



MONTHLY NEWSLETTER OF THE PHYSICAL RESEARCH LABORATORY

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Strong-field ionization of polyatomic molecules: Ultrafast H atom migration and bond formation in photo dissociation of CH₃OH

Rituparna Das, Deepak K. Pandey, Vinitha Nimma, Madhusudhan P, Pranav Bhardwaj, Pooja Chandravanshi, Muhammed Shameem K M, Dheeraj K. Singh, and Rajesh K Kushawaha



Rituparna Das

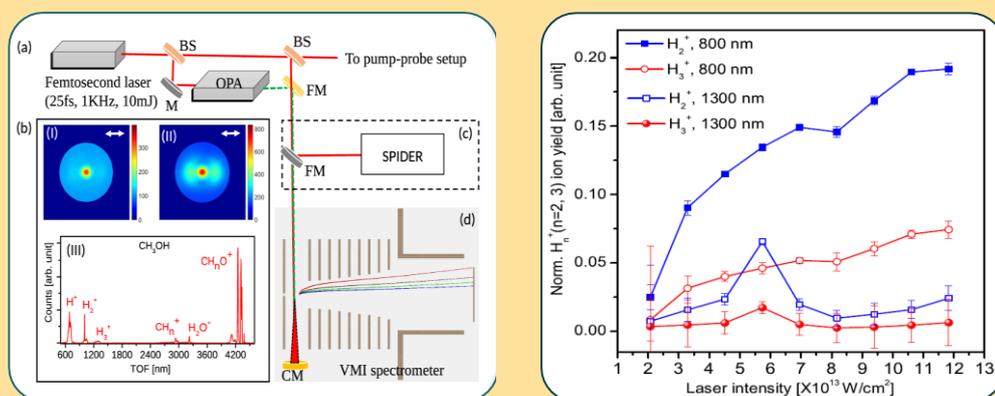


Figure: (left) (a) Schematic diagram of the experimental setup. (b) (I) and (II) show the H_n^+ ($n=1, 2, 3$) ions' VMI images for 800 nm, 29 fs and 195 fs pulses, respectively, (III) shows the time-of-flight (TOF) mass spectrum recorded for methanol, (c) pulse characterization using SPIDER, and (d) multi-plate VMIS. (right) Normalised yield of H_2^+ and H_3^+ ions for 800 nm and 1300 nm pulses, plotted as a function of laser intensity.

Light-induced reactions are the first step of many chemical and biological processes like vision and photosynthesis. The timescale of such reactions is of the order of picoseconds to nanoseconds, so studying these ultrafast reactions in real-time requires the use of intense ultrashort lasers having tens of femtoseconds (fs) or shorter pulse duration. In this study, we have used 800 nm, 29 fs, 1 kHz pulses from a Ti:sapphire laser to study the photodissociation of gas-phase CH_3OH in a home-built Velocity Map Imaging Spectrometer (VMIS). Strong-field ionization of methanol with the laser pulses results in processes like excitation, ionization, bond-breaking, intramolecular H-atom migration, and bond association, prior to complete molecular fragmentation. Our study focused on the intramolecular H-atom migration in methanol, leading to the formation of H_{n+} ($n=1-3$) ions, and controlling the yield of the H_n^+ ions using different laser parameters like intensity, pulse duration, wavelength, and polarization. We have confirmed the H_2^+ and H_3^+ formation

