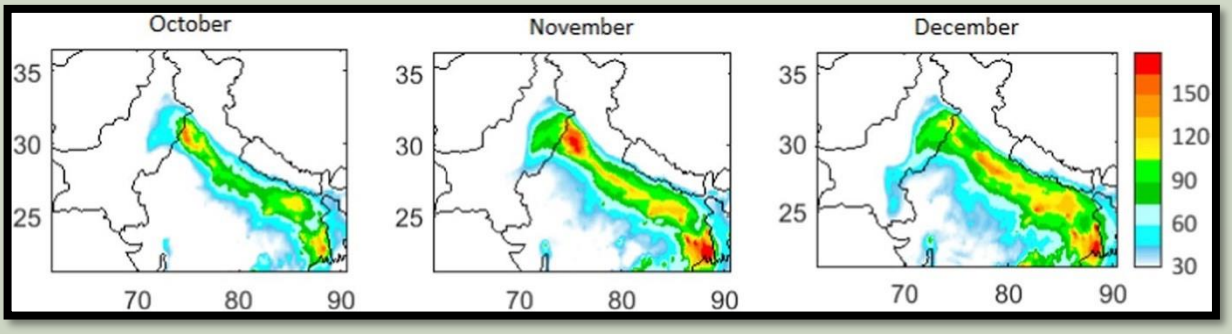
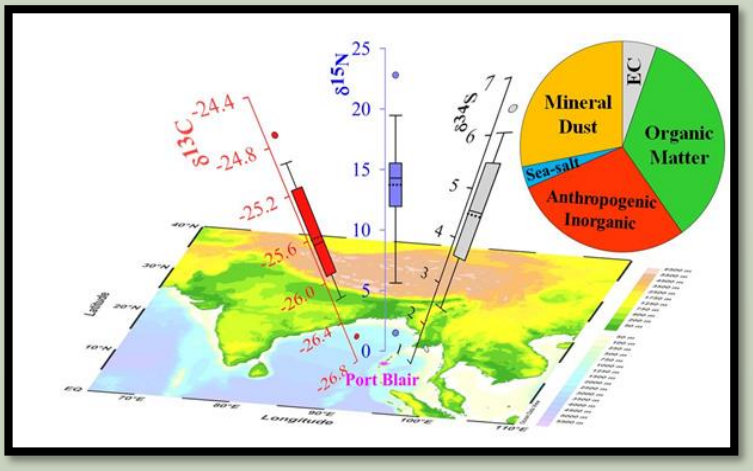
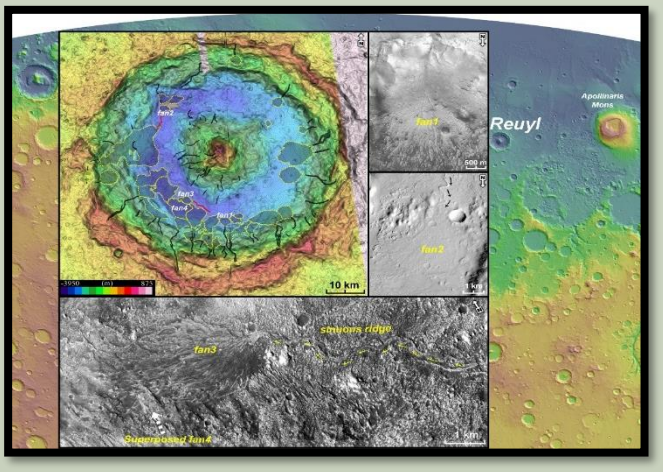
PRL NEWS – THE SPECTRUM

JUNE 2020







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Widespread enhancement in fine particulate matter over Indo-Gangetic Plain towards winter

(N. Ojha, A. Sharma, M. Kumar, I. Girach, T. U. Ansari, S. K. Sharma, N. Singh, A. Pozzer, S. S. Gunthe)

