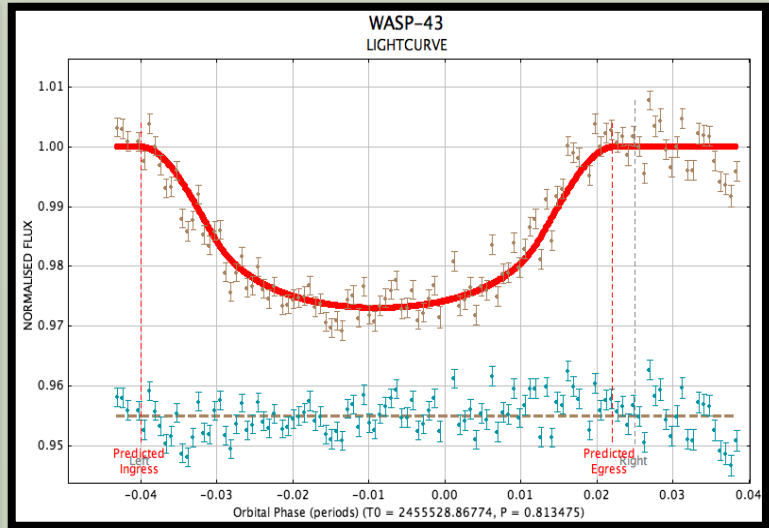
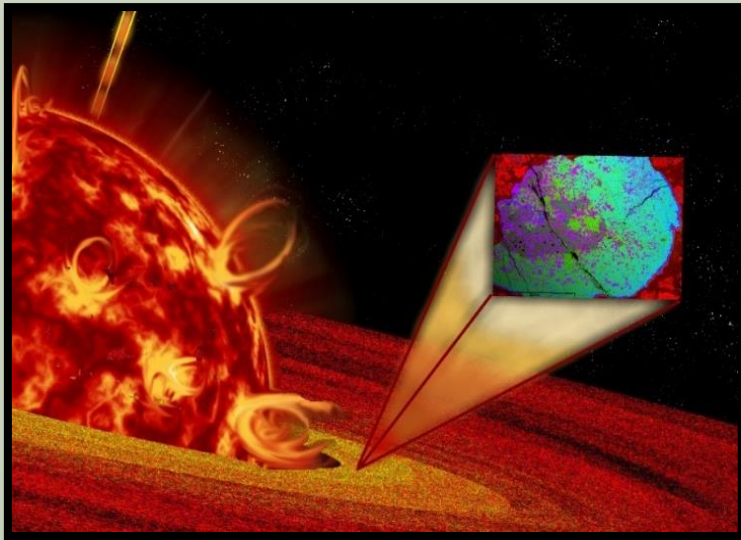




PRL NEWS – THE SPECTRUM

JULY 2019



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भौतिक अनुसंधान प्रयोगशाला
अहमदाबाद-380009
भारत

Evidence of Solar Super flares

Young stellar objects (YSO) are newly formed stars in a very early phase, still gathering mass from its circumstellar disk. They evolve into a proto-star with hydrogen fusion, which is complemented with mass loss in the form of bipolar jets and flares, compensating for the angular momentum. Sudden change in the fusion, radiative episodes and high level of magnetic activity could lead to high intensity episodic flares on the surface of the YSO.

Superflares, as the name suggests, are flares with an intensity 10000 (or more) times higher than contemporary Solar flares. Recent spectroscopic studies reported appearance of superflares on various YSO with solar masses. It has been envisaged, even Sun might have gone through these superflare outburst during its early phase, that is 4.5 billion years ago. Past evidences related to high energy flares, have been checked in terms of energetic particles (part of flares) producing unique isotopes (like excess ^{14}C , ^{44}Ti etc). Little evidence of high (of the order of 10,000 times) intensity flare during 775 AD (from ^{14}C data from the



Kuljeet Marhas

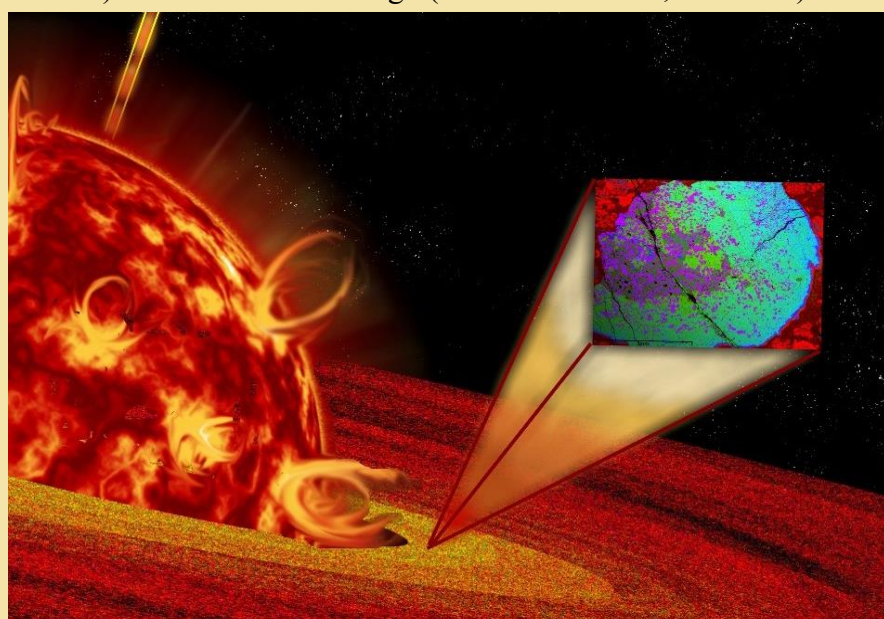


Figure Caption: An artist's impression of Flares during T-Tauri phase of proto-Sun. Zoomed is the false-colored electron probe image of the Calcium Aluminum inclusion, one of the first forming solids of the solar system from Efremovka meteorite.

tree rings) and Carrington event in year 1859 have been reported. For any records of the flaring event earlier, when Sun was in protostar phase, one needs to sample early forming solids. It is now known that some primitive meteorites indeed contain first forming objects in solar system known as Calcium Aluminum Inclusions (CAIs).