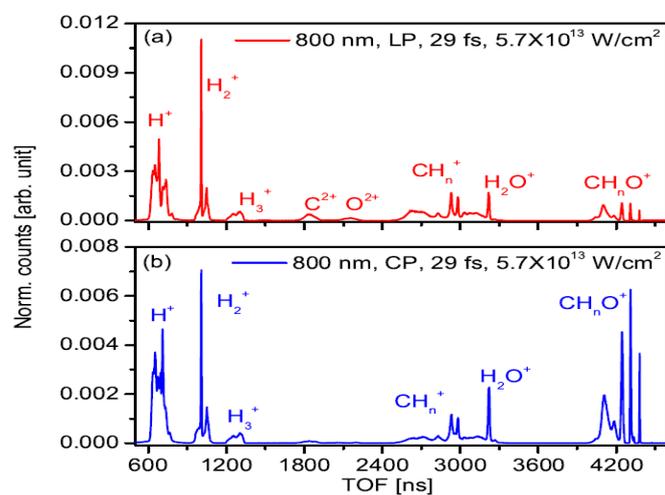
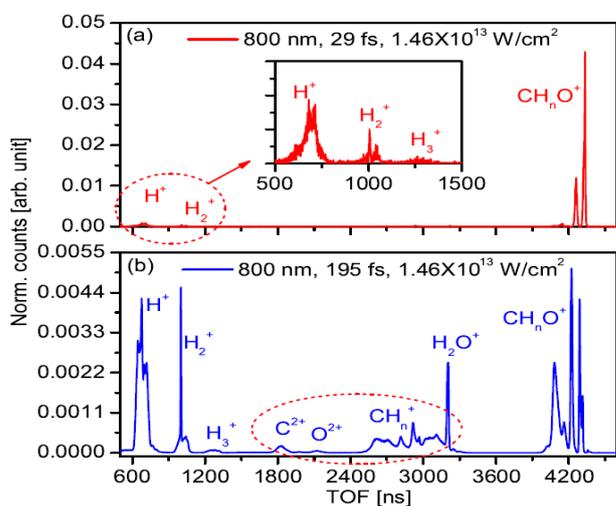


Figure: (left) TOF spectra of CH_3OH for (a) 29 fs, and (b) 195 fs pulses. SF11 glass of 15 mm thickness was used to stretch the pulses to 195 fs. (right) TOF spectra of CH_3OH for (a) linear, and (b) circularly polarized pulses.

Source/Reference of the Work: <https://doi.org/10.1039/D0FD00129E>

via intramolecular H-migration by studying the photodissociation of a deuterated isotopomer of methanol, CD_3OH . To understand the mechanism of intramolecular H-migration and formation of H_n^+ ions from singly-ionized methanol, quantum chemical calculations were performed. CH_3OH^+ dissociation processes along four dissociative channels, leading to the formation of $\text{CHO}^+ + \text{H}_3$, $\text{H}_3^+ + \text{CHO}$, $\text{CH}_2^+ + \text{H}_2\text{O}$, and $\text{H}_2\text{O}^+ + \text{CH}_2$ are primarily probed. Therefore, using the combined approach of experiments and theory, we have successfully explained the mechanism of intramolecular H migration and predicted the dissociative channels of singly-ionized CH_3OH .

Shock processing of amino acids leading to complex structures - Implications to the origin of life

S. V. Singh, J. Vishakantaiah, J. K. Meka, V. Sivaprahasam, V. Chandrasekaran, R.Thombre, V. Thiruvenkatam, A. Mallya, B. N. Rajasekhar, M. Muruganantham, A. Datey, H. Hill, A. Bhardwaj, G. Jagadeesh, K. P. J. Reddy, N. J. Mason and B. Sivaraman



Surendra Vikram

The building blocks of life, amino acids, are believed to have been synthesized in the extreme conditions that prevail in space, starting from simple molecules containing hydrogen, carbon, oxygen and nitrogen. However, the fate and role of amino acids when they are subjected to similar processes largely remain unexplored. Here we report, for the first time, that shock processed amino acids tend to form complex agglomerate structures. Such structures are formed on timescales of about 2 ms due to impact induced shock heating and subsequent cooling. This discovery suggests that the building blocks of life could have self-assembled not just on Earth but on other planetary bodies as a result of impact events. Our study also provides further experimental evidence for the ‘threads’ observed in meteorites being due to assemblages of (bio) molecules arising from impact-induced shocks.

