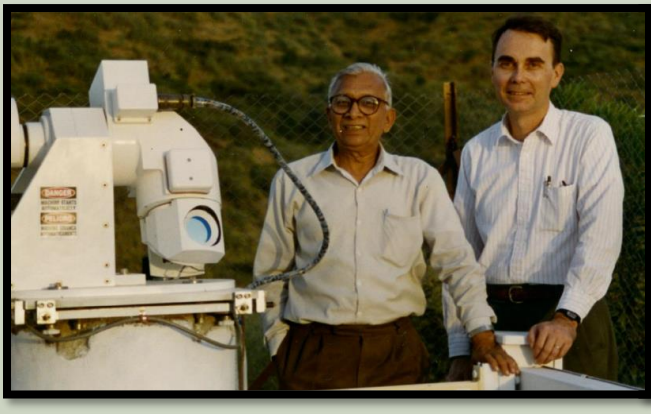
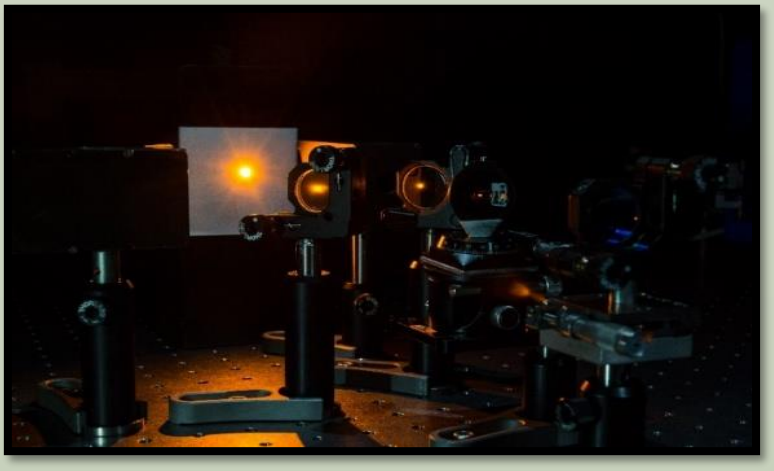
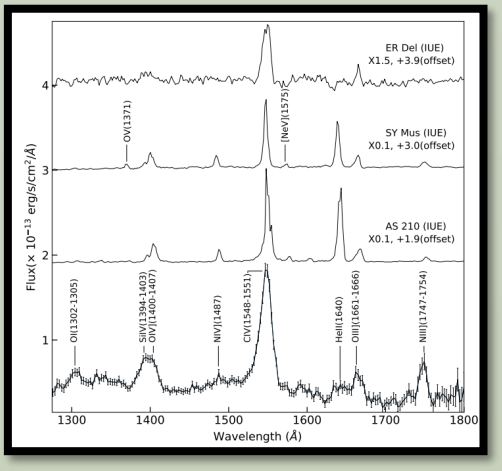
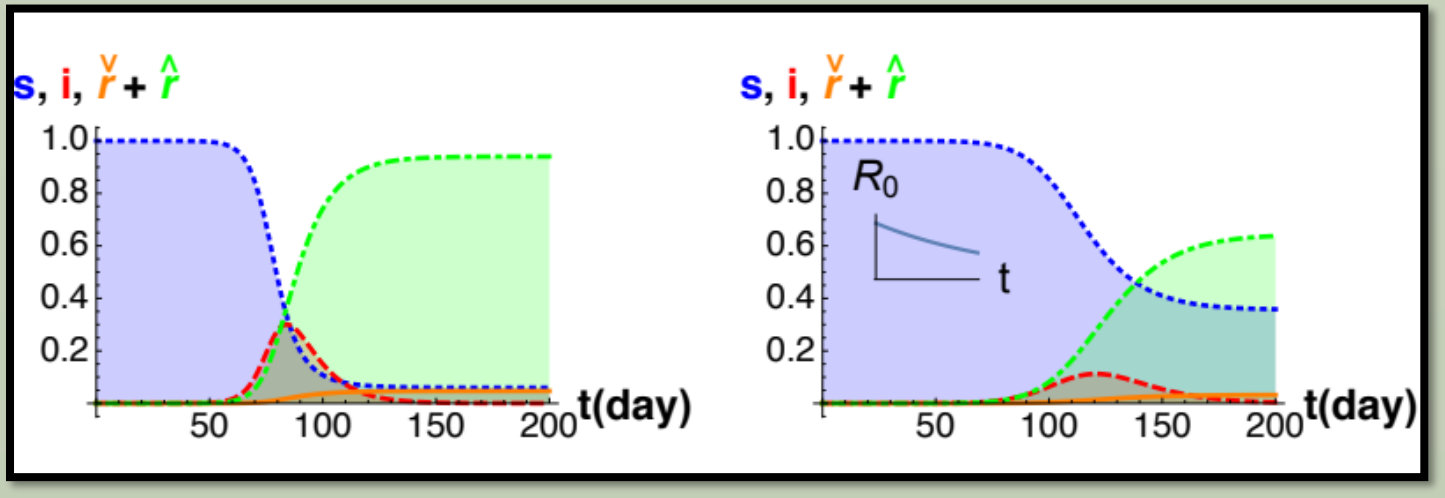
PRL News – The Spectrum