Narendra Ojha

Fine particulate matter ($PM_{2.5}$, aerodynamic diameter ≤2.5 µm) influences the visibility, climate, and air quality. The Indo-Gangetic Plain (IGP) region, home to about one-seventh of the world's population, experiences strongly enhanced $PM_{2.5}$ pollution every winter. We performed high-resolution chemical transport modelling to unravel the role of dynamics and regional emissions over this region. Model, in agreement with measurements, shows that the $PM_{2.5}$ distribution having patches of enhanced concentrations (≥100 µgm^{-3}) during post-monsoon, evolves dramatically into widespread enhancement across IGP during winter (Figure 1). Sensitivity simulation and satellite-based measurements revealed a dominant role of biomass-burning over northwest IGP during post-monsoon. Whereas, in contrast, towards winter, a large-scale decline in temperature, shallow atmospheric boundary layer, and weaker winds drastically reduced ventilation confining anthropogenic influences near the surface. These changes in the controlling processes from post-monsoon to winter profoundly affected the chemical composition of aerosols. The study highlights a west-east gradient in terms of sources, with western IGP dominated by biomass-burning and eastern IGP dominated by anthropogenic sources in post-monsoon; this gradient weakens in winter when entire IGP is dominated by anthropogenic sources. We argue that a generic emission reduction policy will not yield desired results, and advocate for a season-based source-focused policy taking unfavourable atmospheric dynamics into account, to minimize the air quality and climate impacts.

https://www.nature.com/articles/s41598-020-62710-8

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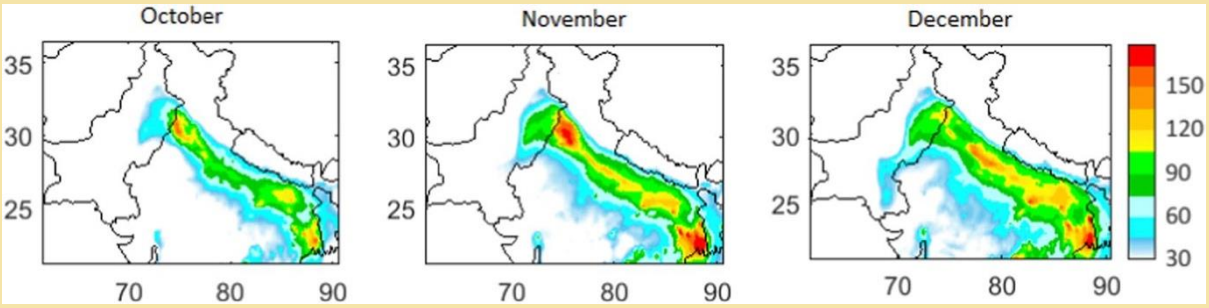


Figure: *Mean distribution of PM2.5 (µgm−3) over the northern Indian region during October, November, and December 2016, as simulated by the WRF-Chem model.*

Chemical and isotopic characteristics of PM10 over the Bay of Bengal: Effects of continental outflow on a marine environment

(Neeraj Rastogi, Rajesh Agnihotri, Ravi Sawlani, Anil Patel, S. Suresh Babu, Rangu Satish)

Neeraj Rastogi

Pollutants transport from South and Southeast Asia can profoundly affect the marine atmospheric boundary layer (MABL) over the Bay of Bengal (BoB). This study presents chemical and stable isotopic composition of PM_{10} collected at Port Blair Island (11.6°N, 92.7°E) located in the middle of the BoB during the late northeast monsoon (February–April), a period when the BoB receives considerable continental outflow. The dominance of continental inputs over a marine realm was evident by a significant amount of nss-SO_4^{2-} (range: 1.8 to 16.9 µg m^{-3}), which accounts for ~65% of the total water-soluble inorganic constituents. The impact of anthropogenic emissions was further evident from the widespread depletion of chloride (range: 57-100 %, avg: 98±7%) from sea-salt aerosols. Carbonaceous species (elemental carbon and organic matter) contributed nearly 35% to PM_{10}. Further, average $\delta^{13}C$ (-25.6‰ ± 0.5) and $\delta^{34}S$ (4.5‰ ± 1.3) values observed over the marine study region were similar to those found in typical urban environments. $\delta^{15}N$ values (13.7‰ ± 5.1) show the significant presence of combustion sources along with the effect of atmospheric processing. Aerosol $\delta^{13}C$ values correlate positively with the ratio of water-soluble organic carbon to total organic carbon, indicating the aging of organic aerosols during the transport. In aggregate, this study provides newer insights into sources of carbonaceous species and their chemical processing in MABL of BoB.