One such CAI, from a meteorite named Efremovka (Russian meteorite) has been analyzed with PRL ion microprobe in search of a unique isotope ^7Be . ^7Be decays to ^7Li with a half-life of 53 days. This short half-life makes ^7Be special and unique as it needs to be produced or incorporated in the target material and stored in the protoplanetary disk within a year of its production. This puts a stringent constraint on the source of short-lived nuclides in the early solar system and also indicates the production of this isotope has to be within the planetary disk. Calculation for production of this short-lived nuclide due to

the energetic particle interaction within the protoplanetary disk, indicates requirement high intensity of energetic particles (10^{14} p/cm²/sr) to produce the ^7Li excess (by decay of ^7Be) as experimentally obtained in the laboratory.

The proton flux converted to X-ray luminosity of high orders provides first time experimental evidence of superflare existence in our solar system. The important inferences from the experimental work along with the theoretical modeling carried out in PRL can be summarized as (1) Sun during its nascent phase was producing super flares with X-ray luminosity (L_x) of 10^{32} erg/sec. These flares are ~ a million time stronger than the strongest X-ray flaring from the contemporaneous Sun. (2) Irradiation by early Sun is one of the sources of short-lived nuclides and by inference of corresponding material making the initial budget of the Solar system. (3) This study also provides a high-resolution temporal record of formation, evolution, history of transport of the first Solar system solids.

The findings have been published in the journal "Nature Astronomy". [R. K. Mishra and **K. K. Marhas** (2019), 3, 498-505] titled "Meteoritic evidences of a late superflare as a source of ^7Be in the early Solar System".

<https://www.nature.com/articles/s41550-019-0716-0>

A Removal of UV/IR mixing and inferring non-minimal coupling in the spacetime noncommutativity (J. Selvaganapathy, Partha Konar and Prasanta Kumar Das)

In classical mechanics, one can specify the position and momentum of the particle at arbitrary precision. But quantum mechanics tells us if the position of the particle determined at arbitrary accuracy then the measurement of the momentum of the particle would be completely uncertain and vice versa. According to Heisenberg uncertainty principle, the product the uncertainty of the position and momentum of a particle is an absolute constant of nature- a Planck constant. Similarly, spacetime noncommutativity (NC) tells that the position measurement of a particle on one axis with respect to other axis would be completely uncertain. The product of the position uncertainty of that particle also absolute constant of nature. In the NC theory, the infamous UV/IR mixing phenomenon is the quite interesting feature i.e., the physics at high energies affects the physics at low energies. In addition, NC theory violates the Lorentz symmetry.



Selvaganapathy. J

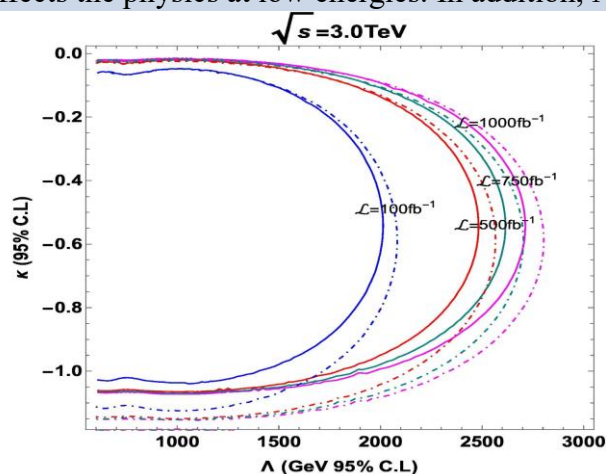


Figure Caption : The figure depicts χ^2 statistical test (95% C.L.) of polarized the noncommutative signal event arises due to azimuthal anisotropy of the $-ve \kappa$. The color line corresponds to $Pe^- = -80\%$, $Pe^+ = 30\%$ and dot-dashed color line corresponds to $Pe^- = -80\%$.

In order to solve the UV/IR mixing in the NC field theory, we have considered the covariant θ -exact noncommutative standard model. Interestingly, this NC theory induces the novel non-minimal interaction between neutral right-handed fermion and abelian gauge field by non-vanishing commutator of those fields in the covariant derivative. Imposing the Glashow-Cohen Very Special Relativity Lorentz sub-group symmetry on NC tensor which provides the space-time and space-space noncommutative duality property. Such duality removes the UV/IR mixing in the Minkowski spacetime as well as it provides UV-free neutrino self-energy correction. But still we have logarithmic IR divergences which can be interpreted as follows: “when the particle moving with momentum p inside the noncommutative plane on one direction and the spatial extension (θp) grows on the other direction, thereby one cannot shrink θp to zero”. Atlast, NC parameter θ constrained by weak gravity conjecture.

In the phenomenological point of view, we have investigated the impact of space-time noncommutativity on top quark pair production (azimuthal anisotropy) at linear collider (LC). In the realistic case the electron and positron beam polarization are taken into account to measure NC coupling κ and Λ by using helicity technique at LC.

