



## Detection of an excessively strong 3- $\mu\text{m}$ absorption near the lunar highland crater Dufay

(C. Woehler, A. Grumpe, M. Bhatt, A. A. Berezhnoy, V. V. Shevchenko, and A. Bhardwaj)

We report an unusually bright structure of  $30 \times 60 \text{ km}^2$  on the lunar equatorial farside near crater Dufay with a significantly stronger OH/H<sub>2</sub>O absorption. We used the near-infrared spectral reflectance data of the Chandrayaan-1 Moon Mineralogy Mapper (M3) instrument to analyse the 3- $\mu\text{m}$

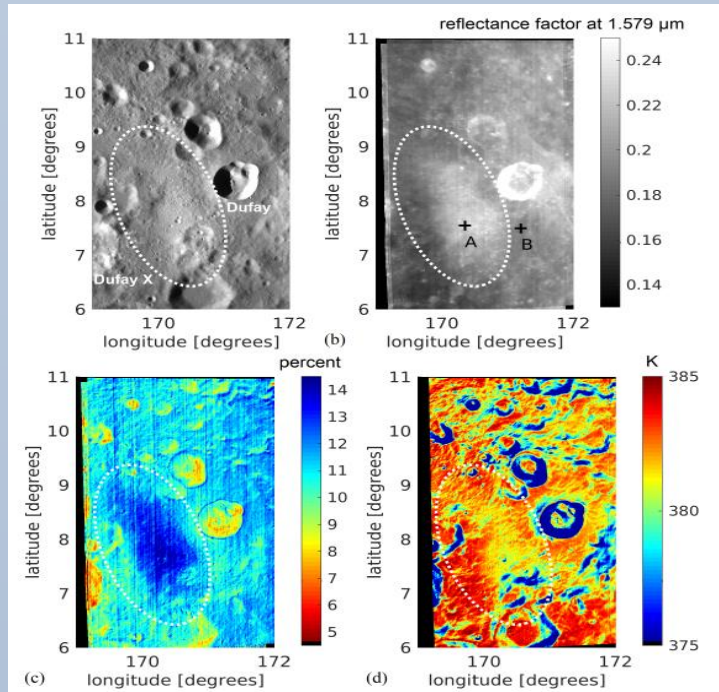


Figure 1: Bright structure southwest of the crater Dufay (marked by white dashed oval). Black pixels denote missing data. Panel a: mosaic of Lunar Reconnaissance Orbiter (LRO) Wide Angle Camera (WAC) data (Speyerer et al. 2016; Sato et al. 2014). Panel b: M3 reflectance at 1.579  $\mu\text{m}$ . Panel c: 3- $\mu\text{m}$  band depth at midday. Panel d: map of the effective temperature at midday.

absorption band feature, which is commonly ascribed to hydroxyl (OH) and/or water (H<sub>2</sub>O). We found that at local midday the 3- $\mu\text{m}$  absorption band feature centered at 170.5°E and 8°N (Figure 1) is about 30% stronger than on the surrounding surface and, surprisingly, stronger than in the illuminated polar highlands. This unique structure neither have any perceivable topographic expression nor a direct link to localized magnetic anomaly.

The average 3- $\mu\text{m}$  band depth is shown in Figure 1c. The bright structure between Dufay and Dufay X is the only localized positive 3- $\mu\text{m}$  band depth anomaly of this kind which we found on the Moon after a rigorous search of the M3-derived global 3- $\mu\text{m}$  band depth data set of Wöhler et al. (2017).

This anomaly is characterized by an excess in 3- $\mu\text{m}$  band depth of about 30% at midday relative to the surrounding highland surface (Figure 1), however it is by far not the brightest surface area in the farside highlands. Highland material that is similarly bright does not show positive 3- $\mu\text{m}$  band depth anomalies (see, e.g., the small fresh highland craters in Figure 1).

