

Astronomers Spot Far Ultra Violet Emissions from Novae in Andromeda Galaxy

Discovery of UV Emissions from Novae

Astronomers have spotted far ultra violet emissions from novae, a special class of [transient astronomical event](#) that causes the sudden appearance of a bright, apparently new star that slowly fades over weeks or months, during their outburst, for the first time in the neighbouring Andromeda galaxy.

What Are Novae and How Do They Occur?

All observed novae involve [white dwarfs](#) in close [binary systems](#), but causes of the dramatic appearance of a nova vary, depending on the circumstances of the two progenitor stars.

A binary pair of stars comprising a White Dwarf, an earth-sized but very hot star, and a Sun-like (or its puffed-up evolved version) star are sometimes found orbiting each other in close proximity. In such systems, the White Dwarf's intense gravitational force can deform the companion star and pull its matter onto the surface of the White Dwarf. The piling up of matter creates such intense densities that the fusion reaction is enhanced, giving off enormous amounts of light, which is seen as a nova eruption. Novae eruptions contribute towards galactic chemical enrichment, and hence they are important for study. These also provide laboratories to study extreme conditions of shock mechanisms, thermonuclear processes, and the binary evolution of stars.

The Role of the Accretion Disk

The accretion process is streamlined by a disc-like structure, known as the **accretion disk**, which forms around the white dwarf.

- These disks are extremely hot, emitting electromagnetic radiation in the ultraviolet (UV) and blue regions of the spectrum.
- Observing these emissions offers valuable insights into the behavior of these binary systems.

Indian Scientists Make a Breakthrough

A team of scientists from the **Indian Institute of Astrophysics (IIA)**, Bengaluru, used data from the **Ultraviolet Imaging Telescope (UVIT)** aboard the AstroSat mission to study novae in the Andromeda Galaxy.

- They accessed public data archives and stumbled upon FUV (Far Ultra Violet) emissions from novae during their eruption phases.
- The study, published in the *Astrophysical Journal*, uncovered ultraviolet emissions from forty two novae, catching four of them mid-outburst.
- The team consisted of Judhajeet Basu (IIA and Pondicherry University), Krishnendu S. (IIA and Amrita University), Sudhanshu Barway (IIA), Shatakshi Chamoli (IIA and Pondicherry University), and G. C. Anupama (IIA).

How This Discovery Helps

The findings provide scientists with opportunities to study these binary star systems at different stages of their evolution.

- Some systems were observed in the process of accumulating matter, while others were seen spewing it into space.
- UVIT's fine spatial resolution and simultaneous observation capability in far and near UV enabled the detection of accretion disks, even in systems 2.5 million light-years away.

Key Observations by the Team

"The brighter the disk, the more rapidly it is consuming its companion matter. We also studied how the flux from these discs changes with time, and as per our expectations, the accretion process was found to be stable in these systems." said Basu, a PhD student at IIA who led the project.

Continuous accumulation of matter onto the White Dwarf leads to extreme temperature, pressure, and density conditions. This layer of material acts like a translucent shell, blocking off some of the radiation from the white dwarf and the accretion disc. Under these circumstances, the brightness of these systems diminishes, and it is a tell-tale signature of what's going to come.

It's like the calm before the storm, and this is exactly what we found in two of these systems in Andromeda Galaxy by using data from UVIT, a telescope built at our CREST campus and launched into space by ISRO," Basu added.

Once the threshold temperature and densities are reached, all the accumulated hydrogen-rich matter undergoes a thermonuclear runaway reaction. “It is much like what happens in a fusion bomb, but on an “astronomical” scale. This explosion naturally leads to the brightening of the system by several orders of magnitude, hurling large quantities of material into the interstellar medium. We serendipitously found four systems caught in this act,” said Barway, a faculty at IIA.

However, it was not easy to detect all of these systems. “The central region of Andromeda is quite bright, encouraging us to use sophisticated image subtraction techniques to uncover more novae. We used two different techniques. Both yielded the same results, confirming what we are seeing are real sources and not bogus,” said Barway.

“Tracing these novae was possible only because of the Andromeda survey proposals taken up by AstroSat UVIT operated by ISRO. More such future missions, especially in UV and X-ray, can discover and follow up these systems, and could answer some of the missing puzzles of novae,” Basu pointed out.