October 2020









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Development of ultrafast, tunable yellow source useful for various medical applications

*Deepika Yadav, Anirban Ghosh, * Ravi K. Saripalli, and G. K. Samanta*

Anirban Ghosh

Ultrafast lasers, especially in yellow-orange spectral range (570 nm - 590 nm), are of tremendous significance in applications such as medicine, biomedical imaging, laser therapy, eye surgery, spectroscopy, and astronomy. It is evident from the literature that the lasers in the yellow spectral range have established their superiority for various medical treatments, including skin pigmentations, eye surgery, and macular retinopathy by laser photocoagulation. Unfortunately, even after sixty years of the first demonstration of the laser in 1960, we have a handful of commercially available lasers with selective wavelength coverage across the electromagnetic spectrum because of the unavailability of the suitable laser gain mediums. As a result, the yellow-orange wavelength range is typically accessed using bulky and inefficient copper vapor lasers, dye lasers, and optical parametric oscillators. While these sources have been used successfully for various applications, however, they suffer from one or more drawbacks in terms of low average power, lack of adequate spatial beam profile, limited or no wavelength tunability, and broad output pulses. To overcome these limitations in a single experimental configuration, we have reported a compact source of high power, tunable, ultrafast yellow radiation using the fourth-harmonic generation of a mid-IR laser in two-stage frequency-doubling processes. The laser could provide us a maximum output average power over 1 W with 130 femtosecond pulses at a repetition rate of 80 MHz with an outstanding spatial beam profile. The laser can be wavelength tuned across 570 - 596 nm. We have also observed excellent power stability over a long time duration, thus opens up a handy source for various applications.

Figure: *Photograph of the yellow laser*

https://doi.org/10.1364/OL.404358

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UV spectroscopy confirms SU Lyn to be a symbiotic star

Vipin Kumar, Mudit K. Srivastava, Dipankar P.K. Banerjee, and Vishal Joshi

Vipin Kumar

Symbiotic star systems are a class of binary star systems consisting of a very hot compact white dwarf and very cool red giant star. The stars have traditionally been identified and characterized by the presence of the emission lines of several high ionization species in their optical spectra. Breaking the mould, SU Lyn – an ostensibly unremarkable red giant star from ground-based observations, was found to emit hard X-rays. This raised the suspicion of SU Lyn harbouring a hidden, hot companion, thereby making SU Lyn a symbiotic system.

The PRL team had been observing SU Lyn since its discovery in 2016 with various Indian observing facilities, most notably with the Ultra-Violet Imaging Telescope (UVIT) aboard ASTROSAT space observatory. From the ground, the star was followed with HESP instrument on IIA-HCT telescope, with indigenous in-house developed MFOSC-P instrument and with Near-Infrared Camera and Spectrometer (NICS) on PRL 1.2m telescope at Mount-Abu.

The Far-UV (1300-1800 angstroms) spectrum of SU Lyn, obtained with the ASTROSAT-UVIT instrument, shows emission lines of Si IV, C IV, OIII, and N III in a spectrum typical of symbiotic stars. The high-resolution optical spectrum shows the weak presence of few emission lines, which are typically seen in the optical spectrum of symbiotic stars. The UV spectrum, complemented by optical and NIR spectra, thus, confirms the symbiotic nature of SU Lyn. With a simple theoretical model to fit UV observations, it was further shown that white dwarf in SU Lyn is orders of magnitude less luminous (0.16 solar luminosity) compared to a white dwarf in a typical traditional symbiotic system (~100-1000 solar luminosity). Instead, the symbiotic phenomenon is predominantly powered by the UV radiation from the accretion disk (0.66 solar luminosity) around the white dwarf. This is the reason for the emission lines to be extremely weak in the optical spectrum, and that is why the symbiotic nature of SU Lyn could not be established from ground-based observations earlier.