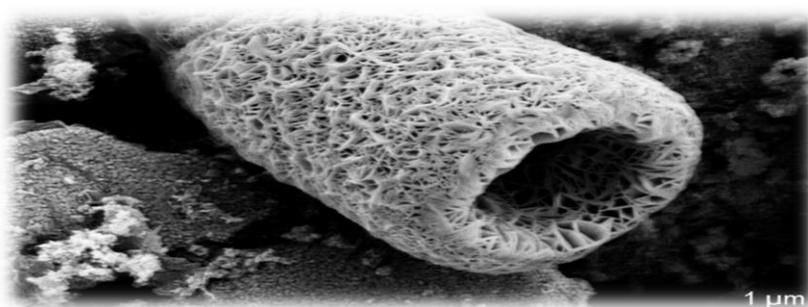


Figure Caption: SEM micrograph of shock processed mixture of amino acids

Source/Reference of the Work: [10.3390/molecules25235634](https://doi.org/10.3390/molecules25235634)



Aravind K

K Aravind, Shashikiran Ganesh, Kumar Venkataramani, Devendra Sahu, Dorje Angchuk, Thirupathi Sivarani, Athira Unni

The publication named "Activity of the first interstellar comet 2I/Borisov around perihelion: Results from Indian observatories" reports the detection and study of the first Interstellar comet, 2I/Borisov, using two Indian observatories, MIRO and HCT. The arrival of an interstellar comet (which was only a hypothesis) is the first of its kind in the more than 150-year history of observational astronomy. Considering the rarity of this event and the fact that this event has been spectroscopically observed by only very few groups worldwide, with the help of large telescopes (minimum 3.6 m), we are happy that we were able to derive important results using only 2-m and 1.2-m telescopes of HCT and MIRO, respectively. This is the first publication on this comet globally, having spectroscopic results pre and post-perihelion which allowed us to infer a possible heterogeneous composition in the nucleus of this "first of its kind" comet. We have found that this interstellar comet has properties very similar to the carbon depleted comets of the Solar system. This indicates that the parent stellar system had a formation process very similar to that of the Solar system