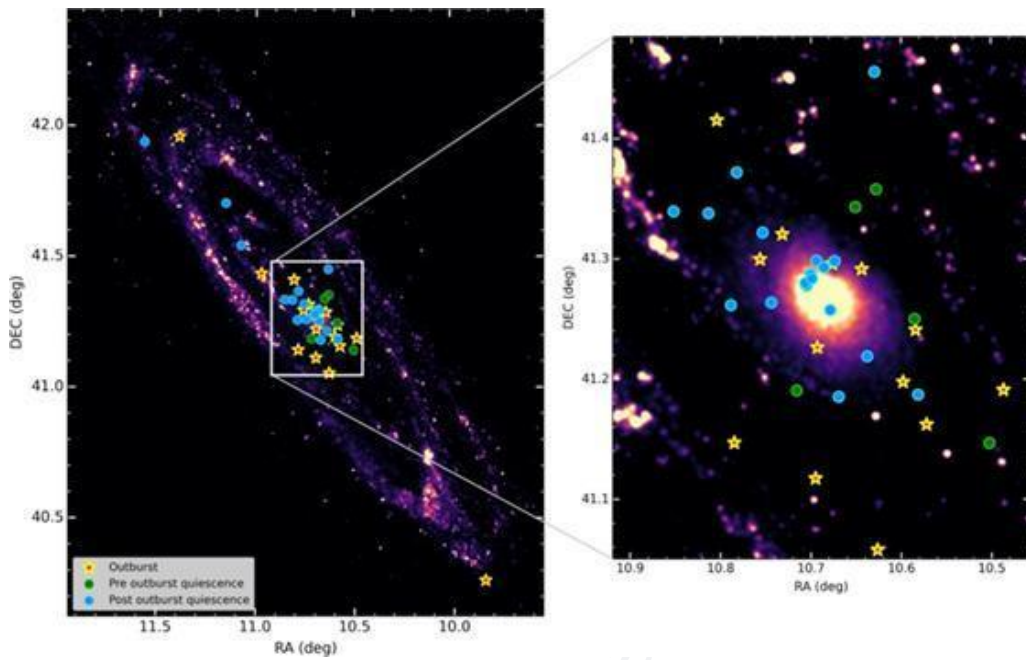


Figure (1): Novae detected in the Andromeda in UVIT's FUV/NUV filter.

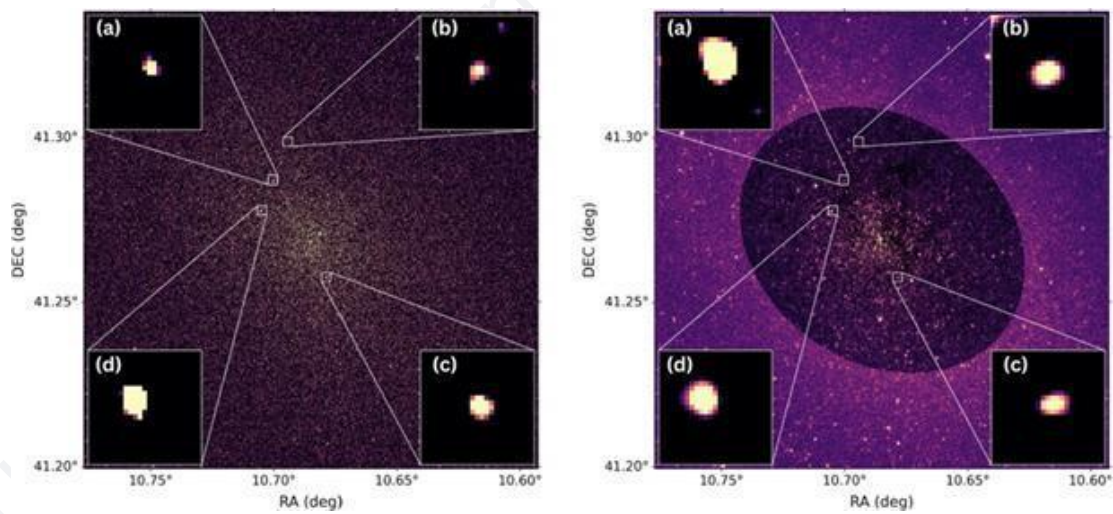


Figure (2): Novae recovered from the bright central bulge of M31 by image subtraction.

Quotes from the Research Team

- **Judhajeet Basu (Project Lead, IIA):**

"UVIT's spatial resolution allowed us to detect accretion disks 2.5 million light-years away. This data confirmed stable accretion processes and revealed tell-tale signatures of pre-eruption dimming."

- **Sudhanshu Barway (IIA Faculty):**

"The explosion of accumulated hydrogen-rich matter is like a fusion bomb on an astronomical scale. We were fortunate to catch four systems in this act."

- **Basu on Future Missions:**

"With more UV and X-ray missions, we could uncover missing pieces of the puzzle and gain a comprehensive understanding of novae."

This discovery marks a significant step forward in understanding novae, their life cycles, and the complex dynamics of binary star systems.

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