[https://doi.org/10.1007/JHEP06\(2019\)108](https://doi.org/10.1007/JHEP06(2019)108)

Investigation of Vertical Wavenumber Spectra during Sudden Stratospheric Warming (SSW) Events over the Indian Region (Priyanka Ghosh, Som Sharma & Kamran Ansari)

Sudden Stratospheric Warmings (SSWs) are one of the important atmospheric phenomena that modulates variety of atmospheric processes. SSW are originating in the polar region but their effects are clearly seen in the various atmospheric parameters up to the equatorial region in the Northern hemisphere. Dynamics of the atmosphere (variety of waves) get modulated during these SSW episodes. In this study, we have investigated vertical wavenumber spectra (VWN) characteristics using temperature observations from SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) onboard TIMED (Thermosphere Ionosphere Mesosphere Energetics Dynamics) satellite for the altitude range of 20–70 km. Highly negative VWN spectral slope value of -4.82 (at 25° N, 77° E) and -4.41 (at 35° N, 77° E) at 40–50 km altitude is observed during the 2013 SSW event, a sort of which is not perceived in any other SSW events during 2003–2016. The combined effect of planetary waves (PWs) with wavenumber 1 and 2 during 2013 SSW may be responsible for such distinctive observation near the peak temperature altitude. This study elicits the importance of polar vortex breakdown during SSWs and their associated impacts on the atmospheric processes through gravity waves over the Indian latitudes.



Som Sharma

<https://doi.org/10.1080/2150704X.2019.1601274>

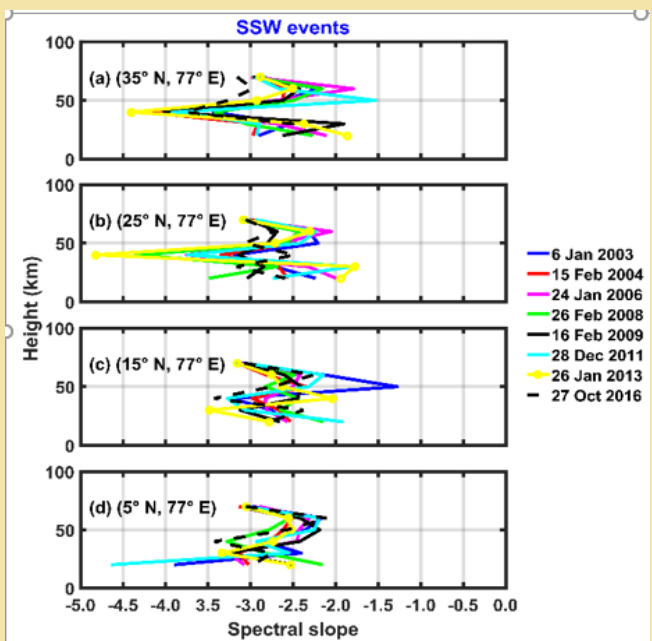
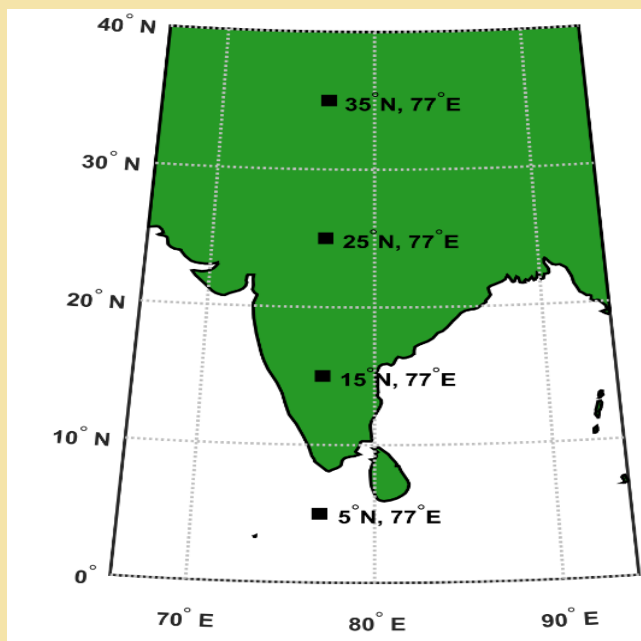


Figure Caption. Left panel depicts the geographical location on the map of India and right panel shows Comparison of vertical wavenumber spectral slopes on the SSW events [(a) 35° N, 77° E; (b) 25° N, 77° E; (c) 15° N, 77° E; (d) 5° N, 77° E] during 2003–2016 for all the four locations (where the colors indicate different years; Blue: 2003, Red: 2004, Magenta: 2006, Green: 2008, Black: 2009, Cyan: 2011, Yellow: 2013, Black dashed line: 2016).

Distribution of Volatile Organic Compounds over Indian subcontinent during winter: WRF-Chem simulation versus Observations (*L. Chutia, N. Ojha, I. Girach, L. K. Sahu, L. Alvarado, J. P. Burrows, B. Pathak, P. Bhuyan*)

Volatile Organic Compounds (VOCs) play vital roles in the atmospheric chemistry and climate, however, their observations are sparse over the Indian subcontinent. We performed high-resolution (12 km x 12 km) simulation using the WRF-Chem (Weather Research and Forecasting coupled with Chemistry) model to investigate the distribution of VOCs over this region during winter conditions (January 2011). Model reveals enhanced VOCs (e.g. propane) over the Indo-Gangetic Plain (16 ppbv) and the northeast region (9.1 ppbv) as compared to other parts of the Indian subcontinent (1.3–8.2 ppbv). WRF-Chem simulated formaldehyde shows the western coast, eastern India and the Indo-Gangetic Plain as the regional hotspots, in agreement with the satellite-based observations (Figure 1). Higher ratio of glyoxal to formaldehyde (~ 0.06) over the northeast suggests stronger influences of biogenic emissions on the distribution of VOCs here. Based on our model results, it is recommended to initiate in situ observations of VOCs over identified regional hotspots (northeast, central India, and the western coast), where observations from different satellite instruments also differ considerably.