These results are significant scientifically as, for the first time, they firmly establish the existence of SU Lyn type symbiotic systems. The presence of emission lines in low-resolution optical spectra has always been the traditional way to identify and discover symbiotic stars. However, these traditional methods would fail to detect SU Lyn type Symbiotics. The known population of Symbiotics in our Galaxy is a few hundred, while their total population is estimated to be around several hundred thousand. Existence of Symbiotics like SU Lyn may be the answer to this puzzling question.

It is also important to note that these results are derived from a lesser-known spectroscopy capability of the UVIT instrument, which is preliminarily designed as an imaging instrument. To the best of our knowledge, this is the first result derived from the spectroscopy capability of UVIT in its five years of operation.

https://doi.org/10.1093/mnrasl/slaa159

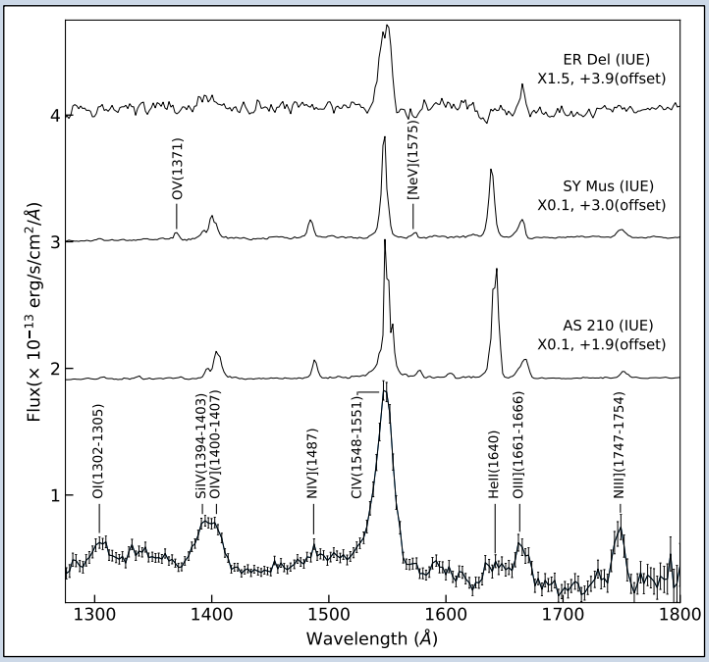


Figure: *The UVIT spectrum of SU Lyn with the lines identified. Archival spectra of three other Symbiotics, ER Del, SY Mus and AS 210, are also shown for comparison*

Modelling the influence of progressive social awareness, lockdown and anthropogenic migration on the dynamics of an epidemic

Ramit Bhattacharyya and Partha Konar

Mathematical modelling of epidemics is important to understand the spread of an infection in a population as people interact among themselves. It is then possible to device various interventions, social or medical, to arrest the spread. A compartmental epidemic model divides population into different compartments, each compartment representing a definite stage of the epidemic in its progression. The basic of such compartmental model is the Susceptible-Infected-Recovered (SIR) model where the population is treated as susceptible (who can get infected), infected or recovered. A strong assumption is, the recovered fraction cannot get infected again, or in other words, a single infection gives a life-long immunity. An important parameter in this regard is the R0, pronounced as "R naught", which quantifies how contagious a disease is. The Fig. 1 shows the actress Kate Winslet explaining the concept in the film Contagion. It is the average number of people who will contract a contagious disease from one person with that disease and standardly, considered to be a constant—property of the virus spreading the disease. In contrast, the work proposes R0 to be a function of time, particularly, a function of social awareness which increases as an epidemic progress. For example, initially a population may not be aware of various deterrents like hand washing, cough/breathing etiquette, or social distancing but learns it eventually—which can arrest the spread. In the proposed model the R0 is considered to be exponentially decaying in time with the time constant determining how fast the particular population can adapt these social deterrents. In Figure 2, we show the progress of the infected fraction (Red curve) along with the susceptible (Blue) and recovered fractions (Orange), in (a) absence and (b) presence of the progressive social awareness, over days. The R0 is shown in the inset of (b). Importantly, the infected fraction is less peaked and more flattened, a desirable outcome. Notably, for COVID19, social awareness is the only deterrent available at present to contain the spread in absence of any vaccine; and the plot shows it is highly effective when followed rigorously.

