India's AstroSat catches astronomical imposter

Indian scientists leading an international team of astronomers showed that a new object discovered in the sky, believed to be related to the latest gravitational wave discovery, was in fact an unrelated gamma ray burst.

The LIGO scientific collaboration's discovery of GW170104 led to a frenzy of activity among partner astronomers around the world, each trying to find any associated explosions in the sky. The Hawaii-based ATLAS group found a source that was in the right place in the sky, and was fading fast – causing excitement all around. But was it really associated with GW170104? Was it the first discovery of an optical source related to a gravitational wave detection? No, according to a study by the AstroSat CZTI team and the international GROWTH collaboration.

While studying observations of the source – named ATLAS17aeu – the team noticed something odd about how fast it was fading. "Analysing the data, I concluded that ATLAS17aeu must be related to some explosion on 5th January, not the 4th", says Varun Bhalerao (IIT Bombay), the lead author in this study. The team had already used CZTI to look for X-rays coming from GW170104, and not seen any. CZTI (Cadmium Zinc Telluride Imager), a gamma ray telescope on ISRO's maiden space observatory AstroSat, proved to be the most sensitive instrument in the world to find transient sources with sub-second durations. So if there was another burst in the sky, they were sure they would find it in CZTI data. Varun continues, "I shot off an email to my student Sujay, asking him to search for a burst in CZTI data in the calculated time window. And then I noticed an email from Vidushi (another student) in my inbox: she had found the burst I was looking for!"

The culprit seemed to be a gamma ray burst GRB 170105A – that exploded in the same part of the sky 21 hours later. But to be sure of this, astronomers needed more data. Enter GROWTH: Global Relay of Observatories Watching Transients Happen. This multi-national team had already swung into action, observing ATLAS17aeu with optical, X-ray and radio telescopes. Team member Dipankar Bhattacharya (IUCAA) said, "The team studied the source with radio, optical and X-ray telescopes for a few days, till it faded away into oblivion. Based on its behaviour we concluded that this event signalled the birth of a new black hole when a massive star imploded in a galaxy several billion light years away."

This gamma ray burst was missed by several other international satellites which were pointing at other parts of the sky at that instant. It was detected only by the Cadmium Zinc Telluride Imager (CZTI) on AstroSat, and by the Chinese-European POLAR instrument. "This is the result of insightful instrument design, imaginative onboard software, and collaborative data analysis from a nationwide team", says A.R. Rao (TIFR). But the team has its eyes on the prize: finding the first electromagnetic counterpart to a gravitational wave source. And the highly sensitive CZTI might not be enough. Rao adds, "We need wide angle detectors scattered over interplanetary space to discover X-rays from LIGO sources. The CZTI team has proposed a small sized instrument called MOTIVE to ISRO as a likely payload for a future interplanetary mission. Together, CZTI and MOTIVE can revolutionize the field!"

CZT-Imager is built by a consortium of Institutes across India. The Tata Institute of Fundamental Research, Mumbai, led the effort with instrument design and development. Vikram Sarabhai Space Centre, Thiruvananthapuram provided the electronic design, assembly and testing. ISRO Satellite Centre (ISAC), Bengaluru provided the mechanical design, quality consultation and project management. The Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune did the Coded Mask design, instrument calibration, and Payload Operation Centre. Space Application Centre (SAC) at Ahmedabad provided the analysis software. Physical Research Laboratory (PRL) Ahmedabad, provided the polarisation detection algorithm and ground calibration. A vast number of industries participated in the fabrication and the University sector pitched in by participating in the test and evaluation of the payload. ***The Indian Space Research Organisation funded, managed and facilitated the project****.*

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More information about the discovery of the gravitational wave source GW170104 can be obtained at https://www.ligo.caltech.edu/page/press-release-gw170104, and in the IndIGO press release.