<https://doi.org/10.1016/j.envpol.2019.05.097>



Narendra Ojha

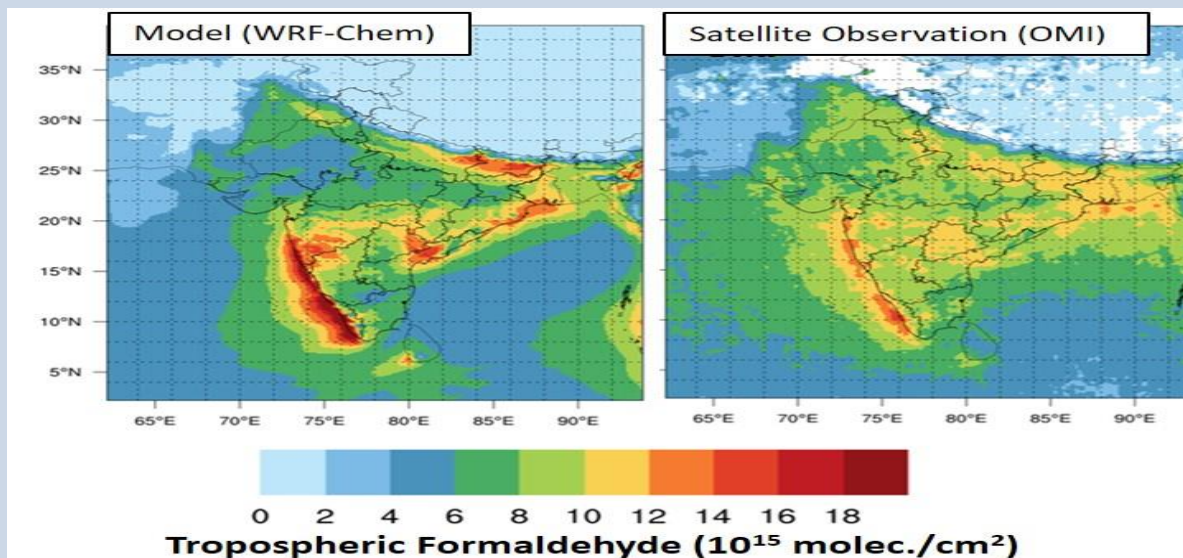


Figure 1: Spatial distribution of tropospheric column formaldehyde (HCHO) over the Indian subcontinent.

Gender Status in the Indian Physics Profession and the Way Forward

(Lekshmi Resmi, Prajval Shastri, Srubabati Goswami, Pragma Pandey, Vandana Nanal, Preeti Kharb, Urbasi Sinha, Tanusri Saha-Dasgupta, Suratna Das and Suchetana Chatterjee)

Gender inequality in India is a multifaceted issue that prevails in all walks of life like health, academics, economics, wages etc. A study was carried out and presented as a country paper in 6th International Conference on Women in Physics, in order to determine the gender status in physics profession in research Institutions and Central Universities of India. The study found that the percentage of women physicists in both types of institutions is low. In a representative sample of eight physics departments from universities and teaching institutions, it was found that on average, ~19% of tenured physics faculty in universities are women (23% without including elite teaching institutions), while in research institutions the corresponding percentage is only 11%. In the higher echelons of the profession, the gender gap is much larger, reflecting the trend in the natural sciences as a whole. There have been continuous efforts by various agencies to fill in this gender gap. In 2017, the Indian Physics Association constituted a national working group on gender in physics, with the mandate to (i) review the status of the profession from the point of view of gender parity, (ii) facilitate forums to deliberate on the issue, and (iii) find ways to address gender disparity. The Indian Physics Association working group aims to implement the resolutions of the IUPAP Women in Physics Working Group. It is heartening that some major plans have materialized in the last few years, still India needs to put in place a lot more policies to ensure gender equity in academics. <https://doi.org/10.1063/1.5110093>



Pragma Pandey

43cm telescope at Mount Abu Infrared Observatory

(Neelam J S S V Prasad, Ashirbad Nayak, Kevi Kumar Lad, Rishikesh Sharma, Kapil Kumar, Abhijit Chakraborty)



Figure 1: The complete telescope assembly of 43cm telescope, kept inside 12ft Astro-Heaven dome.

A PLANEWAVE CDK17, 43 cm primary aperture telescope is installed at Gurushikhar Observatory, Mount Abu, India. The telescope is a F/6.8 Corrected Dall-Kirkham Astrograph telescope with a field of view (FOV) of about 70mm without any field curvature, off-axis coma, or astigmatism. The primary mirror is made up of Fused Silica glass with EA coating which provides ~95% reflectivity. The telescope is mounted on PLANEWAVE ASCENSION 200HR mount, a German equatorial mount, controllable using ASCOM-compatible



Neelam JSSV Prasad

SiTech control software for PC. The RMS tracking error of telescope during calm conditions is typically 0.14" to 0.25". A finder scope is also attached to the telescope. We used the commercially available Iodestar-X2 for telescope auto guiding, which helps in longer exposures and continuous monitoring of sources. The auto guiding camera is attached with the finder telescope and provides tracking accuracy up to 1"/sec. We choose ANDOR ikon 2048X2048 pixels CCD (BEX2-DD) to be used as detector as it is highly efficient (>90%) in the visible range (400nm - 800nm). It provides us a wide field of view of ~33'X33" with a resolution of 0.7"/pixel.