Figure 1: *Kate*

Additionally, the modelling takes into account the influence of lockdowns along with phased unlocking (in various combinations), anthropogenic migration (people travelling from one infected area to other) and separates out the mortality rate from the clinical recovery rate.

https://doi.org/10.1007/s40435-020-00692-1

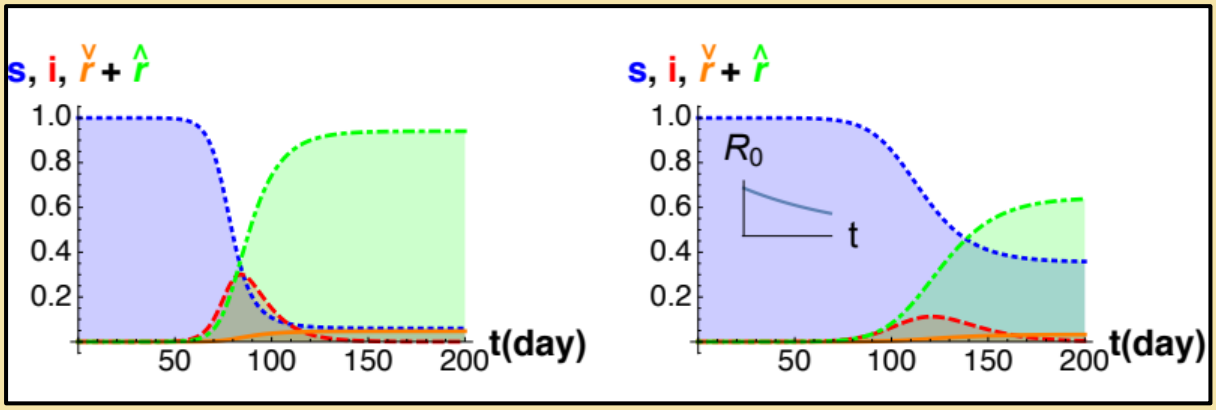


Figure 2: *Dashed red line is the history of the infection fraction (Left plot) in absence of Progressive Social Awareness and (Right plot) in presence of Progressive Social Awareness. Progressive Social Awareness is modelled with time dependent R0 as shown in inset.*

Large Eruptive Solar Flares from Extremely Complex Double-decker Flux Rope Configuration in Mini-sigmoid

Prabir K. Mitra, Bhuwan Joshi, Astrid M. Veronig, Ramesh Chandra, K. Dissauer, Thomas Wiegelmann

Prabir Mitra

Eruptive flares are often produced from the sigmoidal active regions which are identified as S (or reverse S) shaped structures in the coronal emission images (Figure 1(a)). Such complex structures are believed to contain flux ropes which are defined as sets of magnetic field lines wrapped around its central axis. With high twist and overall shear, sigmoidal active regions can store large amount of free magnetic energy which is released during flares. In this work, we report a highly localized sigmoid (within the box in Figure 1(b)) which produced two M-class flares within one hour. As such, this is the smallest sigmoid ever reported.

The answer to its surprisingly high flare productivity in respect to the extremely small size (cf. Figure 1(a) and 1(b)) was revealed by Non-Linear Force Free Field (NLFFF) extrapolation technique. NLFFF extrapolation results readily suggest the presence of two flux ropes intertwined with each other (i.e., a double-decker flux rope; Figure 1(c)) within the mini-sigmoid region. Analysis of magnetic decay index suggests that within the heights of the double-decker system, horizontal magnetic field decreased with height a rate sufficient enough to set the flux ropes into destabilization (indicated by the arrow in Figure 1(d)).

Above the double-decker system, the value of torus instability reached to its critical height for torus instability within a low height (statistically found range of critical height is represented by the hatched regions in Figure 1(d) and 1(e)) which implies that once the destabilized flux ropes reached to the corresponding critical height, torus instability will drive its further eruption toward the formation of the coronal mass ejection. Such studies are essential in order to reach a general understanding of the complexity of the coronal magnetic field and associated solar activities.