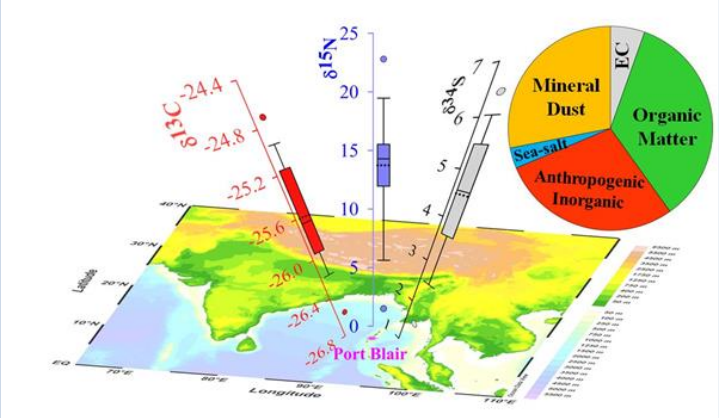
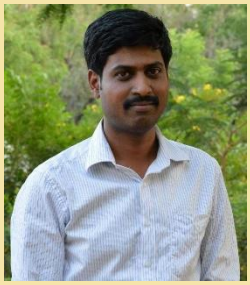


Figure: *Average chemical and isotopic composition of ambient PM10 over the Bay of Bengal*

https://doi.org/10.1016/j.scitotenv.2020.138438

Evidence for Multiple Superposed Fluvial Deposits Within Reuyl Crater, Mars

(S. Vijayan, Rishitosh K. Sinha, Harish and Ritu Anilkumar)



Vijayan S

On Mars, channels and their associated fan deposits within craters brings the consensus of opinion that they are the supportive evidence for the fluvial related activities underwent. These intracrater deposits vary from crater-to-crater; however, until now, the presence of superposed or crosscutting fan deposits are rare and requires dedicated studies. Consolidating evidence on fluvial activities and superimposed fan deposits within craters are of immense importance to better understand the fluvial history, their spatial extents, and their likely episodic nature. In this study, we report Reuyl crater, an Early Hesperian old crater, which hosts diverse deposits, and they are associated with fluvial related activities. Reuyl interior hosts alluvial fans, channels, sinuous ridges, coalesced fan deposits, stacked deposits, deposits within incised channels, toes of fans superimposed each other and bajada like deposits. In addition to this, the Reuyl floor hosts two remarkable sinuous ridges associated with an alluvial fan on different parts of the floor, which is remarkable evidence for surficial fluvial activity within the crater. Our observations suggest that precipitation/snowmelt derived runoff could be the possible source. Overall, Reuyl crater substantiates one more evidence for post-Noachian fluvial related activity on Mars.

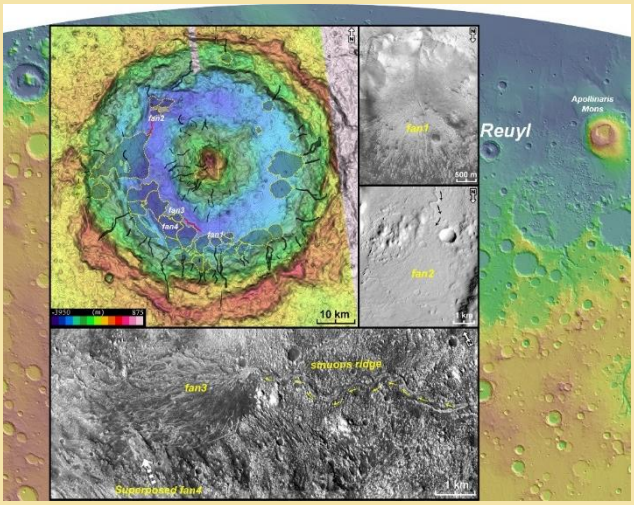


Figure: *Background Mars image shows the location of Reuyl crater. This crater hosts several individual/superposed fan deposits and prominent sinuous ridge associated alluvial fans on its floor.*

https://doi.org/10.1029/2019JE006136

Craters in the vicinity of Valles Marineris region, Mars: Chronological implications to the graben and pits activities