A few of pre-confirmed exoplanetary systems in broad 'I' band is also observed to check the telescope photometric performance. The transit depths estimated on these systems are within the 1-sigma of the predetermined transit depths.

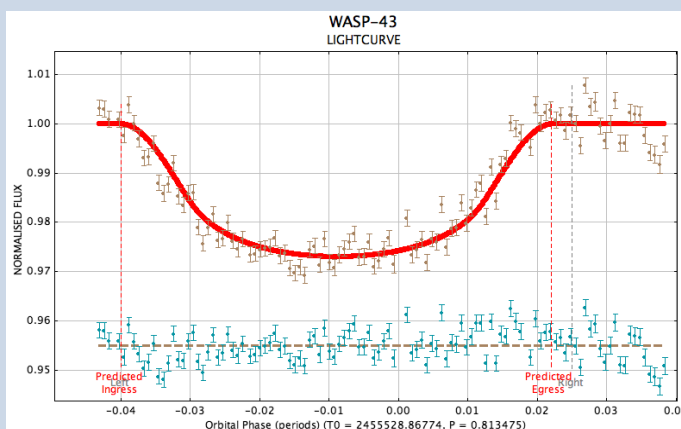
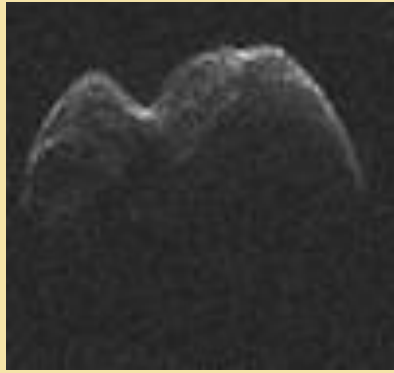


Figure-2: - The brown coloured data points are observed using 43 cm telescope with a cadence of 124.2s for WASP-43 system, while red coloured solid line is the best fit model. In below panel, teal coloured points are the residuals with typical RMS of the of ~1.3 mmag.

Time and phase resolved optical spectra of potentially hazardous asteroid 2014 JO25

(Kumar Venkataramani, Shashikiran Ganesh, Archita Rai, Marek Husarik, K.S. Baliyan and U.C. Joshi)

Asteroids are a class of minor bodies of the solar system which move in different orbits around the Sun. The asteroid “2014 JO25” is a potentially hazardous double-lobed near Earth asteroid belonging to the Hungaria family of asteroids. The asteroid was discovered in May 2014 by A.D. Grauer in the Catalina Sky Survey. The asteroid had a very close Earth flyby on 19th April 2017. At the closest point, the asteroid was within 4.6 lunar distance of Earth. During its close flyby on 19th and 20th April 2017, the asteroid was spectroscopically followed using the low resolution spectrograph LISA mounted on the 1.2 m telescope at Mount Abu Infrared Observatory.



Radar Image (Credits: NASA/JPL)



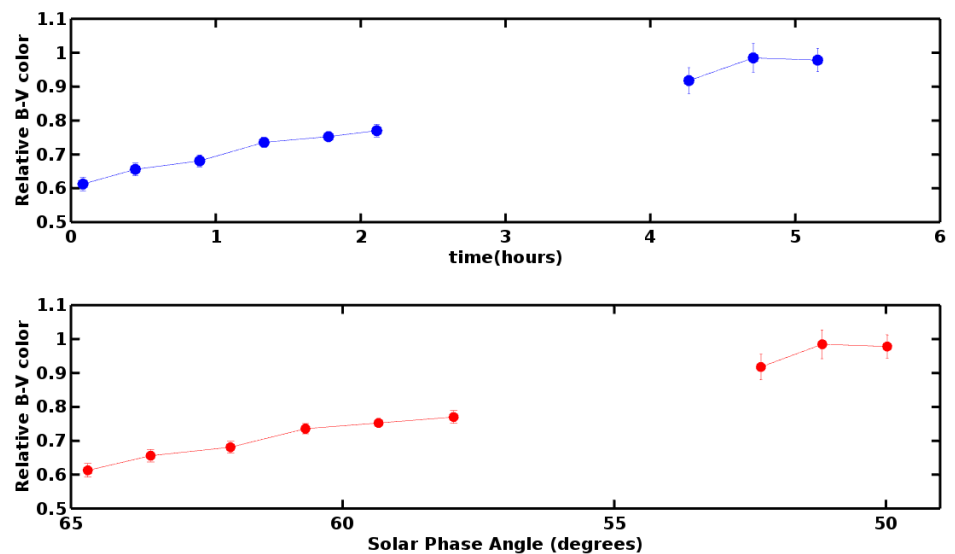
Kumar Venkataramani

Coming from a region close to the Hungaria population of asteroids, this asteroid follows a comet-like orbit with a relatively high inclination and large eccentricity. Hence, we carried out optical spectroscopic observations of the asteroid to look for comet-like molecular emissions or outbursts. However, the asteroid showed a featureless spectrum, devoid of any comet-like features.

The asteroid's light curve was analyzed using V band magnitudes derived from the spectra and the most likely solution for the rotation of the asteroid was obtained. The absolute magnitude ‘H’ and the slope parameter ‘G’ were determined for the asteroid

in V filter band using the IAU accepted standard two parameter H-G model. A peculiar, rarely found result from these observations is its phase bluing trend.

