Predictions by Indian astronomer Sujan Sengupta inspires NASA and Caltech exoplanet research

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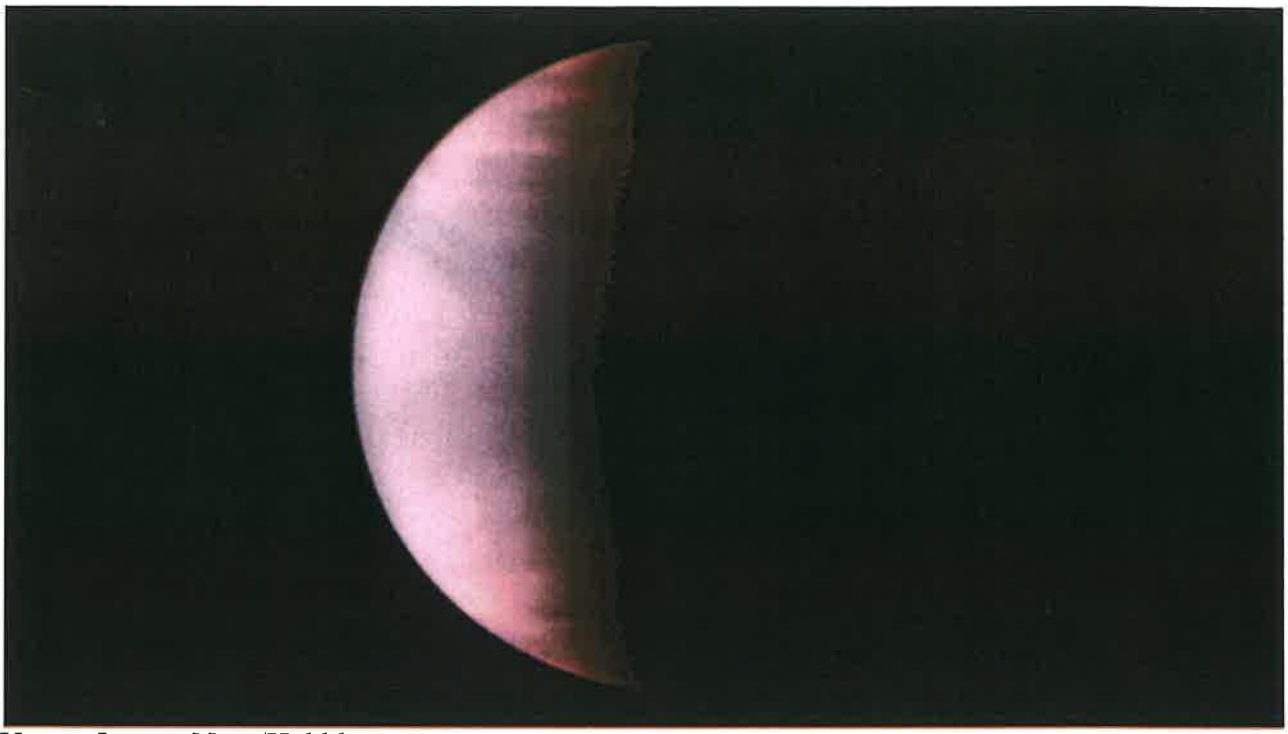
Sujan Kumar Sengupta

By T V Venkateswaran

Inspired by theoretical predictions made by an Indian astronomer, an international group of scientists led by Jet Propulsion Laboratory (JPL) and California Institute of Technology have launched a major project to study and understand clouds and weather in the atmosphere of exoplanets and brown drafts spread across the universe.

The predictions relate to polarisation of light from exoplanets. Sujan Sengupta, senior a scientist at the Indian Institute of Astrophysics, Bengaluru, had made theoretical predictions in collaboration with Mark S.Marley of NASA's Ames Research Centre at California. Now an international team is planning to study atmosphere of exoplanets based on their method using the 200-inch Hale Telescope of Palomar Observatory in California.



Venus. Image: Nasa/Hubble.

Polarisation is a potent method for determining what is in a planet's atmosphere. Scientists had detected the presence of sulphuric acid in the atmosphere of Venus by using this method.

Explaining polarisation, Prof. Sengupta said, "let us take a beam of radiation. When it traverses through a medium, it interacts with the material of the medium and carries the information of the medium to a detector. Light emitted by sun, stars, candle flame are all unpolarised to start with. But, when they are reflected by, say water bodies, they become partially polarised in the direction parallel to its surface. Likewise, starlight bouncing off an exoplanet could be partially polarised and this could be used to understand their atmosphere."

He and Marley have developed a novel technique to exploit polarisation of light from brown dwarfs and exoplanets to understand their atmosphere. The two have theorised that unpolarised starlight would become wee bit linearly polarised, with its electric field aligned in one plane, when it bounces off particles in the atmosphere of exoplanets. Thus if a distant star shows net polarisation it would be a telltale sign of the presence of an exoplanet with sufficient cloud cover.

Further, they have predicted that the method could also be used to detect various characteristics of the exoplanet, such as shape of the planet, density of the clouds, chemical composition of the atmosphere and periodicity of its self-rotation.

If the exoplanet is perfectly circular net polarisation would be zero since polarisation averaged over the surface of a perfectly round object would tend to cancel itself out. On the other hand, if the exoplanet is spinning very fast, like say, Jupiter, then its shape would be oblate, that is non-spherical pumpkin-shaped and thus, polarisation averaged over its surface would not cancel out. The residual polarisation will give non-zero value.

Their technique could also help predict if there is an exoplanet with an exomoon orbiting it. For, when a large natural satellite or exomoon transits a planet, a tiny bit of its surface would be blocked from view. The polarisation from this eclipsed area would not be available for the averaging, resulting in asymmetry leading to a non-zero value. The fluctuation of the non-zero value of the polarisation would be the significant evidence and indicate the periodicity of the exomoon orbiting the host exoplanet.

The Trappist-1 system has seven earth sized exoplanets. Image: Nasa.

The new technique is expected to be of particular use in detecting exoplanets with lesser mass, such as Earth-sized planets, which are difficult to detect through existing means. In addition, astronomers could use this innovative method detect extrasolar planets that have highly elliptical orbits, which are unable to make their host star wobble or blink by transiting in front of them.

Dr. Sengupta had predicted that light of brown dwarf, a stellar body that is at least 17000 times heavier than Earth, but not massive enough to become a star, should be polarized, because it had silicon cloud. This was subsequently confirmed through observations and now it is known that 95% of the brown dwarfs are polarized.

Besides this project, the proposed TMT (Thirty Meter Telescope) will also have a sensitive polarimeter for exoplanet research. It is being designed and developed by Indian astronomers. Sengupta is a member of the TMT's International Science Development Team for Exoplanets

research. Sengupta says "polarimeter proposed will also be used in characterising and detecting exoplanets and exomoon."

Dimitri Mawet of Caltech, who is leading the international team, says that they are proposing to "commission high precision near-infrared imaging low-resolution spectro-polarimeter for the 200-inch Hale telescope on Mt Palomar to study the composition, morphology, and dynamics of the scattering clouds of exoplanets". The team includes Indian astronomer, A.N. Ramaprakash of The Inter-University Centre for Astronomy and Astrophysics, Pune.

The research team includes Heather Knutson, Rebecca Oppenheimer, Ricky Nilsson, Gautam Vasisht, Eugene Serabyn, Kaew Tinyamont, Ming Zhao, Pushkar Kopparla, Suniti Sanghavi, Richard Dekany, Roger Smith and Dave Hale.

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