Study sheds more light on the diffuse radio emission from the galaxy cluster Abell 1213

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European astronomers have observed a galaxy cluster known as Abell 1213 using various spacecraft and ground-based facilities. The observations unveiled essential information about the diffuse radio emission from this source. The findings are reported in a paper published March 4 on the *arXiv* pre-print server.

Galaxy clusters 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.

At a redshift of 0.047, Abell 1213 is a poor low-mass galaxy cluster dominated in its central region by the radio galaxy 4C29.41 and two other radio galaxies. Previous observations of this cluster have found that it hosts a radio source assumed to be a small-sized radio halo—a diffuse, low-surface brightness synchrotron source.

A team of astronomers led by Walter Boschin of the University of La Laguna, Spain, has analyzed a huge set of data from space telescopes and ground-based observatories in order to shed more light on the properties of Abell 1213, the nature of its radio source and the diffuse emission from it.

"We used optical SDSS data to study the internal dynamics of the cluster. We also analyzed archival XMM-Newton X-ray data to unveil the properties of its hot intracluster medium. Finally we used recent

LOFAR data at 144 MHz, together with VLA data at 1.4 GHz, to study the spectral behavior of the diffuse radio source," the researchers wrote in the paper.

First of all, the observations found that Abell 1213 exhibits disturbed dynamics as its brightest cluster galaxy (BCG) has a very significant peculiar velocity. The results suggest that Abell 1213 is composed of several galaxy groups and its core is quite intricate. Furthermore, it was found that blue, star-forming galaxies are not restricted to the peripheral regions of Abell 1213, which seems to indicate that the cluster was formed through accretion of several poor groups rich in late-type galaxies.

Radio observations of Abell 1213 show that the diffuse radio emission has a size of about 1.66 million light years. However, it turned out that this radio emission does not follow the X-ray emission. Therefore, the extended source may be not a radio halo, but a tail of the central radio galaxy 4C29.41 bent by the interaction with the intracluster medium (ICM). Moreover, the data provided some evidence of fragmented diffuse radio emissions at the cluster center whose nature is uncertain.

The astronomers also suppose that the source of radio emission in Abell 1213 may be a radio relic, hence "fossil" electrons of 4C29.41 are reaccelerated by shock due to a merger. They argue that the spectral index distribution supports this hypothesis.

"The spectral index map of the radio source is compatible with a relic interpretation, possibly due to a merger in the N-S or NE-SW direction, in agreement with the substructures detected through the optical analysis. The fragmented, diffuse radio emissions at the cluster center could be the surface brightness peaks of a faint central radio halo," the researchers explained.

The authors of the paper noted that deeper X-ray observations of Abell 1213 are necessary in order to draw final conclusions regarding the nature of its diffuse radio emission.

More information: W. Boschin et al, Optical/X-ray/radio view of Abell 1213: A galaxy cluster with anomalous diffuse radio emission, *arXiv* (2023). 128.84.21.203/abs/2303.02528

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