Source/Reference of the Work: <https://doi.org/10.1093/mnras/stab084>

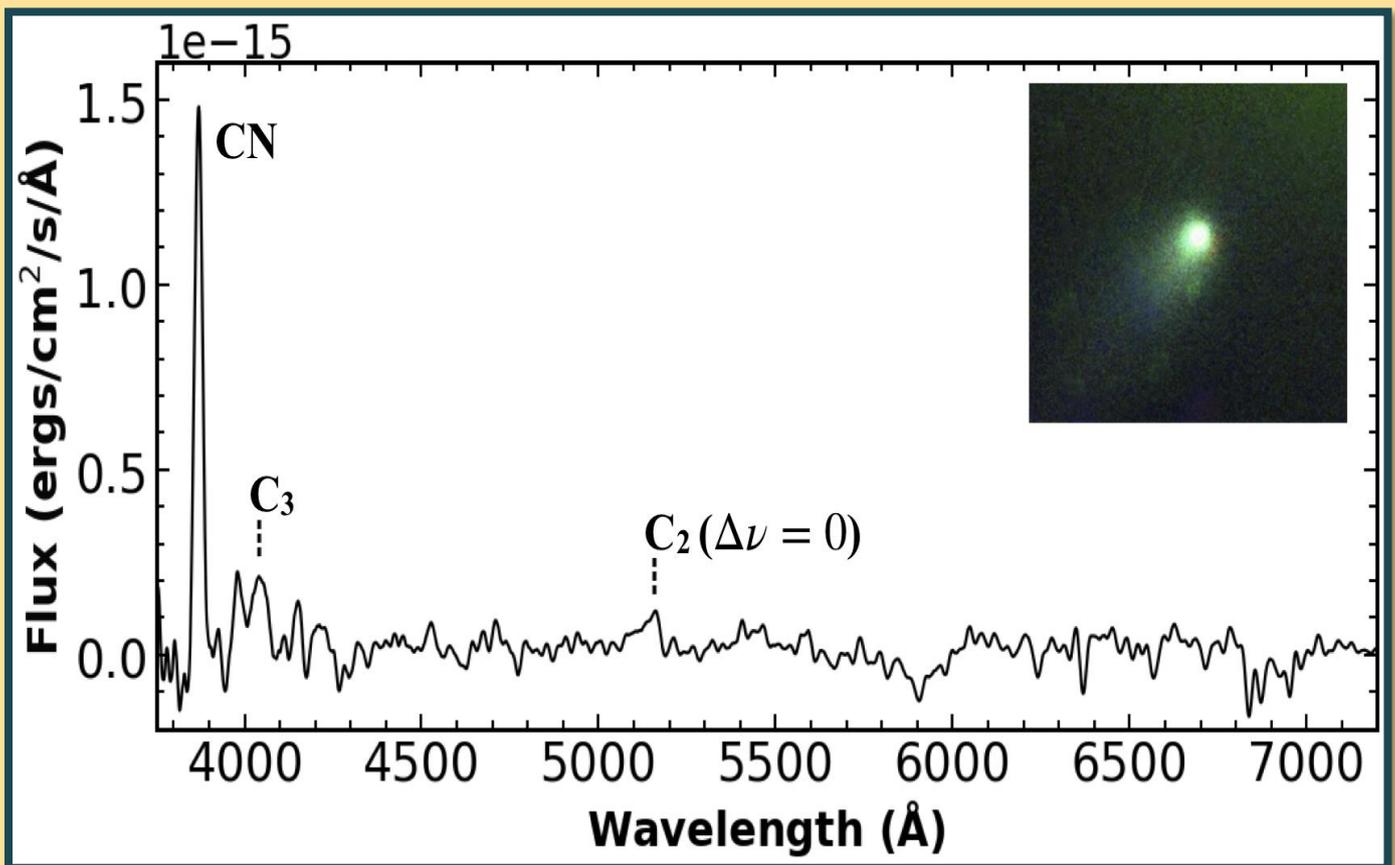


Figure: Optical spectrum of 2I/Borisov observed with the HFOSC instrument on HCT on 2019-12-22.965 UT. Inset shows the RGB colour composite view of the comet on the same night using images taken with HFOSC.



Ananya Mukherjee

“The Dark Arts are many, varied, ever-changing, and eternal. Fighting them is like fighting a many-headed monster.....” —Severus Snape in “The Half-Blood Prince”

Several cosmological challenges of particle physics keep us motivated in search of some avenues which are to unravel. These avenues lead us to solve the mysteries related to the existence of dark matter (DM), which constitutes almost 26% of the total energy density of the Universe. Along with finding the potential origin of DM there coexist another unsolved problem of astroparticle physics namely the matter-antimatter asymmetry of the Universe linked by the tiny ghost particle “neutrino”, by its mass generation mechanism. We present here a brief description of a framework which renders explanation for all the above mentioned beyond standard model phenomena in an appealing manner.

Asymmetries are the cause we exist. For instance, when mirror-image particles with equal and opposite charges do not exhibit equal-and-opposite conduct, that might result into the cause leading to our Universe being baryon asymmetric. It does not contain antimatter in amounts comparable with matter, and this inequity is quantified as $b=6 \times 10^{-10}$. The matter-antimatter asymmetry can be well realized by a process known as leptogenesis, which implies for the production of more number of anti-leptons than leptons in the early Universe. In regard to the appealing connection among neutrino mass, dark matter and matter-antimatter asymmetry one can notice here that the particles involved in the entire process of leptogenesis are also responsible for making the neutrinos massive. The scenario becomes more fascinating when the particle spectrum can also accommodate a potential dark matter particle which belongs to the dark sector. This framework is found to be even more interesting in presence of a modified cosmological background at the time of dark matter genesis and leptogenesis.

We have explored an SM extension with a pseudo-Dirac kind dark matter to look for a potential origin of the matter-antimatter asymmetry and a possible origin of the tiny nature of neutrino mass. The extra scalar present in the dark sector particle spectrum decays to standard model lepton and a dark sector particle creating lepton asymmetry which further leads to the baryon asymmetry of the Universe. This interaction is governed by the complex Yukawa couplings which are determined from neutrino mass and mixing data along with the scalar mass. The presence of a modified cosmological background (unlike the one dominated by radiation) substantially affects the model parameter space both in the DM phenomenology and the process baryon asymmetry creation. We have considered both standard and non-standard cosmology and presented a relative analysis between the two. The modified cosmology here implied a faster expansion of the Universe which influences the evolution of DM number density and also the lepton asymmetry significantly. Due to this faster expansion of the Universe we could achieve a lower mass window for the dark sector scalar (107 GeV) which may be phenomenologically interesting. This rapid expansion also introduces huge deviation in the DM direct detection parameter space as compared to the standard expansion of the Universe.