The map of the estimated effective temperature shown in Figure 1d indicates that at 11:45 the temperature difference between the bright structure and the surrounding darker surface is below 2 K. The suggested explanation for the observed results is a recent low-speed infall of a thin layer of OH/H<sub>2</sub>O-rich meteoritic or cometary material, where the spectrally observed OH/H<sub>2</sub>O is assumed to be bounded in states of relatively high activation energy. It will be interesting to observe this site with Chandrayaan-2 imaging spectrometer IIRS will provide complete coverage of the 3  $\mu\text{m}$  band, allowing for the analysis of the time-of-day-dependent band depth and shape as well as possibly the distinction between OH and H<sub>2</sub>O and an estimation of their respective time-of-day-dependent fractions

- Reference: Wöhler, C., Grumpe, A., Berezhnoy, A. A., & Shevchenko, V. V. 2017, *Sci. Adv.*, 3, E1701286
- Source of the Work: <https://doi.org/10.1051/0004-6361/201935927>



Megha Bhatt

## Probing the inert doublet model using jet substructure with a multivariate analysis

(Akanksha Bhardwaj, Partha Konar, Tanumoy Mandal and Soumya Sadhukhan)

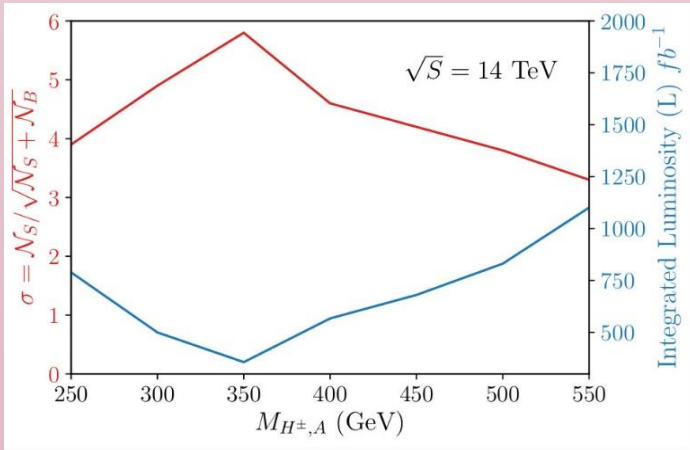
After the successful run of the Large Hadron Collider (LHC) phase I, which established the discovery of long-sought Higgs boson within the Standard Model (SM) framework it opens a new paradigm to search for physics beyond the SM in its next phase. The SM does not contain any particle that can satisfy the observed density of the Dark Matter (DM), along with explaining its other properties. The Inert Higgs Doublet

model (IHDM) is a theoretically well-motivated model among the Minimal Consistent Dark Matter (MCDM) models and provides many interesting signatures at the LHC. In this study, we choose the case of a hierarchical BSM spectrum with light DM mass  $< 80$



Akanksha Bhardwaj

GeV, along with an almost degenerate heavy charged scalar and a pseudo-scalar.



**Figure** Significance (Red Curve) as a function of heavy scalar mass at the 14 TeV LHC with 3000 fb<sup>-1</sup> integrated luminosity. Blue curve represents required luminosity for the exclusion (2 $\sigma$ ) of different benchmark points based on this heavy scalar mass.

This significant mass differences between the DM candidate and heavy charged scalar or pseudo-scalar give rise to interesting signal topology characterized by two boosted jets along with large missing transverse energy.

We utilize different kinematics features of signal topology which are mainly based on the jet-substructure of boosted W/Z originated from the decay of heavy IHDM scalars. These features along with Multi-Variate analysis (MVA) provides the large acceptance rate of signal over the large rate of background rejection. MVA helps to make a non-linear decision boundary by splitting the phase space into a large number of hypercubes. The discovery and exclusion prospect of this parameter space is presented in the figure at the 14 TeV LHC, which strongly advocates that this region can be explored entirely in the upcoming run of LHC using the presented analysis.