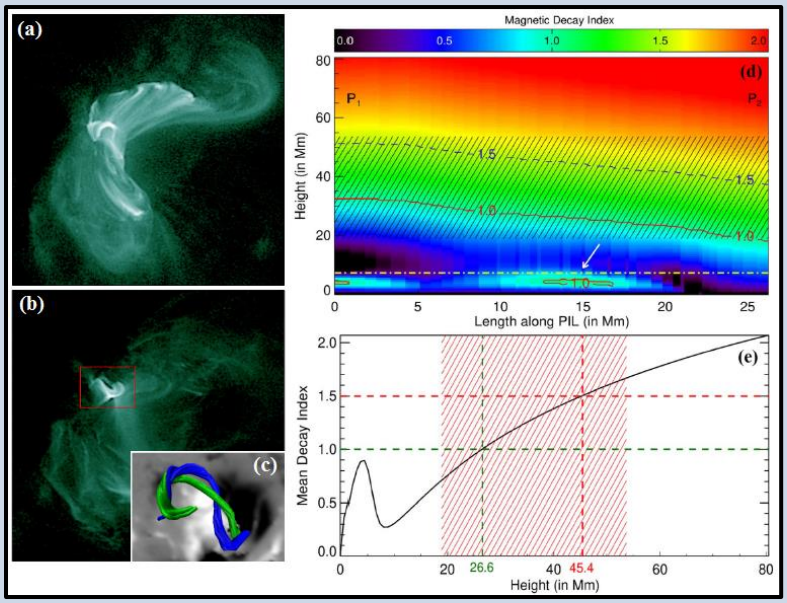


Figure: *(a) A standard 'S' shaped coronal sigmoid. (b) The mini-sigmoid (within the red box) reported in this work. (c)A double decker flux rope configuration within the mini-sigmoid. (d)Distribution of magnetic decay index above the double-decker flux rope axis. (e)Distribution of decay index with height averaged over the flux rope axis. The hatched regions in panels (d) and (e) indicate the statistically found critical height range for torus instability.*

https://doi.org/10.3847/1538-4357/aba900

Events and Activities

हिंदी पखवाड़ा

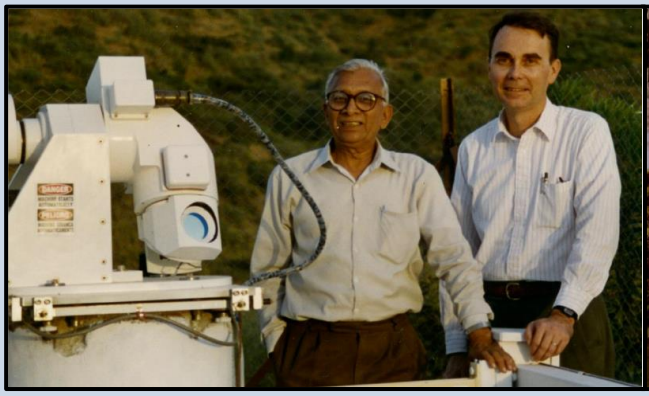
14 सितंबर 1949 को भारत की संविधान ने हिंदी को भारत की आधिकारिक भाषा के रूप में स्वीकार किया था। यह निर्णय भारत के संविधान द्वारा स्वीकृत किया गया और 26 जनवरी 1950 को लागू हुआ। अनुच्छेद 343 के अनुसार देवनागरी लिपि में लिखी गई हिंदी को आधिकारिक भाषा के रूप में उपयोग के लिए सर्वसम्मति प्राप्त हुई थी। इस दिन को मूल रूप से पूरी दुनिया में हिंदी भाषा की संस्कृति को बढ़ावा देने और प्रसार करने के लिए मनाया जाता है। हिंदी दिवस का महत्व इस दिन आयोजित कार्यक्रमों, समारोहों, प्रतियोगिताओं और विभिन्न प्रकार के उत्सवों द्वारा प्रदर्शित किया जाता है।

भौतिक अनुसंधान प्रयोगशाला में हिंदी दिवस के सम्मान में हिंदी पखवाड़ा मनाया गया। इसका प्रारंभ 14 सितंबर को उदघाटन कार्यक्रम से हुआ जिसमें निदेशक महोदय एवं रजिस्ट्रार महोदय द्वारा कार्यालय के सदस्यों से सभी कार्यक्रमों में भाग लेने के लिए उत्साहित किया गया, तथा राजभाषा विभाग के लक्ष्यों को प्राप्त करने पर विशेष बल दिया गया। हिंदी पखवाड़ा समिति के सदस्यों द्वारा विभिन्न कार्यक्रमों की योजना बनाई गई। इस अवसर पर सबसे महत्वपूर्ण बात यह रही कि देश में वर्तमान महामारी की परिस्थिति को ध्यान में रखते हुए सभी कार्यक्रमों का आयोजन ऑनलाइन माध्यम पर किया गया। इस दौरान हिंदी टंकण, सुलेख, चित्र वर्णन, आशुभाषण, वैज्ञानिक प्रस्तुति, शब्द प्रश्नोत्तरी, कविता पाठ जैसे विभिन्न कार्यक्रमों का आयोजन किया गया जिसमें हिंदी एवं हिंदीतर भाषी सदस्यों ने बड़ी संख्या में बढ़-चढ़कर भाग लिया।