(Harish and S. Vijayan)

Harish

Valles Marineris (VM) on the surface of Mars is one of the longest and widest spatial features in our solar system, which is ~4000 km long, ~300 km wide, and ~10 km deep. The formation period of VM ranges from ~200 million to billions of years during the early history of Mars. However, there are no detailed study to decipher their recent activities. The periphery of the VM region is dominated by graben and pits, which is used in our study to infer the recent development in its surrounding region. In this regard, we scouted craters located within ~100 km boundary of VM and found 1516 craters. Only those craters which exhibit a clear association with graben and pits and have discernible ejecta were selected for our study.

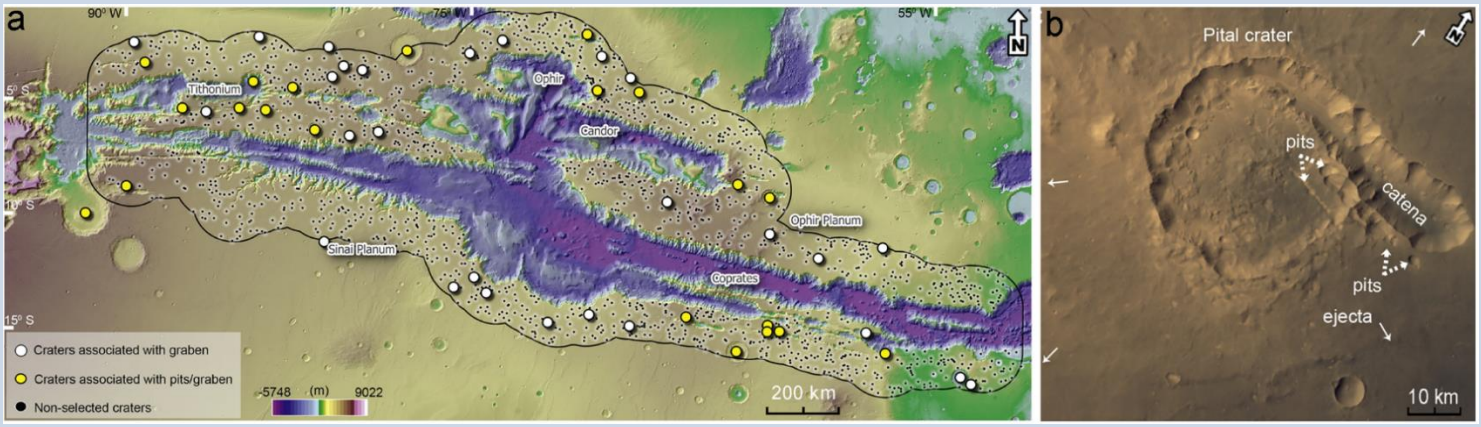


Figure: *a) Color shaded-relief map derived from MOLA topography (20°S to 0°N) of the Valles Marineris region, and distribution of 1516 craters within ~100 km vicinity. b) Pital crater with superposed pits, pit*

Craters selected in this study provide evidence for: 1) graben formation on the crater floor after 3.7Ga, 2) one of the longest pit formed on or post 1.14 Ga, which is much younger than what is generally presumed. This study reveals that the VM modification occurred till that last ~1 billion year, which is a record of large scale internal activity on the surface of Mars.

https://doi.org/10.1016/j.icarus.2020.113704

Emissions and atmospheric concentrations of *α*-pinene at an urban site of India: Role of changes in meteorology

(*Nidhi Tripathi and Lokesh Kumar Sahu)*

Nidhi Tripathi

Global vegetation plays a crucial role in biosphere-atmosphere interactions and impacts the sink and source processes of important trace gases. Particularly in developing countries of the tropics, the increasing frequency of heat and drought and extreme rainfall events will have impacts on emission rates of biogenic-volatile organic compounds (BVOC). In the urban region, the elevated concentrations of BVOCs such as isoprene and monoterpenes can have significant implications on regional atmospheric chemistry related to the formation of ozone and SOA. However, the role of urban vegetation on the regulation of ozone concentrations is a complex issue influenced by compound-specific emission rates of BVOCs and ozone deposition rates, both highly modified by the physiological status of the tree. Monoterpenes are important BVOCs and have significant effects on atmospheric chemistry and climate as precursors of ozone and secondary organic aerosol (SOA). The measurements of a monoterpene (*α*-pinene) were performed by the high time- and mass- resolution Proton Transfer Reaction-Time of Flight-Mass Spectrometer (PTR-TOF-MS) instrument at

