Student questions: SESE Graduate Student colloquium:

Nivedita Mahesh: Imaging with FARSIDE: A Radio Telescope on the Lunar Farside

4/13/22

Why is it so difficult to find exoplanets if radio telescopes can see and focus on objects through dust and other obstructions?

Because of 3 main reasons: 1.) we expect these radio emissions from the host star and planet to be at really low radio frequencies (<2 MHz). This is because the earth's ionosphere tends to block these frequencies, 2.) Also, these radio events will be transient and will happen only when the star exhibits high activity (solar flares, Coronal mass ejections). So it's possible that telescopes looking for them so far haven't observed such systems long enough and may have missed these events, and 3.) radio emission from the exoplanet depends on the planet's magnetic field. And if a planet doesn't have a magnetic field, it won't emit radiation in the radio frequencies.

How do you plan for unexpected noise or interference for the antenna array on the moon's farside?

In the same way, we have been dealing with on the Earth. We will employ flagging and filtering schemes on the data in the software pipeline.

The array is going to be placed by humans or it's going to be remotely placed?

It will be deployed by teleoperated two-wheeled axel rovers.

In relation to exoplanet study what are the conditions required to detect magnetospheres of nearby exoplanets by FARSIDE?

The necessary requirements for the telescope are: 1.) it must operate at low frequencies (<2 MHz), and it must have multiple pointings on the sky so that it can look at multiple systems for these transient events (ref Q.1) 3.) Similarly, we require long hours of observations on each target system

In terms of conditions around the exoplanet- We require coronal mass ejections from the host star that will interact with the exoplanet's magnetic field to produce these radio radiations.

How extensive of a communication network will be required to gather all of that data from the far side of the moon and transmit back to earth?

So one of the main advantages of the Artemis mission is that they are preparing for a Lunar gateway that will provide communication with the farside of the moon and serve as a dedicated station for the moon. FARSIDE will leverage the power of this lunar gateway

On the website it says it will image the entire sky every minute, wouldn't this be a massive strain on communication equipment getting it back to earth at that rate?

Yes, we expect to receive about 65GB of data per day, and the Lunar gateway can handle more than that.

Does the imaging of FARSIDE, have potential to be applied to other planetary projects?

Yes! It will help us better understand the auroral radio emissions from planets in our solar system and help us understand the planetary structure better. In addition, a few of the additional science cases of FARSIDE are the study of lunar quakes, lunar seismology, and studying the regolith properties on the back of the moon.

Is the cosmic timeline taken into consideration for calibration for the radio telescope?

For the Dark ages cosmology science case, we have to calibrate the radio telescope, and current the plan for calibration is to fly a CubeSat with a standard calibrator over the array

How does understanding the polarization of exoplanets help us understand space and the planets as a whole?

The radio emission from exoplanets is produced by a process called Electron Cyclotron Maser due to the planet's magnetic field, which inherently produces circularly polarized data. Thus, if we study the polarization information, we can directly study the planet's magnetic field, which could give us some information about the interiors of the planet that form the dynamo to produce the planetary magnetic field.