अगर प्रौद्योगिकी की बात करें तो आज दुनिया की हर बड़ी से बड़ी कंपनी का वेबसाइट या एप्प हिंदी में उपयोग किया जा सकता है। हिंदी भाषा के महत्व को ना सिर्फ साधारण लोग बल्कि बड़े-बड़े टेक्नोलॉजी से जुडी कंपनियां भी समझ चुकी हैं और वह भी अपने परियोजनाओं को हिंदी भाषा में भी विकसित करने में लगे हुए हैं।

हम सभी का यह प्रयास है कि अपने संवैधानिक दायित्व को निभाते हुए राजभाषा के प्रचार-प्रसार में योगदान देते रहें एवं देश को गौरवान्वित करें।

The Foundation Day of the Udaipur Solar Observatory (USO)



The Foundation Day was commemorated on 22nd September 2020. This year the event was conducted online with a live stream on Youtube. The USO Foundation Day 2020 was a special occasion as it celebrated 25 years of the GONG project. GONG or the Global Oscillation Network Group is one of the flagship synoptic programmes at the National Solar Observatory (NSO) USA and USO-PRL is privileged to be a part of this important global partnership. A stellar panel of speakers from NSO included Dr. John Leibacher, Dr. Jack Harvey, Dr. Frank Hill, and Dr. Alexei Pevtsov.

They spoke on the origin of the NSO-GONG partnership, the technical aspects of GONG, the transitions to the present, and the future of GONG, respectively. Dr. Anil Bhardwaj, Director PRL, welcomed the gathering, and the speakers were introduced by Prof. Nandita Srivastava. Prof. Shibu Mathew presented the vote of thanks and Dr. Rohan Louis coordinated the online programme. The event can be accessed at https://www.youtube.com/watch?v=d7Z0RaABH-w. A special word of appreciation to Mr. Jaya Krishna Meka, Dr. Bhushit Vaishnav, and Mr. Jigar Raval for setting up the online stream.

Lectures, Talks and Colloquia

- **Anil Bhardwaj, (Director, PRL)** delivered the Sixth A P Mitra Memorial lecture on "Indian Planetary Missions" on 16 Sep 2020. This Public Lecture was organised by InRASS, NPL-FSF and NPL.

- **S. Ramachandran, (Sr. Professor, SPASC. PRL)** delivered a talk on: "Ozone: Past, Present & Future" on 16 Sep 2020. This Talk was organized by Climate Change Department, Government of Gujarat and Department of Science and Technology on the occasion of World Ozone Day.

- **Andrew Forbes, (Professor, University of the Witwatersrand, South Africa)** delivered a lecture on "Shaping Waves" on 23 Sep 2020. This online Public lecture was organized by the PRL, OSA student Chapter.

- **Narendra Ojha, (Reader, SPASC, PRL)** delivered a colloquium on Atmospheric Chemistry and Dynamics over India on 30 Sep 2020.

Hearty Welcome to New Members

SURAJ KUMAR
ASSISTANT

SABA ABBASI
ASSISTANT

ABHISHEK PRASAD
ASSISTANT

OBITUARY

LATE SHRI J.T. VINCHHI TECHNICAL ASSISTANT-E	
Date of Birth	24.10.1944
Date of joining	22.08.1966
Date of retirement	31.10.2004
Date of Death	22.09.2020

We mourn the demise of our former employee and fondly remember his contributions to PRL. We pray for the well-being of his bereaved family. May his soul rest in peace.

The Editorial Board

BIJAYA SAHOO

PRAGYA PANDEY

DEEKSHYA SARKAR

GARIMA ARORA

A.SHIVAM

ROHAN LOUIS

PRASHANT JANGID

CORONAVIRUS

PRECAUTIONARY TIPS

1. Wash your hands frequently.
2. Maintain social distancing.
3. Avoid touching eyes, nose and mouth.
4. Practice respiratory hygiene.
5. If you have fever, cough and difficulty breathing, seek medical care early.