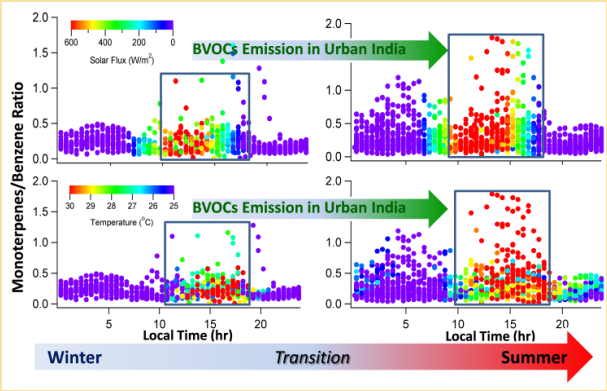


Figure 1: *Diurnal pattern of α-pinene/benzene ratio indicating dependence of biogenic emissions to solar radiation flux and atmospheric temperature during the transition from winter to summer conditions at a semi-arid urban site of India.*

Figure 2: *Measurements of monoterpenes (α-pinene) and other VOCs using high mass- and time- resolution PTR-TOF-MS instrument at PRL, Ahmedabad.*

an urban site (Ahmedabad) of India from mid-January to March (winter-to-summer transition period) of the year 2014. We estimated that the anthropogenic contribution of monoterpenes are dominant during the winter season but biogenic contributions of monoterpene increased by ~53% due to the transition in meteorological conditions from the second-half of January to second-half of March. Our results elucidate the response of monoterpene emissions to the change of weather conditions. Our analysis suggests that the combined effect of the northwest wind flow and higher air temperatures in March favored the emissions of BVOCs from local vegetation. The emissions of BVOCs from plants and trees depend on both biotic stress and environmental conditions. This is the first study reporting the change in monoterpenes during winter-summer transition over India.
(https://doi.org/10.1016/j.chemosphere.2020.127071)

A study of the altitudinal variation of solar coronal rotation

(Jaidev Sharma, Brajesh Kumar, Anil K. Malik, and Hari Om Vats)

Brajesh Kumar

We report on the variability of rotation periods of solar coronal layers with respect to temperature (or, height). For this purpose, we have used observations from Atmospheric Imaging Assembly (AIA) telescope on board Solar Dynamics Observatory (SDO) space mission. The images used are at the wavelengths: 94, 131, 171, 193, 211, and 335 Angstroms during the period from 2012 to 2018. Analysis of solar full-disk images obtained at these wavelengths by AIA is carried out using flux modulation method. Rectangular strips/bins at equal interval of 10 degrees (extending from 80°S to 80°N) are selected to extract a time series of extreme ultraviolet (EUV) intensity variations to obtain autocorrelation coefficient. The peak of Gaussian fit to first secondary maxima in the autocorrelogram gives synodic rotation period. Our analysis shows the differential rotation with respect to latitude as well as temperature (or, height). In this study, we find that the sidereal rotation periods of different coronal layers decrease with increasing temperature (or, height). Average sidereal rotation period at the lowest temperature (~600000 Kelvin) corresponding to AIA-171 Angstrom which originates from the upper transition region/quiet corona is 27.03 days. The sidereal rotation period decreases with temperature (or, height) to 25.47 days at the higher temperature (~ 10 million Kelvin) corresponding to the flaring regions of solar corona as seen in AIA-131 Angstrom observations. Earlier studies employing global helioseismology have reported a considerable decreasing trend of average rotation rate from the interior of the Sun outward to the photosphere. It is to be noted that in this case the temperature decreases from the solar interior on moving upward in the photosphere. Thus, it appears that the rotation of the solar interior and its atmosphere are linked to show a similar variation with temperature.