Source/Reference of the Work: [https://doi.org/10.1007/JHEP03\(2021\)044](https://doi.org/10.1007/JHEP03(2021)044)



The Himalaya has immense significance in governing the climatic processes including the hydrological cycle. Nevertheless, it has been extremely challenging to simulate the atmospheric variability over the Himalaya since the climate models fail to resolve the complex topography. In this regard, we explored the potential of the Weather Research and Forecasting (WRF) model over the Central Himalaya at very high spatial resolutions. Model performance has been evaluated against the observations conducted during the Ganges Valley Aerosol Experiment (GVAX). The comparison of WRF simulation over three domains with different resolutions (d01: 15 km x 15 km; d02: 5 km x 5 km; d03: 1 km x 1 km) with reanalysis data is shown here. Our results show that model performance varies strongly with grid resolutions and that the sharp changes in topography influence the wind patterns and moisture. Model simulation (d01) shows warm bias by 2.8°C and dry bias by 6% over central Himalaya and the biases are lower over high-resolution domain (d03) in agreement with GVAX observations. Interpolating the simulation from coarser domains to the station altitude also reduces the biases but suppresses diurnal variations. This result highlights the importance of representing a well-resolved terrain (d03) in the model. Additionally, model captures the dominant easterly wind component at 1 km x 1 km resolution missing in coarse simulations. Implementation of the high-resolution (3 s) topography input (SRTM) improves the prediction of wind directions, nevertheless, further studies are needed to improve simulations of dynamics over the Himalaya.