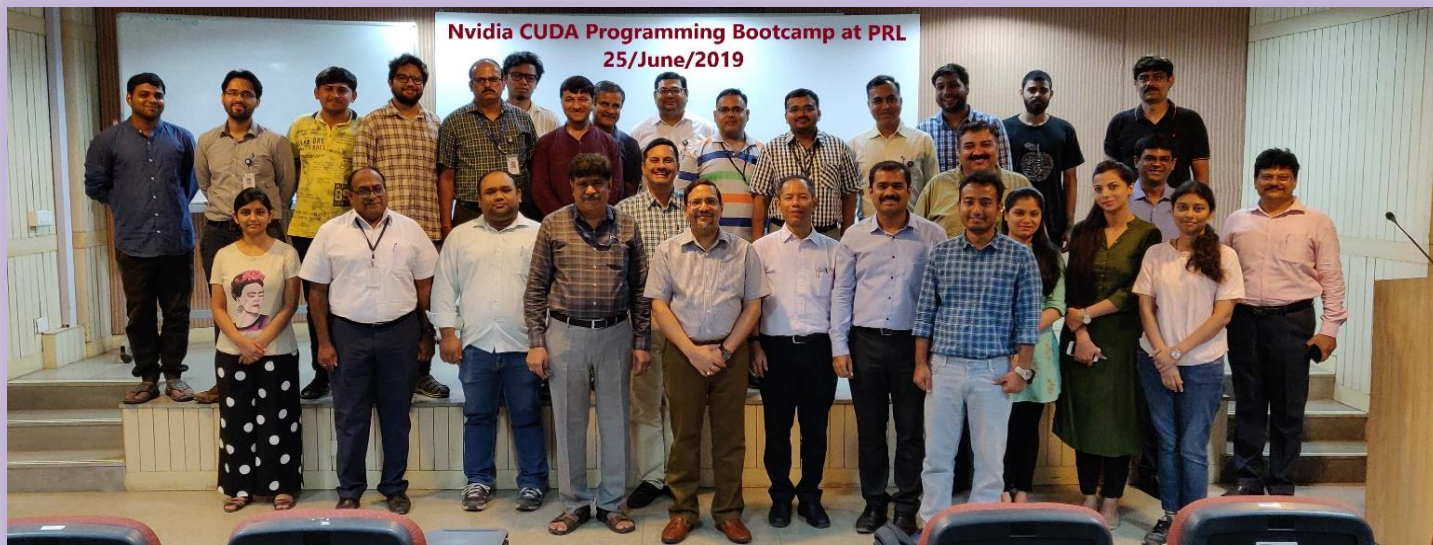
The relative B-V color index seems to decrease with increasing phase angle, which indicates a phase bluing trend. Such trends have seldom been reported in literature. However, phase reddening in asteroids is very common. The asymmetry parameter ‘g’ and the single scattering albedo ‘w’ were estimated for the asteroid by fitting the Hapke phase function to the observed data. The asteroid shows relatively large value for the single scattering albedo and a highly back scattering surface.



<https://doi.org/10.3847/1538-3881/ab0f26>

Figure Caption: The B-V color of the asteroid as a function of time (top panel) and solar phase angle (bottom panel). The asteroid seems to be more blue at higher phase angles.

One Day Training “Nvidia CUDA Programming Bootcamp” for PRL Users at Computer Centre



A one-day workshop on June 25, 2019, was organized by Computer Centre in coordination with M/s. NVIDIA Ltd. and M/s. Tata Consultancy Services. The main objective of the workshop was to encourage our users to use GPU and harness the compute power of GPU to run their applications more efficiently on our High-Performance Cluster – Vikram 100.

Dr. Anil Bhardwaj, Director, PRL inaugurated the workshop with his encouraging remarks. Mr. C.V.R.G. Deekshitulu, Registrar, PRL, mentioned the importance of capacity building through such workshops and training programs. Prof. Angom Dilip Kumar Singh welcomed all the speakers, participants and briefed about the workshop agenda.

During the training sessions, the users were informed about the parallel programming techniques and how to leverage the compute power of GPU using different programming techniques. The users also learnt through hands-on session about how to use OpenACC, compile the GPU code using Portland (PG) Compiler and run codes using GPU.

Visit of members of Akashmitra Mandal to USO/PRL



Akashmitra Mandal, Kalyan Mumbai, was formed in 1986 with the aim of popularizing astronomy in the country. They have been organizing Basic Astronomy Courses, Sky Watching Programmes, and Solar Eclipse tours for non-professionals. It was the first institute in India to organize a state level amateur astronomer's meet. In order to have better connectivity with amateur astronomers all over the nation, Akashmitra Mandal published a 'Directory of persons associated with Astronomy in India' in 1999. Apart from organizing programs focused on popularization of astronomy, the members have been carrying out observations of meteor showers, variable stars, double stars and have been sending their data to professional, international organizations, which include the International Meteor

Organization (IMO), the American Association of Variable Stars Observers (AAVSO), International Occultation Timing Association (IOTA), etc. A 6 member team of Akashmitra Mandal visited USO on 10th June 2019 and were given an overview of the research activities at the Observatory by Prof. Nandita Srivastava. The visitors were then given a tour of the MAST and SPAR telescope on the island, followed by the GONG and e-CALLISTO facilities in the office premises. Mr. Shishir Deshmukh and Mr. Ameya Deshpande gave a presentation titled "Stellar Occultation by Asteroids" and also described their portable hardware which is necessary for their observing campaigns. Mr. Prabhakar Gokhale presented USO with a book titled “Astronomy of Eclipses” written by Hemant Mone and Shishir Deshmukh, as a token of their appreciation.