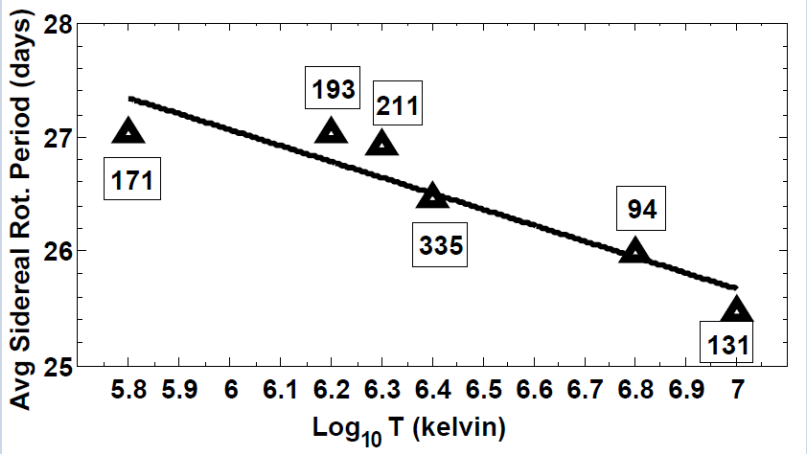


Figure. *The plot shows the overall trend (averaged over the period 2012-2018) in sidereal rotation period (days) with respect to temperature (or, height) in the solar atmosphere.*

https://doi.org/10.1093/mnras/staa188

On the Spontaneous Generation of Three-dimensional Magnetic Nulls

(Sushree S Nayak, R Bhattacharyya, P K Smolarkiewicz, S Kumar, A Prasad)

Sushree S Nayak

Magnetic null points, or the points where magnetic field vanishes, are important as they are locations of magnetic reconnections at Sun's atmosphere, resulting various solar transients. Although contemporary research recognizes their importance, still the genesis of the nulls is not well explored. Here we report results of two different numerical simulations establishing nulls as self-organized states getting spontaneously generated by repeated reconnections. The simulations are carried out using the EULAG-MHD numerical model and employing three-dimensional Cartesian geometry. In the first approach, we have deformed one potential 3D null point with a sinusoidal flow. Using this deformed field as initial state, the plasma is then relaxed with the dissipation of magnetic and kinetic energies via reconnection and viscous dissipation. Consequently, a current carrying null (non-potential) is generated at the the end of the evolution. Secondly, we have used a modified Arnold-Beltrami-Childress (ABC) magnetic field as the initial state, which is a combination of sine and cosine functions, yet satisfying the solenoidality. The uniqueness of this ABC field lies in its formulation as it has chaotic nature, a non-zero Lorentz force and importantly no null points within the computational volume. The Lorentz force helps in driving the magnetofluid from the initial state. Interestingly, like the first case, multiple 3D nulls are generated here at the end of the relaxation process. Three snapshots are shown in the Fig.-1 depicting the whole relaxation process of the modified ABC field. The nulls being ordered structures, their generation from chaos is an example of self-organization and indicate nulls to be ubiquitous in the solar corona. All these simulations are performed using Vikram-100 HPC facility at PRL.

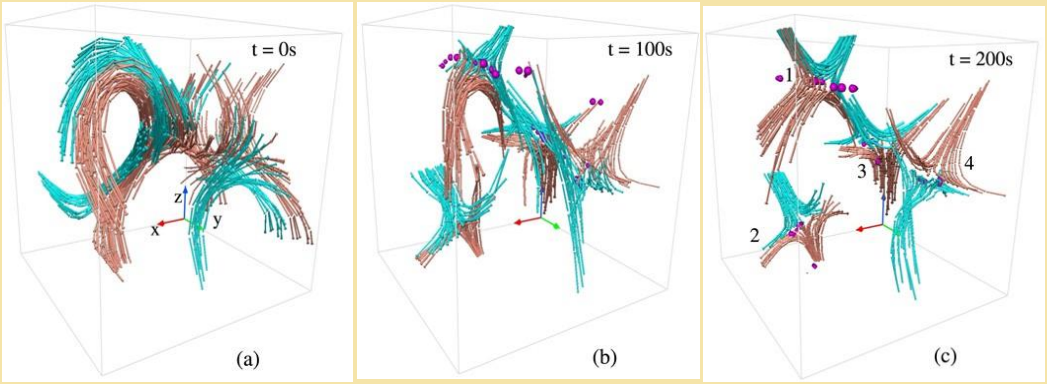
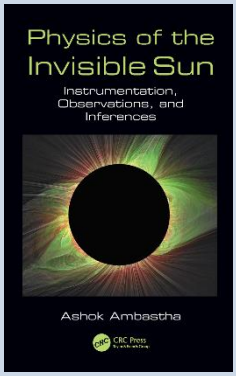


