy and astrophysics. For such purposes, the universities and colleges are encouraged to regard IUCAA as their field station, whose facilities are at their disposal. Indeed, Professor Arun Nigavekar, the then Chairman of the UGC, has written in 2004 to all the university Vice-Chancellors urging them to look upon IUCAA in this spirit and to make it possible for the Visiting Associates to use its facilities to the maximum extent possible. I enclose for your ready reference a copy of this letter from the Chairman.

As part of the Associateship Programme, IUCAA has selected 20 new Visiting Associates this year and has extended the term of 38 Visiting Associates for a further period of three years. I am happy to inform you that **Dr. Moon Moon Devi** from your University has been selected a Visiting Associate for three years from August 1, 2019. Under the Associateship Programme, IUCAA will pay the travel and per diem of the Visiting Associates coming to IUCAA for their scientific work.

I do hope that you will encourage Dr. Devi to take advantage of this offer. I request you to treat Dr. Devi's stay at IUCAA as a part of her duties and to provide her with leave as "*on duty*" so that she can make good use of her Associateship. I enclose the Terms and Conditions of the Associateship Programme for your information.

With kind regards,

Sincerely,

Kandaswamy Subramanian

Prof. Kandaswamy Subramanian

Encl : (i) UGC Chairman's Letter. (ii) Terms and Conditions of Associateship Programme.
cc : Dr. Moon Moon Devi, Tezpur University, Assam.

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डॉ. अरुण निगवेकर
अध्यक्ष

Dr. Arun Nigavekar
Chairman

ज्ञान-विज्ञानं विमुक्तये

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D.O. No. F.1-11/2004 (CM/IUC)

September 2, 2004

Dear

The University Grants Commission has set up a number of Inter-University Centres and Consortia in order to provide front line research and developmental facilities to the staff and students from universities and colleges in selected thrust areas. It is extremely important, therefore, that the prospective users of the Inter-University Centres are freely permitted to participate in their various programmes as if they are "on duty". In some universities, it is noted that the scholars' visits were not considered as on duty.

Amongst such Centres, the Inter-University Centre for Astronomy and Astrophysics (IUCAA) has an Associateship programme under which selected Associates from universities and colleges are invited to visit IUCAA as Associates of the Centre. Each Associate has a tenure of three years, which can be renewed depending on his/her performance, in teaching, research and developmental activities. It is understood that during these three years, the Associate visits IUCAA several times for visits of at least two weeks duration at a time, without compromising with his/her lecturing and other duties in the parent institution. Their visits are fully covered by IUCAA and hence has no financial implication to the university/college.

IUCAA has a number of facilities like an excellent Library, state of the art Computer Centre, Virtual Observatory as well as an Instrumentation Laboratory where the university staff members can make their own instruments as well as participate in collaborative instrumentation projects. As of now, IUCAA has over eighty Associates on its roll. In order to improve their efficiency, it is important that they are permitted to take advantage of these facilities as much as possible.

I, therefore, urge you to facilitate the participation of Associates from your Institution in the above programme by treating their leave of absence as on duty when they visit IUCAA, which is specifically created by the University Grants Commission as a common facility for all universities.

With kind regards,

Yours sincerely,

(Arun Nigavekar)

To the Vice Chancellors of 150 UGC Funded Universities

Copy to:

1. Prof. Naresh Dadhich, Director, Inter University Centre for Astronomy and Astrophysics, IUCAA, Post Box No. 4, Ganeshkhind Road, Pune – 411 007.

2. Dr. P. Prakash, JS (T/IUC), UGC, New Delhi.

TERMS AND CONDITIONS OF IUCAA's ASSOCIATESHIP PROGRAMME

- **Visiting Associateship** is awarded to a faculty member of a college, university department or institution, which has the status of a university recognized by the UGC.

- Visiting Associateship is awarded for a period of three years at a time. If a Visiting Associate ceases to have a formal link with a college or university during the period of an Associateship, then the Associateship stands terminated. Information regarding such a change should be conveyed to the Dean, Visitor Academic Programmes.

- A Visiting Associate can visit IUCAA a maximum of three times as an Associate during each academic year, which extends from August 1 to July 31. There has to be at least one visit during each academic year.