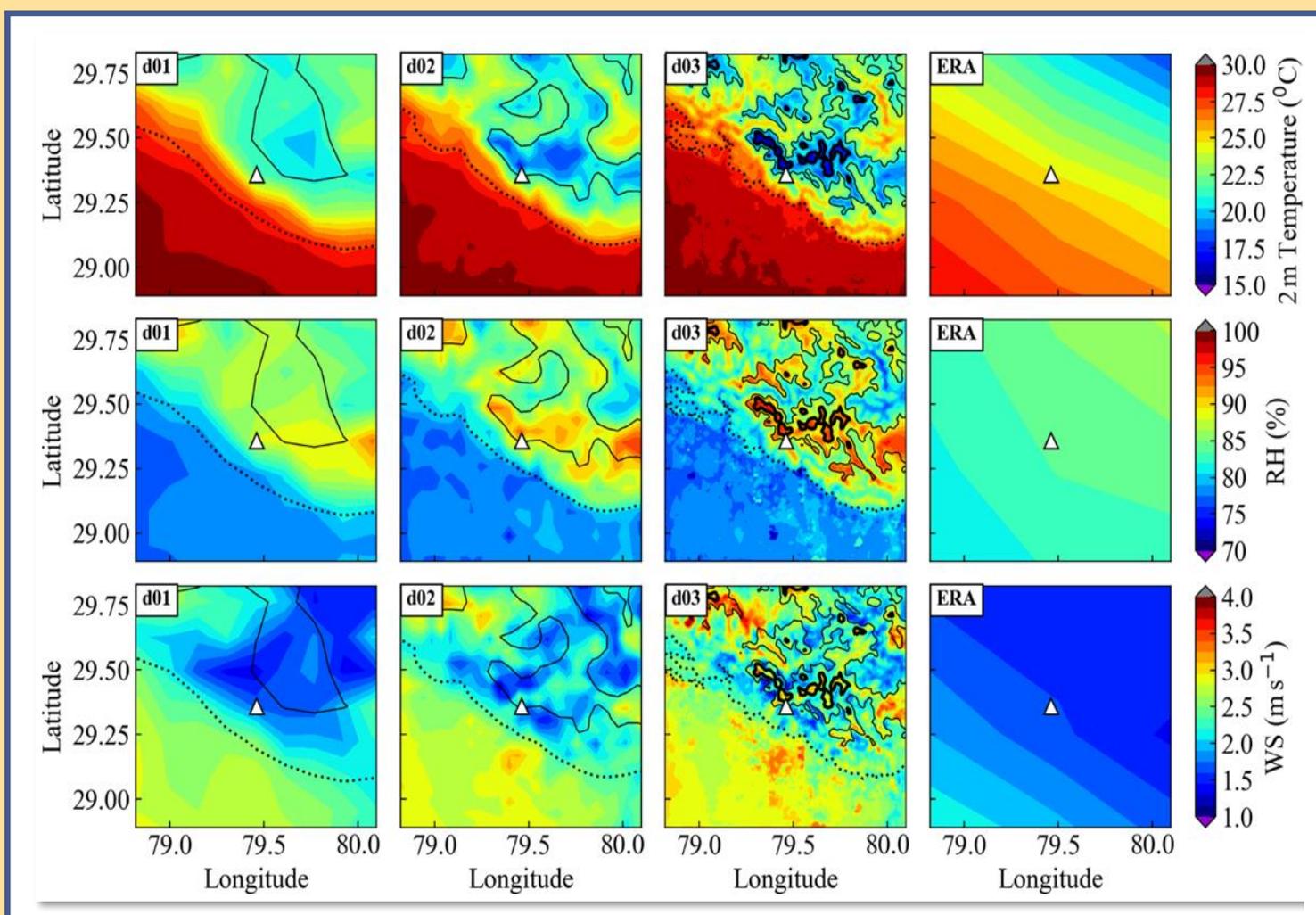


Figure: Variability in temperature, relative humidity (RH), and wind speed (WS) from WRF simulations and ERA-Interim reanalysis.

Source/Reference of the Work: <https://gmd.copernicus.org/articles/14/1427/2021/>

Swachhta Pakhwada 2021 @ PRL, Ahmedabad

Swachhta Pakhwada 2021 was organized at PRL, Ahmedabad, with a focus on creating awareness on hygiene and sanitation. All the employees, faculty, scholars administered Swachhta pledge in Hindi as well as in English in a division-wise manner at PRL Navrangpura & Thaltej campuses, staff quarters by strictly adhering to all protocols and guidelines related to COVID-19. Apart from the sanitation of office premises, a special cleanliness drive was conducted at the staff quarters (Vikramnagar, Navrangpura) & guest house premises. PRL Doctors conducted a Medical camp for 70 staff working with the works contracts in a staggered manner. Face masks were distributed at “Jaspur” village.

As part of the Swachhta Pakhwada Celebrations-2021, a webinar on “Sanitation, Health and Solid Waste management” was delivered on 12th March 2020 by Shri *Harshad Rai Solanki*, Director, Solid Waste Management, Ahmedabad Municipal Corporation (AMC), through the online platform Webex. Through this webinar, the speaker had explained the importance of the sanitation practices, the hygiene practices amidst COVID -19 and necessity of segregation of dry and wet wastes at origin or source for their environment friendly disposal. Further, he explained about the PIRANA the waste dumping yard located in the city and the steps initiated to clear the garbage in eco-friendly manner. In order to dispose the waste generated, and for streamlining the disposal of dry and wet waste, colored dust bins (Blue and Green) are distributed for all the PRL campuses, staff quarters, Guest house areas, so that the waste can be segregated & disposed as per the AMC norms.

PRL has explored the ways to dispose the discarded electronic parts i.e., e-waste generated at the housing colonies. As a part of it, the collected e-waste was handed over to M/s ECS company (Authorized by AMC) which is taking care of safe and eco-friendly disposal. The M/s ECS company issued a “*Certificate of Recycling*” to PRL Ahmedabad states that the supplied 3.30 Kg of e-waste has been processed according to the environment-friendly standards. During this Swachhta celebrations, an herbal garden development program was initiated at all the campuses of PRL including Mt. Abu & Udaipur campus.