Solar Physics Summer School in Leh



The Indian Institute of Astrophysics (IIA), Bangalore organized an International summer school on Solar Physics from 10 – 16 June 2019 at the Raman Science Center in Leh, Jammu and Kashmir. Two PhD students from Udaipur Solar Observatory, Kamlesh Bora and Suvadip Sinha, participated in the summer school. The six-day programme covered key aspects of Solar Physics, such as, Solar dynamo, Spectro-polarimetry, MHD waves, Coronal heating, Solar Wind, etc. Around 35 students from all over the world participated in this school. The main goal of this school was to train PhD students with advanced theoretical and observational techniques which would help in enhancing the scientific outcome of various, existing and upcoming, observational solar facilities in the world.

Workshop on awareness regarding the Rajbhasha Hindi



A Workshop regarding “Hindi Implementation and Incentive Schemes” was conducted in PRL on 24th June 2019 wherein the employees were informed about different Rajbhasha Rules and the different Incentive Schemes for doing official work in Hindi or for any creative writing apart from competitions being held throughout the year. The duties and responsibilities of staff members working in different positions in Central Government Offices were clearly outlined. There was also a presentation on the usage of different software, tools and techniques, which can be used to work easily in Hindi. The workshop aims at bringing a positive change towards the usage of Raj bhasha in all official purposes. The participants were also awarded with certificates at the end of the program.

Optical Spectroscopic Studies of Minor Bodies of the Solar System

The minor bodies in the solar system comprise of asteroids, comets, trans-Neptunian objects, dwarf planets, planetary satellites, the Trojans of the giant planets, Centaurs and Kuiper belt objects. Comets carry a significant amount of pristine material from the early solar system and are relatively bright objects which can be observed and studied using even one-meter class telescopes. Therefore, this thesis work has focused on studying comets and near-Earth asteroids on comet like orbits. Optical spectroscopic studies of these objects have been carried out using the 0.5 m and 1.2 m telescopes at the Mount Abu Infra-red Observatory with an aim of contributing towards answering some of the questions in cometary and solar-system science.



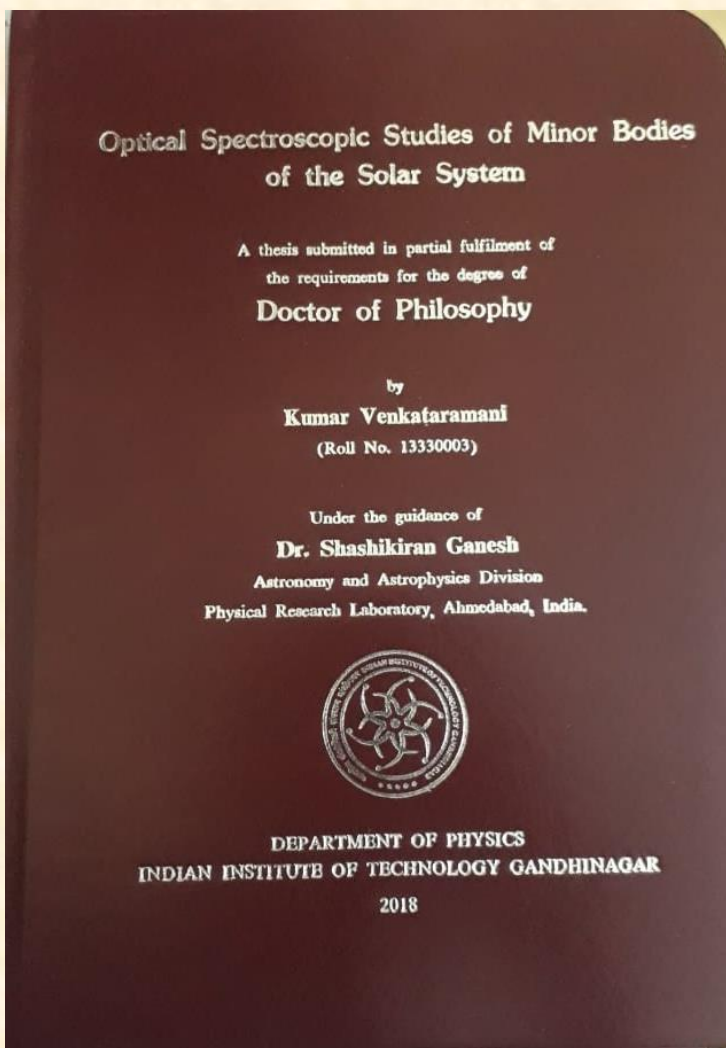
Kumar Venkataramani

A plethora of emission lines are seen in the optical spectrum of a comet. These arise due to the fluorescence excitation of the various molecular and ionic species of the gases present in comet's coma. In this work, we have monitored the activity in different comets by spectroscopically observing them at various heliocentric distances.

The low-resolution spectrograph LISA has been used to obtain the optical spectrum of different comets and asteroids. The optical spectrum of long period comets: C/2014 Q2 (Lovejoy), C/2013 US10 (Panstarrs), C/2013 X1 (Panstarrs), C/2015 V2 (Johnson) and two short period comets: 41P/Tuttle–Giacobini–Kresák and 45P/Honda–Mrkos–Pajdušáková were obtained at different epochs. The production rates, production rate ratios, dust production and dust to gas ratio was estimated for these comets and its trend with the heliocentric distance were studied. The comets 41P and C/2015 V2 have also been imaged using the Hale-Bopp Narrow band filters. Comet C/2016 R2 showed an unusual spectrum, quite different from the general cometary spectra. An in-depth analysis of the optical spectrum of this comet has been carried out. First comet observations with the Hanle Echelle Spectrograph at the 2m Himalayan Chandra Telescope were done during the course of this work.