- A visit under the Visiting Associateship programme has to be preferably at least of 15 days duration. A maximum of 150 days can be spent at IUCAA during any one academic year.

- During the three year period of a Visiting Associateship, there can be a maximum of six visits, totally to a maximum of 365 days.

- **Travel:** It is expected that journeys will generally be by air or rail or road by the direct shortest route. All Visiting Associates are entitled to travel by train AC-II tier. Travel reimbursement will only be to the extent of the actual class of travel upto AC-II tier. The claimant will have to produce to and fro tickets/copies of tickets.

  Limited funds are available for air travel of Visiting Associates. Air travel may be permitted subject to the following conditions:

  (a) Grade Pay of the claimant is at least Rs. 5400/- or equivalent per month.
  (b) The claimant stays at IUCAA for a minimum of 15 days.
  (c) Air travel should be by Air India flights only as per GOI rules.

  Even when these conditions are satisfied, **prior approval from the Dean, Visitor Academic Programmes** will have to be obtained. Air travel over special sectors, especially in the North-Eastern parts of the country, may be permitted even when the conditions (a) and (b) are not met. Details about this may be had from the Administrative Officer (Visitor Services). The air travel will have to be by the shortest direct route. Those who are not eligible for air travel can choose to travel by air with the understanding that they will be reimbursed only to the extent of eligible train fare or actual air fare, whichever is lower.

- **Daily Allowance (DA):** Visiting Associates are paid DA @ Rs. 500/- per day with free lodging. Charges for Canteen, Cable TV and cooking gas, wherever applicable, will be recovered.

- **Acknowledgement :** Visiting Associates should not give IUCAA as their affiliation. But those who use the IUCAA facilities for research work leading to publications should acknowledge IUCAA in their publication.

- **Accommodation :** We try to ensure that Visiting Associates are accommodated whenever they wish to visit IUCAA. However, there is very high demand during vacations, when most visitors like to come to IUCAA. All intending visitors are, therefore, urged to write to us about their plans for a stay at IUCAA at least two months in advance. This is particularly necessary for family accommodation, since the number of units, which can accommodate families is very limited. Please write to us well in advance with alternative dates and await confirmation from us. You will be guaranteed accommodation on arrival at IUCAA only if you have a word of confirmation sent by us.

- **Visit by research students of Visiting Associates:** The students should write to the Dean, Visitor Academic Programmes, along with a copy of their bio-data, proposed plan of work at IUCAA, and a recommendation by the concerned Visiting Associate.

  At a given time, only one student of a Visiting Associate can visit IUCAA. It is not essential for the guide/the concerned Visiting Associate to be present at the time of a student's visit, except for students who are visiting for the first time.

  The DA entitlement for research students (registered for M. Phil/Ph.D.) is Rs. 250/- per day with free lodging, and canteen will be charged. They are entitled to travel by train by AC Chair Car or AC –III tier by the direct shortest route. Travel by AC-II tier will be permitted only if the trains on the shortest route do not have any of the above classes. The tickets/copies of the tickets will have to be submitted with the claim. However, the following provisions apply:

Gmail **Moon Moon Devi <devi.moonmoon@gmail.com>**

Inputs for the IUCAA Annual Report 2020-21

4 messages

Visitor Services <vs@iucaa.in> Mon, Apr 12, 2021 at 12:14 PM
To: IUCAA Associates <associates@iucaa.in>
Cc: Visitor Services <vs@iucaa.in>

Dear Visiting Associates,

Trust this email finds all of you safe and in good health.

I am writing to you in connection with the IUCAA Annual Report which carries the research work by Associates during the academic year (April-March).

Please send your report (list of publications, awards, etc.) in brief along with abstracts of any two of your published papers in any refereed journals for the period April 1, 2020 till March 31, 2021.

Kindly note that:

1. The abstracts are required to be sent in tex/latex along with the corresponding PDF files.

2. The list of publications can be sent as an MSWord file.

You could also send a photograph showing an award being conferred on you during this period, for inclusion in the Annual Report.