**Source:** <https://doi.org/10.1103/PhysRevD.100.055040>

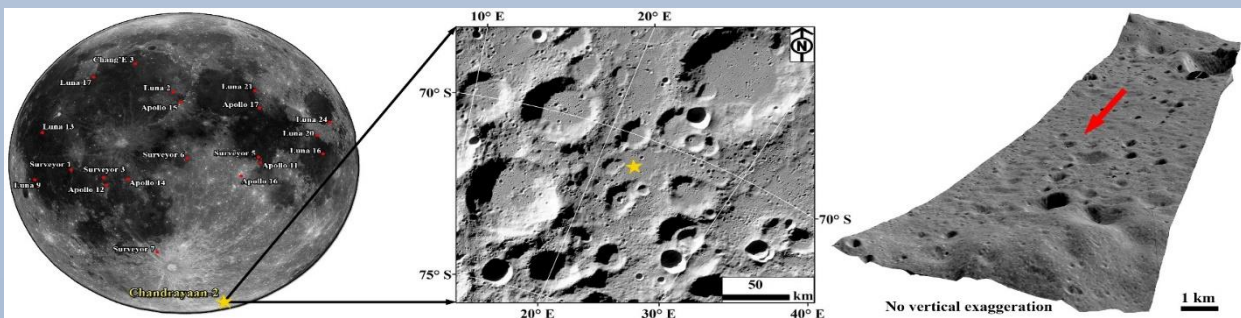
## Geological characteristics of Chandrayaan-2 Vikram landing site in the southern high latitudes of the Moon *(Rishitosh K. Sinha, Vijayan Sivaprahasam, Megha Bhatt, Harish, Nandita Kumari, Neeraj Srivastava, Indhu Varatharajan, Dwijesh Ray, Christian Wöhler, and Anil Bhardwaj)*

ISRO's lunar orbiter-lander-rover mission Chandrayaan-2 was successfully launched on 22<sup>nd</sup> July 2019. The landing site of the Vikram lander was identified as 70.9°S, 22.8°E in the southern high-latitude highland region. In this contribution, a detailed study of the landing ellipse (~15x8 km) was conducted to provide an overview of morphology, topography, composition and chronology that can be used for surface and sub-surface geological observations. The landing site is ~350 km north of South Pole Aitken (SPA) basin rim, which is the largest and oldest basin on the Moon. Topography of the landing ellipse is flat with slope <15°. The landing ellipse hosts craters of varying diameter that are characterized by morphologies varying from fresh to degraded, and yields an age of ~3.7 Ga. Analysis of the

spectral reflectance data reveal that the landing ellipse is dominantly feldspathic/highland material. The estimated average abundance of elements within the landing ellipse are: Fe: 4.2wt.%, Mg: 5.4wt.%, Ca: 10wt.%, and Ti: 0.3wt.%. The results indicate that the surface composition might correspond to Ferroan Anorthosite material. Furthermore, we propose possible mixing of highland material with ejecta from multiple craters surrounding the landing ellipse and/or SPA basin, resulting in hybridisation of highland regolith. **Source/Reference of the Work:** <https://doi.org/10.1016/j.icarus.2019.113449>



Rishitosh K. Sinha



**Figure Caption:** (Left) Chandrayaan-2 landing site in the southern high latitude region is shown by star symbol on the Lunar Reconnaissance Orbiter (LRO) Wide – Angle Camera (WAC) image mosaic. (Middle) Polar stereographic WAC image mosaic of the landing region (star symbol). (Right) LRO Narrow Angle Camera (NAC) stereo images derived Digital Terrain Model (DTM) of the landing region. The landing site is shown by arrow.



## Garba @ PRL



PRL celebrated Navratri festival by organizing Garba event with full energy and enthusiasm on 12/10/2019 at PRL Thaltej Campus. Director, PRL, inaugurated the programme by performing 'aarti' of Goddess Amba. PRLites were seen in rich, traditional and colorful attires performing Garba, a popular folk dance of Gujarat, for over 3-4 hour with full passion and fervor. All students, PRL members and Children enjoyed the event. Prize in various categories were distributed to the respective winners. Also, this time a creative quiz (questions related to garba) was initiated by SWC Team of

volunteers. Everybody actively participated-in with full zest. The Staff Welfare Committee of USO/PRL, also organized Garba at the USO office premises on 7th October 2019 as a part of the Navratri festival. The colourful evening witnessed USO staff, students, and their family members participate in the programme with great gusto. In addition to the traditional Garba, the members, including children, participated enthusiastically in other cultural activities, such as, singing, dancing, recitation, etc. making it a truly memorable evening.