The near Earth asteroid 2014 JO25 was spectroscopically followed during its close flyby of Earth in April 2017. A significant range of phase angle was covered during the observations of this asteroid. Results from these observations have also been discussed.

Most of the observations have been carried out using smaller class of telescopes and a small spectrograph. This demonstrates and exemplifies the importance of small telescopes and ground based observations of minor bodies of the solar system.'



Colloquia @ PRL:

- ✚ **Sivarani Thirupathi** (Associate Professor, Indian Institute of Astrophysics (IIA), Bangalore) delivered a colloquium entitled “*Thirty-meter telescope (TMT): An overview of the science and instrumentation program*” on 11th June 2019.

Monsoon & Health

The Monsoon is a very pleasant and cheerful season. As much beautiful it is, it also makes our neighborhood a wet or damp place which surely welcomes lots of mosquitoes and flies. These insects are the prime agents for most of the monsoonal diseases. But this season could be enjoyed and it can be relaxing if certain preventions and precautions are taken.



Shital Patel

They are:

(1) Follow a healthy diet:

- Because of the cool temperature you might be tempted to a lot of spicy and hot food.
- Avoid food from hawkers or street vendors as Jaundice, cholera, typhoid, gastroenteritis etc. are mainly spread by the unhygienic conditions of food.
- Eat good nutritious food from home, which is cooked properly with proper hygiene.
- Take plenty of fluids
- You can take lot of herbs like tulsi, ginger etc. which keeps digestive & respiratory system healthy.

(2) Avoid walking in the rain:

- Some people easily get infected with viral disease, skin diseases in this season particularly extreme age, diabetes and severely ill patients.
- If you previously had any allergies or if your doctor advises you otherwise then also avoid rain and dampy surroundings.

(3) At Home:

- There may be breeding sites for fungal growth at home, so clean and wipe the walls and floors of the house properly.

(4) Outside Home:

- To prevent mosquito growth, be careful about water collection which may be in flower pots, unused vessels, tyres, rubber tubes or unsealed gutters.
- Try to evaluate such places or at least put kerosene drops. It will prevent mosquito breeding. We can save ourselves from Malaria, Dengue, Chikungunya etc. and other mosquito transmitted diseases.
- Slippery roads can cause road traffic accidents , avoid over-speeding and rough driving.

(5) Personal Hygiene:

- Bath twice a day to prevent fungal infection.
- Don't touch eyes frequently because it will invite conjunctivitis.
- Proper cough hygiene to prevent viral spread to other people.
- Proper disposal of household waste otherwise it will invite houseflies that spread the diseases.
- Wash hands with soap and water after using toilet to prevent spread of diseases like Typhoid, Cholera, Jaundice etc.

Prevention from diseases spreading through mosquitoes: -

- Use full sleeve clothes.
- Use insecticide treated mosquito net over the bed.
- Keep mosquito repellent on.

International Day of Yoga - 2019

PRL joined the 5th International Yoga Day celebrations on 21st June 2019. It was celebrated enthusiastically at all the centres of PRL viz., Ahmedabad, Mount-Abu Observatory and the Udaipur Solar Observatory. External experts in Yoga visited PRL to guide the PRL fraternity towards the correct and the best practices in Yoga. The art of Yoga was explained as an ancient science from India that integrates the three vital aspects of our existence, viz., Body, Mind and Spirit. It was outlined that Yoga is even more relevant in the current world because of the highly stressful lives, fast-paced world and all the unhealthy eating habits and lifestyle of the human generation today. Yoga brings peace.

Yoga fills the body with vital energy and positivity. Yoga makes one realise the inner self.

The day's celebrations were joined in large numbers by the staff members and the students of PRL. Various stretching positions, *Aasanas*, *Pranayams* and the practice of *Dhyana* were demonstrated by the experts which were performed by PRLites in a highly enthusiastic manner. It was evident that everybody enjoyed the session. Here are some glimpses of the celebrations.



PRL Volleyball Tournament 2019



Every year the whole of PRL comes together and fights their way to be the “Volleyball Champions of PRL”. This year, amidst the World Cup of Cricket and the irregular rainfall at Ahmedabad, the volleyball tournament was a grand success. There were 8 teams in total, shedding sweat and blood on the court, to sit on top of the points table and be anointed as Champions. The games carried a certain speck of mystery in them throughout the tournament, with surprising victories and other not so surprising knockouts, some unexpected injuries (thankfully not fatal), it was a “*tour de force*”.

The matches saw the audience joining in large numbers and displayed their talents in cheering and there was a tough competition outside the court too – who cheers the best!

The players had their excitement and energy filled to the brim and displayed phenomenal heart in all the games. Most of the games were anything but obvious, with each team devising strategies to defeat the other, not giving any straight-set victories to the opponent.

The final was a nail-biting one, with the Astronomy and Astrophysics team standing victorious. Atomic, Molecular and Optical Physics team was the runner-up and the Geosciences team grabbed the 3rd position in the tournament. A lot of hands behind the screen worked tirelessly for the success of this event without whom, it'd have remained as just an idea. Some cheers were heard to the stars and back, so was the encouragement offered by the audience without which this would have felt more official, but now it felt like a festival.





Bijaya Sahoo



Partha Konar



A. Shivam



Deekshya Sarkar



Prashant Jangid



Som Sharma



Garima Arora



Rohan Louis



Pragya Pandey



Neeraj Srivastava



Vivek Mishra



Kartik Patel



Veeresh Singh