Please refer to the following URL for the Annual Report of the previous years:

http://publication.iucaa.in/index.php/annual/issue/archive

Please send your contributions to <vs@iucaa.in> by Saturday, May 08, 2021, which shall be duly acknowledged.

Thanks and Regards,

=~=
Visitor Services
INTER-UNIVERSITY CENTRE FOR ASTRONOMY AND ASTROPHYSICS
Post Bag 4, Ganeshkhind, Pune 411007, Maharashtra, INDIA
Phone : +91-20-25604100 / E-mail : <vs@iucaa.in>
=~=

Visitor Services <vs@iucaa.in> Wed, Apr 28, 2021 at 10:46 AM
To: IUCAA Associates <associates@iucaa.in>
Cc: Visitor Services <vs@iucaa.in>

Dear Visiting Associates,

This is just a gentle reminder requesting you to submit your inputs for the IUCAA Annual Report (2020-21) by the deadline of May 8, 2021.

Those who have already submitted their inputs earlier may kindly ignore this mail.

Regards,

Visitor Services

=~=
Visitor Services
INTER-UNIVERSITY CENTRE FOR ASTRONOMY AND ASTROPHYSICS
Post Bag 4, Ganeshkhind, Pune 411007, Maharashtra, INDIA
Phone : +91-20-25604100 / E-mail : <vs@iucaa.in>
=~=

From: "Visitor Services" <vs@iucaa.in>
To: "IUCAA Associates" <associates@iucaa.in>
Cc: "Visitor Services" <vs@iucaa.in>
Sent: Monday, April 12, 2021 12:14:00 PM
Subject: Inputs for the IUCAA Annual Report 2020-21
[Quoted text hidden]

Visitor Services <vs@iucaa.in> Fri, May 7, 2021 at 10:32 AM
To: IUCAA Associates <associates@iucaa.in>

GENTLE REMINDER PLEASE.

Those who have already responded may kindly ignore this mail.

Regards,
Visitor Services

From: "Visitor Services" <vs@iucaa.in>
To: "IUCAA Associates" <associates@iucaa.in>
Cc: "Visitor Services" <vs@iucaa.in>
Sent: Wednesday, April 28, 2021 10:46:43 AM
[Quoted text hidden]
[Quoted text hidden]

Moon Moon Devi <devi.moonmoon@gmail.com> Sat, May 8, 2021 at 11:57 AM
To: Visitor Services <vs@iucaa.in>

Dear Sir/Ma'am,

Please find attached my inputs. Please let me know if any modifications are required.

Regards,
Moon Moon
[Quoted text hidden]
--

....
Moon Moon Devi
Assistant Professor

Department of Physics
Tezpur University
Napaam, Sonitpur 784028
Assam, INDIA
Email devimm[at]tezu.ernet.in
Tel(O) +91-3712-27-5565

.....

3 attachments

IUCAA_associate_2021_MMDevi.docx
8K

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1878K

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4499K

Gmail **Moon Moon Devi <devi.moonmoon@gmail.com>**

Rescheduled Online Neem Seminar on 27th October, 2020 at 4pm

1 message

Kandaswamy Subramanian <kandu@iucaa.in> Tue, Oct 27, 2020 at 9:21 AM
To: Santosh Jagade <santoshj@iucaa.in>
Cc: Kandaswamy Subramanian <kandu@iucaa.in>, Moon Moon Devi <devi.moonmoon@gmail.com>

Dear All

Just a reminder about today's online Neem Seminar by Dr. Moon Moon Devi.
See you online,

best wishes
Kandaswamy Subramanian

Dear All

There will be an online Neem Seminar by Dr. Moon Moon Devi on
Tuesday, 27th October, 2020 at 4pm. The details are given below.

Speaker: Dr. Moon Moon Devi

(Department of Physics, Tezpur University)

Title: Detectors for Astroparticle Physics

Abstract attached.

