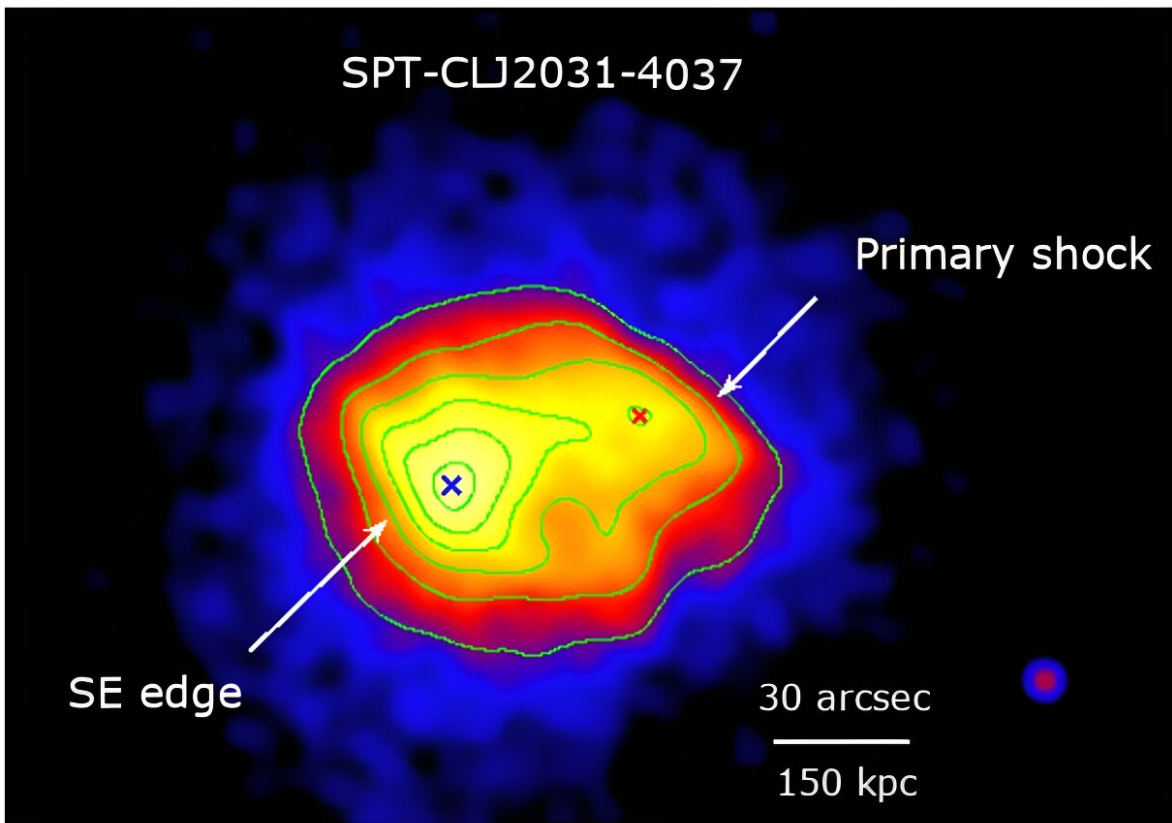


Astronomers observe a strong shock front in galaxy cluster SPT-CLJ 2031-4037

July 3 2024, by Tomasz Nowakowski



The exposure corrected image of SPT J2031. Credit: Diwanji et al., 2024.

Using NASA's Chandra X-ray spacecraft, astronomers from the University of Alabama in Huntsville have observed a merging galaxy cluster known as SPT-CLJ 2031-4037. They detected a rarely seen

strong shock front in this galaxy cluster. The finding was reported in a research paper [published](#) June 27 on the pre-print server *arXiv*.

Galaxy clusters are formed through hierarchical mergers of smaller subclusters and contain up to thousands of galaxies bound together by gravity. They are the largest known gravitationally bound structures in the universe, and could serve as excellent laboratories for studying galaxy evolution and cosmology.

Mergers of [galaxy clusters](#) are the most energetic events in the universe after the Big Bang. A fraction of the kinetic energy released during these mergers is dissipated into the [intracluster medium](#) via shocks and turbulence. The so-called [shock](#) fronts, seen as sharp discontinuities in X-ray brightness and temperature, give astronomers a rare opportunity to observe and investigate such merger systems and their geometry.

SPT-CLJ 2031-4037 (or SPT J2031 for short) is a merging galaxy cluster at a redshift of 0.34. It is a massive system with an estimated mass of about 800 trillion [solar masses](#) and X-ray luminosity at a level of 1.04 quattuordecillion erg/s.

A team of astronomers led by University of Alabama's Purva Diwanji has conducted a search for shock fronts in SPT J2031 with the help of the Chandra X-ray observatory.

"SPT J2031 was observed by the Chandra Advanced CCD Imaging Spectrometer (ACIS) detector in the Very Faint (VFAINT) mode for a total of 256 ks spread over 10 [observations](#)," the researchers wrote in the paper.

The observation allowed the team to detect two shock fronts in SPT J2031—the stronger one to the northwest and the weaker one to the southeast (the southeastern edge). The stronger shock front has a density

jump of 3.16 across the sharp surface brightness edge and a Mach number of 3.36, while the weaker one has a density jump of 1.53 and a Mach number of 1.36.

The authors of the paper underline that the finding makes SPT J2031 one of the rare merging systems with a Mach number of over 2.0. They note that only a handful of merger shock fronts with such a high Mach number have been discovered by Chandra.

The study also found that SPT J2031 exhibits [merger](#) geometry and that the post-shock electron temperature of the stronger shock front is lower than the temperature predicted for the instant shock heating model and favors the collisional equilibration model. These findings are consistent with results provided by previous studies.

More information: Purva Diwanji et al, A rare, strong shock front in the merging cluster SPT-CL J2031-4037, *arXiv* (2024). [DOI: 10.48550/arxiv.2406.19264](#)

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