Figure: *The chaotic magnetic field lines in cyan and peach color in panel (a) represent the initial state without any 3D magnetic null. The panels (b) and (c) represent the spontaneous development of 3D magnetic nulls from the chaotic field as self-organized states when the system relaxes towards a quasi-steady state at t =200s. The null points are marked as 1,2,3 and 4 in panel (c). The low magnetic field strength near the null point is highlighted by pink color* isovalue.

https://iopscience.iop.org/article/10.3847/1538-4357/ab75bb

Book Publication

Physics of the invisible Sun: Instrumentation, Observations and Inferences



A new book titled "Physics of the invisible Sun: Instrumentation, Observations and Inferences" by Prof. Ashok Ambastha was published on 27 March 2020 under the auspices of CRC Press (Taylor & Francis Group), USA. This book serves as a reference book for scientific researchers interested in multi-wavelength instrumentation and observational aspects of solar physics. It may also be used as a textbook for a graduate-level course.

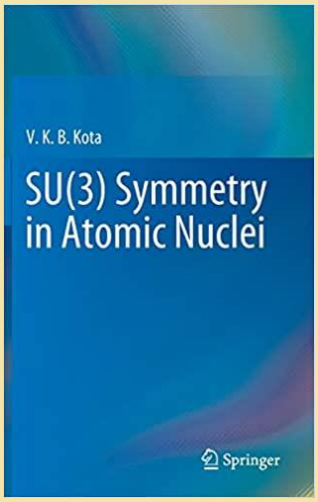
Ashok Ambastha

Book Publication

SU(3) Symmetry in Atomic Nuclei

V.K.B. Kota

This book provides an understandable review of SU(3) representations, SU(3) Wigner–Racah algebra and the SU(3) ⊃ SO(3) integrity basis operators, which are often considered to be difficult and are avoided by most nuclear physicists. Explaining group algebras that apply to specific physical systems and discussing their physical applications, the book is a useful resource for researchers in nuclear physics. At the same time it helps experimentalists to interpret data on rotational nuclei by using SU(3) symmetry that appears in a variety of nuclear models, such as the shell model, pseudo-SU(3) model, proxy-SU(3) model, symplectic Sp(6, R) model, various interacting boson models, various interacting boson–fermion models, and cluster models. In addition to presenting the results from all these models, the book also describes a variety of statistical results that follow from the SU(3) symmetry.



Outreach

Outreach Activity at Jawahar Navodaya Vidyalaya, Mavli, Udaipur, on 3rd March 2020

On 3rd March 2020, a one-day science outreach activity was organized by Udaipur Solar Observatory (USO) at Jawahar Navodaya Vidyalaya (JNV), Mavli, Udaipur, to commemorate National Science Day (NSD), with “Women in Science” being the theme of the year 2020. The JNV School, Mavli is managed by the Ministry of HRD, Govt. of India, and is located in a rural area about 45 km away from Udaipur city. There were about 540 students (girls and boys) from Class VI to Class XI and 25 teachers of the JNV School who participated in this event.

The programme began with the welcome speech of the Principal of the School and the inaugural address by Dr. Brajesh Kumar. The forenoon session consisted of the following talks by the USO team.