Swachhta Pledge



Cleanliness Drive



Medical Camp



Masks Distribution

Swachhta Pakhwada -2021 @ PRL Mt. Abu

Swachhta Pakhwada was organized at PRL Mount Abu with strictly adhering to all protocols and guidelines related to COVID-19. Few photographs of the Swachhta Pakhwada activities conducted at Mt. Abu:



Swachhta Pledge



Anti-Plastic Campaign & Awareness at Primary School Village Janwai, Mount Abu



Saplins Distribution



Cleanliness Drive

Awards and Honors

- ✚ **Dr.Prithish Halder** won the "Best Poster Award from the Indian Academy of Sciences for the year 2021" for his poster titled "A comet dust model based on the findings from the Rosetta mission". This was authored by Dr.Prithish Halder &Dr.Shashikiran Ganesh.
- ✚ **Mr. Sushant Dutta** won the "Best Poster Award for his poster titled "Population of Remnant Radio Galaxies in Deep Radio Surveys" . This was authored by Sushant Dutta, Veeresh Singh, C.H. Ishwara Chandra, Yogesh Wadadeka.'
- ✚ **Surendra Vikram Singh** won consolation prize in the International Sci-Art Image Competition 2021 for the image titled "Natures' play: Complex route from Molecules to Life" organized by the Indian National Young Academy of Sciences (INYAS) in association with the National Young Academy of Bangladesh (NYAB) and Thai Young Scientists Academy (TYSA).
- ✚ **Dr. Nishtha Anilkumar**, Library Officer-F and Head, LIS, is listed in the list of "Top 50 most Eminent Librarians in India for 2020" highlighted on uLektznews.

We congratulate all the winners. All the Best for Future Endeavours.

Superannuation



Ms. Parul Dinesh Makim, Senior Project Assistant superannuated from PRL on 31.03.2021 after serving the institute for nearly 34 years. PRL family thanks her for her contributions towards the betterment of the institute and wishes her a Happy and Healthy superannuated life.

Date of Birth : 31.03.1961

Date of Joining : 26.03.1987

Date of superannuation : 31.03.2021

Hearty Welcome to New Members



Name : Patel Anil Shivpujan

Designation : Technical Assistant

Date of Joining : 04.03.2021

Division/Area : Construction & Maintenance Group

The Newsletter Team



Bijaya Sahoo



Som Sharma



Partha Konar



Vivek Mishra



A. Shivam



Pragya Pandey



Kartik Patel



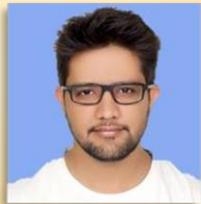
Deekshya Sarkar



Rohan Louis



Garima Arora



Prashant Jangid



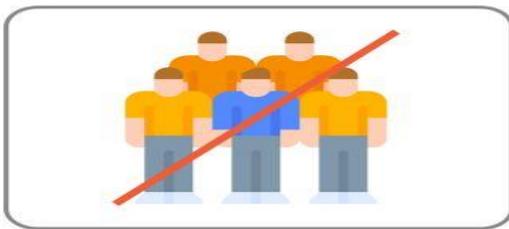
Veeresh Singh



Neeraj Srivastava



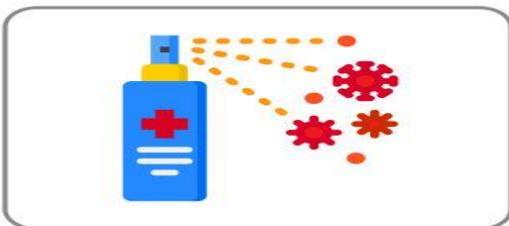
Stay Safe during (COVID-19)



Avoid crowds/mass gatherings.



Maintain hand hygiene.



Disinfect.



Be aware of the signs and symptoms.

Together we can fight C^oVID-19!

#EatRightIndia #SwasthaBharat #HealthForAll