## Hindi Pakhwada Celebration at USO/PRL



A one-day programme was organized at USO/PRL on 26th September 2019 to commemorate the Hindi Pakhwada fortnight (14-28 September), which is celebrated every year with a view to promote the usage of Rajbhasha Hindi in day-to-day official and scientific/technical activities. The programme began with a melodious invocation sung by Ms. Bireddy Ramya, Ms. Anisha Kulhari, Ms. Monika Natwesh, Mr. Ranadeep Sarkar, and Mr. Kushagra Upadhyay. It was followed by the inaugural address by Prof. Nandita Srivastava, Deputy Head (Administration), USO, in which she encouraged everyone to communicate their work in Hindi to the fullest possible extent. Mr. Rakesh Jaroli, convenor of the Hindi Pakhwada Programme at USO, thanked Prof. Srivastava for her encouraging words. The first event of the day was Extempore Speech in which a total number of 11 participants expressed their opinions on different unseen topics covering current affairs, culture, and ethics with the

event conducted by Dr. Brajesh Kumar. This was followed by "Mera Karya Pratiyogita" conducted by Dr. Girjesh Gupta with 11 participants who presented their work and was highly appreciated by the audience. Dr. Bhuwan Joshi invited the family members and children of the USO staff for a poem recitation. The final activity saw the entire audience participate in a General Knowledge and Hindi Quiz contest which was conducted by Dr. Brajesh Kumar and Dr. Rohan Eugene Louis. Prof. Nandita Srivastava, Prof. Shibu K. Mathew, Dr. Bhuwan Joshi, and Mr. Raju Koshy kindly accepted to judge the aforementioned competitions. The programme concluded with the prize distribution ceremony and a vote of thanks. In addition to the above programme, USO staff members generously participated in various offline/online events at PRL during the Hindi Pakhwada and won several prizes in those competitions.

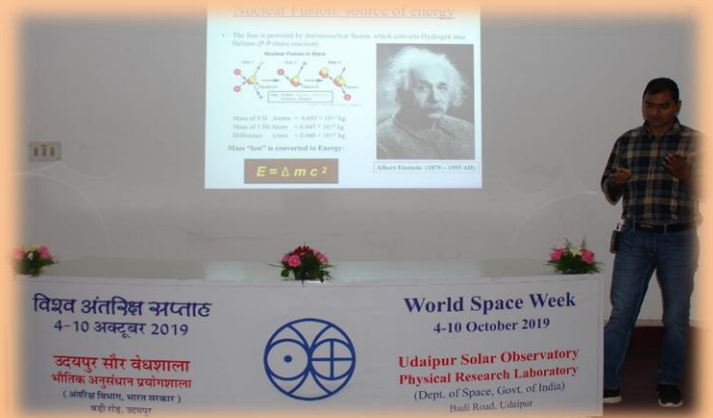


## World Space Week Celebrations at Udaipur Solar Observatory, PRL



The World Space Week (WSW) is an International event celebrated every year from the 4th to 10th of October as declared by the United Nations General Assembly in 1999. This event commemorates the contributions of space science and technology to the betterment of the human condition with a central theme each year. The Moon: Gateway to the Stars has been chosen as the theme for 2019 to honour the 50th anniversary of Apollo 11 and of the first human step on the Moon. On the occasion of WSW, Udaipur Solar Observatory PRL organized a one-day outreach event on October 10th 2019 for 50 meritorious students from Classes 9 to 12 and 5 teachers from Govt. Residency Girls Higher Secondary School, Madhuban, Udaipur. Dr. Megha Bhatt from the Planetary Sciences Division of PRL Ahmedabad, kindly agreed to give a talk on this special occasion. Dr. Brajesh Kumar coordinated the day's event, with USO also providing

local transportation for the students and teachers. The programme began with a Welcome address by Prof. Nandita Srivastava, followed by an Invited Lecture by Dr. Megha Bhatt titled The Moon: Gateway to the Stars. There was a talk by Dr. Rohan Eugene Louis on World Space Week and Space Exploration Events. Demonstration of astro-kits by PDFs, SRFs, and JRFs led by Ms. Sushree Sangeeta Nayak and Ms. Anisha Kulhari. Dr. Girjesh Gupta delivered a talk on The Sun and Solar Activity. A visit to the GONG and e-Callisto facilities was co-ordinated by Ms. Ramya Bireddy, Mr. Hirdesh Kumar, Dr. Sangeetha, Dr. Bhuwan Joshi, and Mr. Kushagra Upadhyay. The event concluded with a group photo of the students and teachers with the USO faculty and staff.



