

## The COSPAR Capacity Building Workshop at Kodaikanal on Coronal and Interplanetary Shocks (January 6-17, 2020)

The COSPAR Capacity-Building Workshop on “Coronal and Interplanetary Shocks: Analysis of Data from Space and Ground-based Instruments” was held recently at the Kodaikanal Solar Observatory, Indian Institute of Astrophysics, Kodaikanal, India during January 6 - 17, 2020

([https://www.iiap.res.in/COSPAR\\_KSO2020/](https://www.iiap.res.in/COSPAR_KSO2020/)). The

Kodiakanal Solar Observatory has been operating for more

than a century and the data have resulted in important discoveries. Thirty-four students from 5 countries and 16 lecturers from 4 countries participated in the workshop.



The main objective of the COSPAR Capacity Building Workshops is to encourage the scientific use of space data by scientists in developing countries (<https://cosparhq.cnes.fr/events/cb-workshops>). The workshops tap into the large number of extensive data archives from the past and current space missions and the online analysis software tools. Thus, a typical workshop aims to provide a highly practical training in the use of one or more of these data archives.

Aligned with these objectives, the 2020 workshop (COSPAR\_KSO2020) made use of the extensive data available at the CDAW Data Center (<https://cdaw.gsfc.nasa.gov>) from SOHO, STEREO, SDO, and Wind missions. These data sets provide information on coronal mass ejections (CMEs), which are the drivers of coronal and interplanetary shocks. These data were supplemented by ground-based radio data from US Air Force’s Radio Solar Telescope Network (RSTN), ISWI’s e-callisto network ([e-callisto.org](http://e-callisto.org)), spectral and imaging observations from the Gauribidanur Solar Radio Observatory (<https://www.iiap.res.in/?q=centers/radio>), and the Radio and Plasma Wave Experiment (WAVES) on board the Wind spacecraft. The radio data provide information on type II radio bursts, which originate from coronal and interplanetary shocks. In particular data assembled in the form of a catalog of type II radio bursts and the associated CMEs and flares ([https://cdaw.gsfc.nasa.gov/CME\\_list/radio/waves\\_type2.html](https://cdaw.gsfc.nasa.gov/CME_list/radio/waves_type2.html)) have been extensively used. Coronal and interplanetary shocks play a key role in solar terrestrial relationship because the shocks are responsible for large solar energetic particle events, sudden commencement of geomagnetic storms, relativistic electron acceleration in the magnetosphere, energetic storm particle events at Earth, and the onset of geomagnetically induced currents.

The first week of COSPAR\_KSO2020 was devoted to lectures in python software, plasma physics, solar physics, CMEs, shocks, interplanetary phenomena, ionospheric phenomena, and radio bursts. Background information was also provided on relevant radio and optical instrumentation. The lectures are available online:

[https://www.iiap.res.in/COSPAR\\_KSO2020/?q=resources](https://www.iiap.res.in/COSPAR_KSO2020/?q=resources).

The second week was devoted to analyzing selected CME-shock events. These events were selected beforehand by the scientific organizing committee and the data were made available online ([https://cdaw.gsfc.nasa.gov/meetings/2020\\_Kodaikanal/](https://cdaw.gsfc.nasa.gov/meetings/2020_Kodaikanal/)). The data include radio dynamic spectra and a matrix of JavaScript movies from SOHO, STEREO, SDO, Wind, and GOES

missions. The movies contain online measurement tools that can obtain CME/shock height-time data and the drift rate of radio bursts.

The participants were divided into six groups, each mentored by one of the lecturers of the workshop. The participants were encouraged to test the ideas they learnt during the first week and develop a complete picture of the events including their solar origin, interplanetary propagation, and geospace impact. Every morning, one participant from each group presented a summary of the data analysis performed during the previous day. On the last day, each group had 20 minutes to present a complete summary of the two events. The presentations are also available online ([https://www.iiap.res.in/COSPAR\\_KSO2020/?q=analysis](https://www.iiap.res.in/COSPAR_KSO2020/?q=analysis)).

During the workshop, there was a cosmic event: the umbral lunar eclipse on January 10. A bonfire was lit after dinner for the participants to stay outside and watch the eclipse. Also, the local harvest festival known as Pongal was celebrated (January 15). The Pongal celebrations include offering to the Sun for the bountiful harvest. The observatory staff invited the participants to partake in the celebrations, which was a unique experience. The participants were also given a tour of the observatory's optical and radio facilities and the observatory museum.

COSPAR was the primary sponsor of the workshop and hosted by the Kodaikanal Solar Observatory of the Indian Institute of Astrophysics. The workshop was cosponsored by India's Department of Science and Technology, NASA, the Scientific Committee on Solar Terrestrial Physics (SCOSTEP), and the International Space Weather Initiative (ISWI).

(Nat Gopalswamy, SOC chair)