Date and Time: Oct 27, 2020 16:00 Hrs

Zoom Link:
https://us02web.zoom.us/j/89378130498?pwd=UGFHM2V1Y3R4Qk5YMWFwUG5ZRC9mUT09

Meeting ID: 893 7813 0498
Passcode: 0J0nN^ZS2i

Please join a few minutes earlier,

See you online
best wishes
Kandaswamy Subramanian

IUCAA_Neem_Seminars.pdf
54K

IUCAA

INTER-UNIVERSITY CENTRE FOR ASTRONOMY AND ASTROPHYSICS
(An Autonomous Institution of the University Grants Commission)
****

NEEM SEMINAR

Dr. Moon Moon Devi
Department of Physics, Tezpur University

Detectors for Astroparticle Physics

Particle detectors in Astroparticle studies have played a huge role in discovering many fundamental particles. A series of gaseous ionization detectors were instrumental in such detection. With new state-of-the-art technologies, lots of newer detectors are in the field and many of them are being widely used in various astroparticle searches. In this talk, with a brief introduction to the early developments, a few detectors (like si-PMT) which have interesting prospects for wider applications in the Astroparticle sector will be discussed.

Online Neem Seminar
October 27, 2020, 16:00 hrs.

DEPARTMENT OF PHYSICS
TEZPUR UNIVERSITY
Napaam, Tezpur - 784 028
Sonitpur (Assam), India

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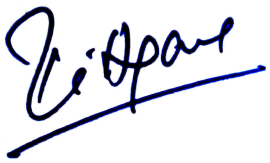
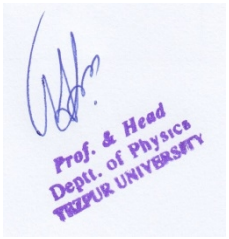
03712-267007-9(ext- 5551,5550)
Fax : 03712-267005, 267006
e-mail- hod_phy@tezu.ernet.in
website: www.tezu.ernet.in

A REPORT ON
Research Collaboration of Dr. Ritupan Sarmah

1. Name of the Collaborative Activity: Collaborative Research Work
2. Nature of Activity: Scientific Research work
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:
   Prof. L. H. Dai,
   State Key Laboratory of Nonlinear Mechanics,
   Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190
   Email: lhdai@lnm.imech.ac.cn

4. Summary of collaboration: This research work started in 2019 till 2021 on the study of Spatio-temporal nature of intermittent stress-strain behavior at low temperature in high entropy alloys, which leads to publication in Philosophical Magazine.
5. List of year-wise activities under the collaboration:
   2019-2020 : Developed methodologies for characterizing the stress-strain signal and computation work was carried out to analyze the data.
   2020-2021 : The manuscript and written and subsequently was published in PHILOSOPHICAL MAGAZINE 2021, VOL. 101, NO. 2, 154–178
   https://doi.org/10.1080/14786435.2020.1822557
6.

Signature of Faculty	Signature and Seal of Head of Department/ Centre/ Cell
 **Name: Dr. R. Sarmah** Designation: Assistant Professor	 Name: Prof. M.K. Das Designation: HoD

DEPARTMENT OF PHYSICS
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Napaam, Tezpur - 784 028
Sonitpur (Assam), India

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03712-267007-9(ext- 5551,5550)
Fax : 03712-267005, 267006
e-mail- hod_phy@tezu.ernet.in
website: www.tezu.ernet.in

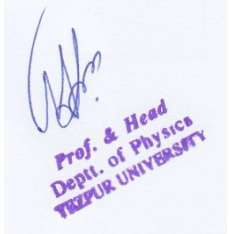
A REPORT ON
Research Collaboration of Dr. Ritupan Sarmah

1. Name of the Collaborative Activity: Collaborative Research Work
2. Nature of Activity: Scientific Research work
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:
   Prof. Nobuo Nakada,
   Department of Materials Science and Engineering,
   Tokyo Institute of Technology, Japan
   Email: nakada.n.aa@m.titech.ac.jp

4. Summary of collaboration: The collaboration was started in the early part of the year 2020 to study the spatio-temporal dynamics of Austenite Stainless Steel at high temperature. Our analysis suggest that at high temperature, the localized deformation bands changes from type A to B to type C continuously as function of time, as opposed to the function of strain rate at room temperature. Using the Ananthakrishna's model, we rationalize the experimental findings with model. This is the first observation where we are able to show that as time evolve plastic strain rate decreases at high temperatre and subsequently, a continuous deformation band transition is seen as function of time.