## Awards & Honors to the PRL Family

- ✦ **D. Pallamraju**, (Chairman, SPASC) has been invited by the President of the Scientific Committee on Solar Terrestrial Physics (SCOSTEP) to serve as the *Co-leader of Pillar 2 (Space weather and the Earth's atmosphere) of the new SCOSTEP Program*, PRESTO (Predictability of variable solar-terrestrial coupling (2020-2024)).
- ✦ **Kuljeet Kaur Marhas**, (Associate Professor, PSDN), has been selected as the *Devendra Lal Memorial Medal recipient for the year 2019*. This award is given in recognition of outstanding earth and/or space sciences research by a scientist belonging to and working in a developing country. As a recipient of this award, she will be presenting a lecture at the American Geophysical Union (AGU), Fall Meeting to be held in December this year in San Francisco, USA.

## Superannuation



**Jitesh R. Bhatt**

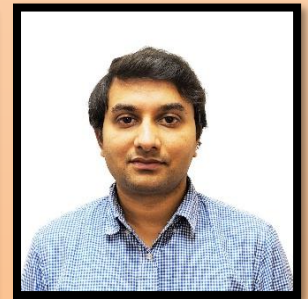
Prof. Jitesh Bhatt of the Theoretical Physics Division, superannuated on 31<sup>st</sup> October, 2019 giving twenty-four years of service to PRL.

We, at PRL, gratefully acknowledge all the contributions made to the institution and to the field of science during his service and wish him a very healthy and peaceful superannuated life ahead!

## A Hearty Welcome to the New Entrants



**Dr. Amzad H. Laskar**  
Reader, GSDN



**Dr. Vineet Goswami**  
Reader, GSDN



## “Integrity – A Way of Life” --- Vigilance Awareness Week-2019 celebration at PRL

The ‘Vigilance Awareness Week 2019’ was observed in Physical Research Laboratory, Ahmedabad from 28.10.2019 to 02.11.2019 and the Vigilance Awareness Pledge was administered to all the staff members of PRL on 29.10.2019. Banners and various pamphlets with regard to Vigilance



IPS Gandhinagar, Gujarat on 30.10.2019 in PRL. Besides, 76 Permanent and 9 Temporary Employees of PRL have been registered for e-Pledge in the CVC portal.

Awareness were displayed at prime locations of Physical Research Laboratory, Ahmedabad. An essay writing competition on this year theme “Integrity-A way of life” as a part of vigilance awareness week was also organized on 31.10.2019 at PRL, Ahmedabad, Infra-Red Observatory, Mount Abu and Udaipur Solar Observatory, Udaipur. A Vigilance Awareness Lecture on this year theme "Integrity- A way of life " was delivered by Shri K. Nityanandam, Retired

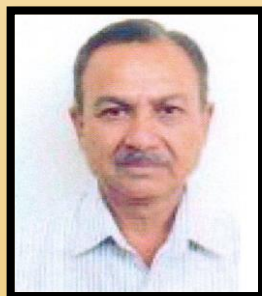


## Colloquia at PRL

- ✚ **M Shanmugam**, (Engineer – SF, Planetary Sciences Division, PRL) delivered a colloquium on “*Scientific experiments onboard Chandrayaan-2 mission: PRL's contribution*” on 3<sup>rd</sup> October 2019.
- ✚ **Alberto Sainz Dalda** (Researcher, Bay Area Environmental Research Institute, CA USA) delivered a colloquium entitled “*IRIS2: using representative profiles to invert IRIS Mg II h & kline*” on 31<sup>st</sup> Oct 2019 at USO, PRL.



Ms. V.J. Hukamani  
18.04.1947 – 13.10.2019



Mr. S.K. Bhavsar  
30.03.1944 – 15.10.2019

## Obituary

PRL deeply mourns the sad demise of two of the former PRL employees – Ms. V.J. Hukmani and Mr. S.K. Bhavsar. PRL family extends heartfelt condolences to their bereaved families and pray for their strength in this hour of grief.