Observers investigate a nearby galaxy cluster merger

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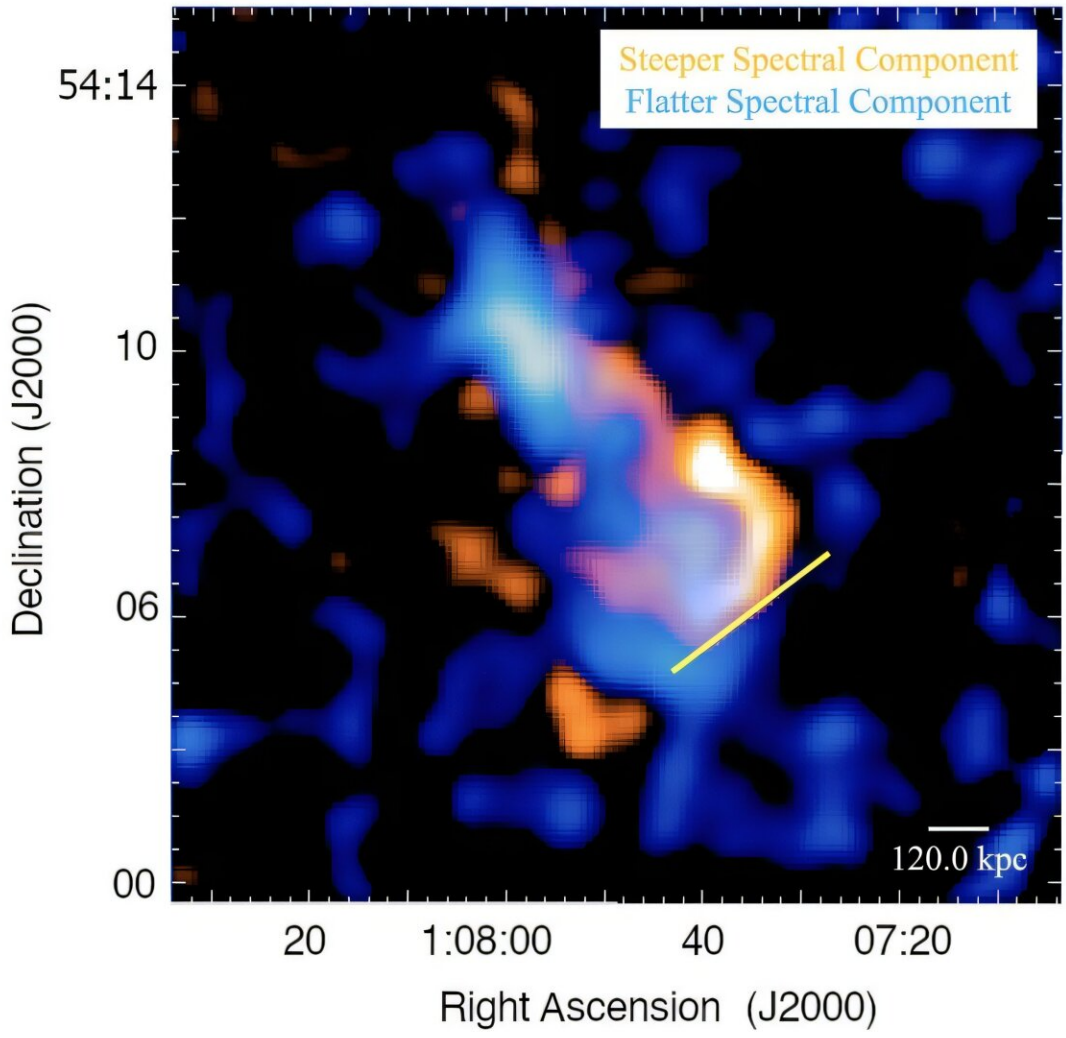

Spectral separation image produced using a technique related to that of spectral tomography in order to highlight the flatter and steeper components in

CIZA0107. Credit: *arXiv* (2024). DOI: 10.48550/arxiv.2412.15015

Using the Very Large Array (VLA), an international team of astronomers have observed a nearby galaxy merger known as CIZA J0107.7+5408. Results of the observational campaign, presented December 20 on the preprint server *arXiv*, could help us better understand the merging processes that take place between galaxy clusters.

Galaxy clusters contain up to thousands of galaxies bound together by gravity. They generally form as a result of mergers and grow by accreting sub-clusters. These processes provide an excellent opportunity to study matter in conditions that cannot be explored in laboratories on Earth. In particular, merging galaxy clusters could help us better understand the physics of shock and cold fronts seen in the diffuse intra-cluster medium, the cosmic ray acceleration in clusters, and the self-interaction properties of dark matter.

At a redshift of approximately 0.1, CIZA J0107.7+5408, or CIZA0107 for short, is a nearby, post-core passage, dissociative binary cluster merger. It is a large, roughly equal mass disturbed system consisting of two subclusters, hosting two optical density peaks, with associated but offset X-ray emission peaks.

A group of astronomers led by Emma Schwartzmann of the U.S. Naval Research Laboratory in Washington, D.C., explored CIZA0107 with VLA, in order to shed more light on its properties.

"We present new 240–470 MHz and 2.0–4.0 GHz Very Large Array observations of CIZA0107. We image the diffuse emission at high resolution, constrain its integrated spectrum, and map the spectral index

distribution," the researchers wrote in the paper.

The new VLA observations confirmed the complex dynamical state of CIZA0107. The images show a dramatically disturbed merger system with a merger axis along the northeast–southwest direction.

The observations at 340 MHz and 3.0 GHz showcase diffuse radio emission on a scale of about 1.6 million light years in each of the two subclusters of CIZA0107. At 340 MHz, the astronomers also detected emission from two ultra-steep spectrum regions located to the northwest and southeast of the diffuse radio emission peak in the southwestern subcluster.

Furthermore, the study found that the two subclusters have a similar spectral index of approximately -1.3. For the ultra-steep spectrum regions, the researchers measured steeper spectral slopes between 74 MHz and 340 MHz of about −2.2 and −2.9 for the northwestern and southeastern regions, respectively.

The observations also found that the diffuse emission associated with the southwestern subcluster shows a sharp radio edge at 340 MHz. However, at 3.0 GHz the diffuse emission does not show any feature at the location of the 340 MHz radio edge and X-ray shock front, and in fact it extends beyond the shock.

Summing up the results, the authors of the paper underlined that the properties of the emission in CIZA0107 suggest that the system may host a double halo structure, or the emission may have its origin in two relics projected on the central cluster regions.

More information: Emma Schwartzman et al, Multi-frequency Radio Observations of the Dissociative Cluster Merger CIZA J0107.7+5408, *arXiv* (2024). DOI: 10.48550/arxiv.2412.15015

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