5. List of year-wise activities under the collaboration:
   2020-21 : Formulation of the research work, Design Methodologies
   2021-22 : Analysis of the experimental signal was carried out and computational work was performed. A manuscript was prepared and submitted for peer review in the journal of Acta Materialia. The Manuscript is under process and an online copy may be obtain from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4001341. This is a long term collaboration as there are many analysis remain to be carried out.

6.

Signature of Faculty	Signature and Seal of Head of Department/ Centre/ Cell
	
Name: Dr. R. Sarmah Designation: Assistant Professor	Name: Prof. M.K. Das Designation: HoD

DEPARTMENT OF PHYSICS
TEZPUR UNIVERSITY
Napaam, Tezpur - 784 028
Sonitpur (Assam), India

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Fax : 03712-267005, 267006
e-mail- hod_phy@tezu.ernet.in
website: www.tezu.ernet.in

A REPORT ON
Research Collaboration of Dr. Ritupan Sarmah

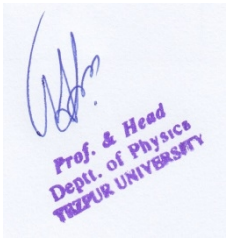
1. Name of the Collaborative Activity: Collaborative Research Work
2. Nature of Activity: Scientific Research work
3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:

   Prof. G. Ananthakrishna
   Material Research Center,
   Indian Institute of Science, Bangalore 560012
   Email: garani@iisc.ac.in

4. Summary of collaboration: Our collaborative research work has been going on since 2010 on different areas of scientific interest. We are working on a number of scientifically intrigue problem, and considerable progress is made during last two years.

5. List of year-wise activities under the collaboration:
   - 2014-2015 : Our 2010 project on correlation of the nature of spatio-temporal nature of dislocation bands in polycrystalline alloys was published in Acta Materialia, 91, 192-201.
   - 2015-2016 : In this project we are able to formulate a general framework for acoustic emission during plastic deformation in crystals and was published in Physical Review B, 92, 144109.
   - 2017-2018: We have exchanged many scientific ideas and a model was developed.
   - 2018-2019: Numerical methodologies were developed.
   - 2019-2020: The developed methodologies for characterizing the stress-strain signal was applied to the real time experimental signal and computation work was carried out to analyze the experimental data. A manuscript was prepared.
   - 2020-2021 : The manuscript was published in the peer reviewed journal of PHILOSOPHICAL MAGAZINE, vol. 101, no. 2, 154–178. We have also carried out the computational work required for the model developed in 2018. A manuscript is under preparation.

6.

Signature of Faculty	Signature and Seal of Head of Department/ Centre/ Cell
	
Name: Dr. R. Sarmah Designation: Assistant Professor	Name: Prof. M.K. Das Designation: HoD

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e-mail- hod_phy@tezu.ernet.in
website: www.tezu.ernet.in

A REPORT ON

Research Collaboration of Dr. Ritupan Sarmah

1. Name of the Collaborative Activity:Collaborative Research Work

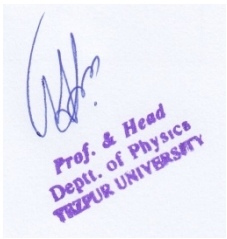
2. Nature of Activity: Scientific Research work

3. Name of the Collaborating Agency/ Individual with affiliation, and contact details:
   Dr. Jagadish Kumar,
   Utkal Unversity, Bhubaneshwar, Odisha
   Email: jagadish.physics@utkaluniversity.ac.in

4. Summary of collaboration: We begin our collaboration in 2014 onwards. A number of scientific ideas were exchanged and is under steady progress.

5. List of year-wise activities under the collaboration:
   2015-2016 : Our first collaborative work is published in Physical Review B, 92, 144109.
   2018-2019 : Scientific Input and design of a collaborative research work was undertaken.
   2019-2020 : Nonlinear time series on Accoustic Emission data is under process.
   2020-2021 : We developed a model on SARS-COV-19 and a manuscript is under process.

6.