Ms. Sushree Sangeeta Nayak spoke on Importance of celebrating NSD and IDWGS & Women In Science. An introduction to The Sun & Research @ USO was given by **Dr. Rohan Louis**. This was followed by a presentation on Solar Activity & Space Weather by **Dr. Girjesh Gupta**. **Ms. Bireddy Ramya** highlighted the role of Engineering in Science. Concluding remarks on Career Prospects in Science were given by **Dr. Brajesh Kumar.**

Roles/Activities by PRL members

Essay Competition Evaluation

Nandita Srivastava, was invited as a judge for an Essay Competition on the topic: "Challenges to Women in Career Building in Science". This competition was organised by the Physics Department for the Post-Graduate students in Science stream of the Mohan Lal Sukhadia University on the occasion of Women's Day on 8 March 2020. Three best essays were selected for a prize.

Vigyan Samiti Visit to USO

A 30-member group from **Vigyan Samiti**, Udaipur visited the MAST and SPAR facility of USO on 13th March 2020. Vigyan Samiti is a voluntary organization founded in 1959 in Kelwa village, Rajsamand district, Rajasthan under the inspiration of the then Prime Minister of India Pundit Jawaharlal Nehru. Its primary mission is to spread the knowledge of science amongst the common masses and contribute to societal development. Vigyan Samiti has shared effective, exemplary, and influential partnership in various programs of the State Government including Tribal Welfare, Science & Technology, Agriculture & Horticulture, Women & Child Development, Agriculture Universities, Rajasthan Livelihood Mission, etc. and has risen to pre-eminence due to the dedicated and selfless service offered by its technical experts, and able administrators from different fields and disciplines.

Vidya Bhawan Polytechnic College Visit to USO

A group of 25 students accompanied by 5 faculty members from the Electronics Department of Vidya Bhawan Polytechnic College visited USO on 6th March 2020. **Ms. Kamlesh Bohra** gave an introductory talk on the Sun and **Prof. Nandita Srivastava** briefed the visitors on the research activities at USO. The students were also given a tour of the e-Callisto facility on the office premises by **Mr. Kushagra Upadhyay**.

Seminar by Prof. R. P. Sharma

Prof. R. P. Sharma of the Centre of Energy Studies (CES), IIT Delhi visited USO on 6th March 2020. Prof. Sharma has been a part of CES since 1977 and served as the Head of the Division from 2010 to 2014. He is a recipient of several prestigious fellowships including the Alexander von Humboldt fellowship, NASA senior fellowship at Godard Space Flight Centre (GSFC), Max Planck fellowship, and the European Commission fellowship. Prof. Sharma specializes in laser plasma interaction and its applications and has collaborated with Noble Laureate **Prof. Donna Strickland**. During his visit at USO, he was shown the island Observatory and interacted with the students. The title of his talk was 'Nonlinear Waves and Turbulence in the Solar Atmosphere'.

Events and Activities

Badminton Tournament by the USO SWC

The Staff Welfare Committee of USO organized a Badminton Tournament on Sunday 8th March 2020 at the Vaikunth Sports Academy. The event witnessed a tough, energetic, and enthusiastic performance from all participants. There were a total of 5 events amongst the 16 participants and the results were as follows:

	Winner	Runner-up
Women's Singles	Ms. Sushree Nayak	Dr. Hema
Junior's Singles	Mstr. Shaun Louis	Mstr. Revant Ankala
Women's & Junior's Mixed Double	Mstr. Revant Ankala & Dr. Hema	Mstr. Dev Saradava & Ms. Sushree Nayak
Men's Singles	Mr. Mukesh Saradava	Dr. Rohan Louis
Men's Doubles	Mr. Satyam Agarwal & Dr. Rohan Louis	Mr. Hirdesh Kumar & Dr. Raja Bayanna

Awards & Honours

- **Dr. Gautam Samanta**, Associate Professor, Atomic and Molecular & Optical Physics Division, PRL has been invited to be a member of the Advisory Panel of the Journal of Optics, IOP.

PRL Congratulates colleagues conferred with awards and honours

Farewell

Prof. Subhendra Mohanty, Senior Professor H Grade, Theoretical Physics Division

Mr. Raju Koshy, Senior Admin. Officer, Udaipur Solar Observatory

Mr. P K Sivadasan, Senior Purchase & Store Officer, Purchase Section

PRL family bids farewell to the staff and thank them for their exemplary services to PRL. Many good wishes for a happy and healthy superannuated life ahead.