Signature of Faculty	Signature and Seal of Head of Department/ Centre/ Cell
	
Name: Dr. R. Sarmah Designation: Assistant Professor	Name: Prof. M.K. Das Designation: HoD

PHILOSOPHICAL MAGAZINE
2021, VOL. 101, NO. 2, 154–178
https://doi.org/10.1080/14786435.2020.1822557

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Taylor & Francis Group

Spatio-temporal dynamics of jerky flow in high-entropy alloy at extremely low temperature

Z. Pu[a,b,c], Z. C. Xie[a,b,c], R. Sarmah[d], Y. Chen[a,b,c], C. Lu[e], G. Ananthakrishna[f] and L. H. Dai[a,b,c]

[a]State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing, People's Republic of China; [b]School of Engineering Science, University of Chinese Academy of Sciences, Beijing, People's Republic of China; [c]CAS Center for Excellence in Complex System Mechanics, Beijing, People's Republic of China; [d]Department of Physics, Tezpur University, Tezpur, India; [e]School of Civil and Mechanical Engineering, Curtin University, Western Australia, Australia; [f]Materials Research Centre, Indian Institute of Science, Bangalore, India

ABSTRACT

Despite a large body of literature, mechanisms contributing to low temperature jerky flow remain controversial. Here, we report a cross-over from a smooth at room and liquid nitrogen temperatures to serrated plastic flow at 4.2 K in high-entropy CrMnFeCoNi alloy. Several complimentary investigations have been carried out to get a coherent physical picture of low temperature jerky flow in these alloys. Microstructural characterisations at 77 K and 4.2 K show that the number of Lomer-Cottrell (L-C) locks at 4.2 K is much higher than that at 77 K, inducing stronger barriers for dislocation glide at 4.2 K. A stability analysis shows that the jerky flow results from an interaction between dislocation inertial motion with L-C locks. The instability results from a competition between inertial and viscous time scales characterised by a Deborah number. A detailed nonlinear time series analysis of experimental serrated stress signals shows that jerky flow is chaotic characterised by the existence of a finite correlation dimension and a positive Lyapunov exponent. Further, the minimum degree of freedom required for the chaotic dynamics turns out to be four, consistent with four collective modes degrees of freedom used in our model equations. These results highlight the crucial ingredients for jerky flow at liquid helium temperatures.

ARTICLE HISTORY
Received 29 February 2020
Accepted 25 August 2020

KEYWORDS
High-entropy alloy; cryogenic temperature; jerky flow; linear perturbation analysis; chaotic

1. Introduction

Jerky or serrated plastic flow is a ubiquitous phenomenon observed from room to cryogenic temperatures. The topic continues to engage the attention of scientists due to fact that it is one of the few striking examples of the *complexity of*

CONTACT L. H. Dai lhdai@lnm.imech.ac.cn State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, People's Republic of China; School of Engineering Science, University of Chinese Academy of Sciences, Beijing 100049, People's Republic of China; CAS Center for Excellence in Complex System Mechanics, Beijing 100190, People's Republic of China

Serrated Flow Accompanied with Dynamic Type Transition of the Portevin–Le Chatelier Effect in Austenitic Stainless Steel

Seung-Yong Lee[a,*], Sita Chettri[b], Ritupan Sarmah[b], Chikako Takushima[c], Jun-ichi Hamada[c], Nobuo Nakada[a]

[a]Department of Materials Science and Engineering, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama-shi, Kanagawa-ken 226-8503, Japan

[b]Department of Physics, Tezpur University, Nappam, Tezpur - 784028, India

[c]Research & Development Center, NIPPON STEEL Stainless Steel Corporation, Hikari 743-8550, Japan

*E-mail of the corresponding author: lee.s.aw@m.titech.ac.jp

*Postal address of the corresponding author: J3-20, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama-shi, Kanagawa-ken 226-8503, Japan

*Telephone number of the corresponding author: +81-045-924-5579

General framework for acoustic emission during plastic deformation

Jagadish Kumar,[1] Ritupan Sarmah,[2] and G. Ananthakrishna[3]
[1]*Department of Physics, Utkal University, Bhubaneswar 751004, India*
[2]*Department of Physics, Tezpur University, Tezpur-784028, India*
[3]*Materials Research Centre, Indian Institute of Science, Bangalore 560012, India*
(Received 23 April 2015; revised manuscript received 13 August 2015; published 20 October 2015)

Despite the long history, so far there is no general theoretical framework for calculating the acoustic emission spectrum accompanying any plastic deformation. We set up a discrete wave equation with plastic strain rate as a source term and include the Rayleigh-dissipation function to represent dissipation accompanying acoustic emission. We devise a method of bridging the widely separated time scales of plastic deformation and elastic degrees of freedom. While this equation is applicable to any type of plastic deformation, it should be supplemented by evolution equations for the dislocation microstructure for calculating the plastic strain rate. The efficacy of the framework is illustrated by considering three distinct cases of plastic deformation. The first one is the acoustic emission during a typical continuous yield exhibiting a smooth stress-strain curve. We first construct an appropriate set of evolution equations for two types of dislocation densities and then show that the shape of the model stress-strain curve and accompanying acoustic emission spectrum match very well with experimental results. The second and the third are the more complex cases of the Portevin-Le Chatelier bands and the Lüders band. These two cases are dealt with in the context of the Ananthakrishna model since the model predicts the three types of the Portevin-Le Chatelier bands and also Lüders-like bands. Our results show that for the type-C bands where the serration amplitude is large, the acoustic emission spectrum consists of well-separated bursts of acoustic emission. At higher strain rates of hopping type-B bands, the burst-type acoustic emission spectrum tends to overlap, forming a nearly continuous background with some sharp acoustic emission bursts. The latter can be identified with the nucleation of new bands. The acoustic emission spectrum associated with the continuously propagating type-A band is continuous. These predictions are consistent with experimental results. More importantly, our study shows that the low-amplitude continuous acoustic emission spectrum seen in both the type-B and type-A band regimes is directly correlated to small-amplitude serrations induced by propagating bands. The acoustic emission spectrum of the Lüders-like band matches with recent experiments as well. In all of these cases, acoustic emission signals are burstlike, reflecting the intermittent character of dislocation-mediated plastic flow.

DOI: 10.1103/PhysRevB.92.144109 PACS number(s): 43.40.Le, 62.20.fq, 05.45.−a, 83.50.−v

I. INTRODUCTION

Two striking features of acoustic emission are its intermittent character and its occurrence in a surprisingly large variety of systems, ranging from geological scales to laboratory scales. A good example from the geological scale is the acoustic emission (AE) during volcanic activity [1]. Varied laboratory scale examples such as AE from crack nucleation and propagation in fracture of solids [2–4], thermal cycling of martensites [5–7], peeling of an adhesive tape [8–11], and collective dislocation motion [12–14] can be cited. Clearly, while the sources that lead to AE signals in such widely different situations are necessarily different, they are generally attributed to the release of stored elastic energy in the system. Further, the AE spectrum in all of these cases is intermittent, a feature reflective of the underlying jerky motion of the sources generating the AE signals. The phenomenon has been effectively used as a nondestructive tool in locating the sources and mechanisms generating the AE signals [15]. The method involves recording the arrival times of a wave at multiple transducers which, in turn, determines the distances of the AE source from the transducers. This procedure is akin to that adopted in fracture studies on rock samples [2,13]. This method has been used to explain the power-law distribution of the amplitudes of the AE signals in the deformation studies of ice samples [12,13].

Considerable insight into the intermittent character of dislocation-mediated plastic deformation has come from acoustic emission measurements [12,13,15]. Indeed, such AE studies carried out for over five decades have established specific correlations between the nature of the AE signals and the stress-strain curves for different situations [16–24]. However, there is lack of clarity as to why such distinct correlations exist [16–22,25]. For instance, even early studies on the AE spectrum for the smooth homogeneous yield phenomenon showed an intermittent AE spectrum [16]. Improved techniques confirm the pulselike character of the AE events. The general shape of the AE spectrum for this case exhibits a peak just beyond the elastic regime decaying for larger strains [16,19]. Since the stress-strain ($\sigma - \epsilon$) curves remain smooth, the pulselike acoustic emission signals are attributed to the intrinsic intermittent motion of dislocations. Then, the smooth $\sigma - \epsilon$ curves are interpreted as resulting from the averaging process of the dislocation activity in the sample. Indeed, the intermittent character of dislocation motion at the microscopic level is reflected in the strong stress fluctuations seen in nanometer-sized samples that are not seen in macroscopic samples [26].

In contrast, the nature of the AE spectrum is qualitatively different for the case of discontinuous flows where the stress-strain curves display stress serrations. For example, studies of the Portevin-Le Chatelier (PLC) effect, a kind of propagative instability, have established specific types of correlations between the AE spectrum and the different types of deformation bands and the associated stress-strain curves [17,20–22,25]. Similar correlations exist for the Lüders band [21–24], another

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Correlation between band propagation property and the nature of serrations in the Portevin–Le Chatelier effect

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Abstract—We investigate the correlation between the band propagation property and the nature and amplitude of serrations in the Portevin–Le Chatelier effect within the framework of the Ananthakrishna model. Several significant results emerge. First, we find that spatial and temporal correlations continuously increase with strain rate from type C to type A bands. Consequently, the nature of the bands also changes continuously from type C to A bands, and so do the changes in the associated serrations. Second, even the smallest extent of propagation induces small amplitude serrations. The spatial extent of band propagation is directly correlated with the duration of small amplitude serrations, a result that is consistent with recent experiments. This correspondence allows one to estimate the spatial extent of band propagation by just measuring the temporal stretch of small amplitude serrations. Therefore, this should be of practical value when only stress versus strain is recorded. Third, the average stress drop magnitude of the small amplitude serrations induced by the propagating bands remains small and nearly constant with strain rate. As a consequence, the fully propagating type A bands are in a state of criticality. We rationalize the increasing levels of spatial and temporal correlations found with increasing strain rates. Lastly, the model also predicts several band morphologies seen in experiments including the Lüders-like propagating band.

Keywords: Portevin–Le Chatelier effect; Plastic instability; Band types; Small amplitude serrations; Dynamical approach

1. Introduction

The Portevin–Le Chatelier (PLC) effect is one of the most intriguing spatio-temporal instabilities in metallurgy that has continuously attracted the attention of scientists for over half a century due to its technological and scientific importance [1]. The PLC instability is found when dilute metallic alloys are deformed under constant strain rate conditions [1]. The instability manifests itself as irregular stress serrations in a window of strain rates $\dot{\varepsilon}_a$ and temperatures T [2–5]. Conventionally, three types of plastic deformation bands have been identified [2–12]. For a range of low strain rates, randomly nucleated static type C bands are seen along with large amplitude nearly regular serrations. At intermediate strain rates, bands are formed sequentially one ahead of the other identified as the 'hopping' type B band. The serrations are smaller and more irregular. At high $\dot{\varepsilon}_a$ the continuously propagating type A bands are seen and the associated stress drops are even smaller. The instability domain typically spans two to three orders of magnitude in strain rate. Despite the enormous attention, there is a lack of clarity regarding several aspects relating to the band types, their propagation property and its influence on the nature of serrations. The purpose of this paper is to identify these issues and answer them within the context of the Ananthakrishna (AK) model for the PLC effect.

The original model due to Cottrell [13,14] has been revisited by several authors [15–17]. The basic mechanism of the instability is attributed to the interplay of two time scales, one corresponding to the waiting time of dislocations temporarily arrested by forest dislocations and the other to the diffusivity of solute atoms. When the two time scales are very different, either the dislocations are immobilized by solute atoms (low $\dot{\varepsilon}_a$ or high T) or they see solute atoms as immobile obstacles (high $\dot{\varepsilon}_a$ or low T). In the region where these two time scales differ less, a competition between the two mechanisms sets-in. Lower strain rates or longer waiting times allow higher solute concentrations at the dislocations leading to a higher unpinning stress. This in turn induces negative strain rate sensitivity. This phenomenon is called dynamics strain aging (DSA). When the stress reaches the critical unpinning value, the unpinned dislocations move at high velocities only to be arrested by obstacles. From a dynamic point of view, the slow pinning of dislocations and their abrupt unpinning induces negative strain rate sensitivity [2,3,16–20]. However, as dislocation interactions have their own positive strain rate sensitivity, no instability can occur as long as the total strain rate sensitivity is positive. The PLC instability sets-in when

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