Radio-loud active galactic nucleus detected in the protocluster SPT2349-56

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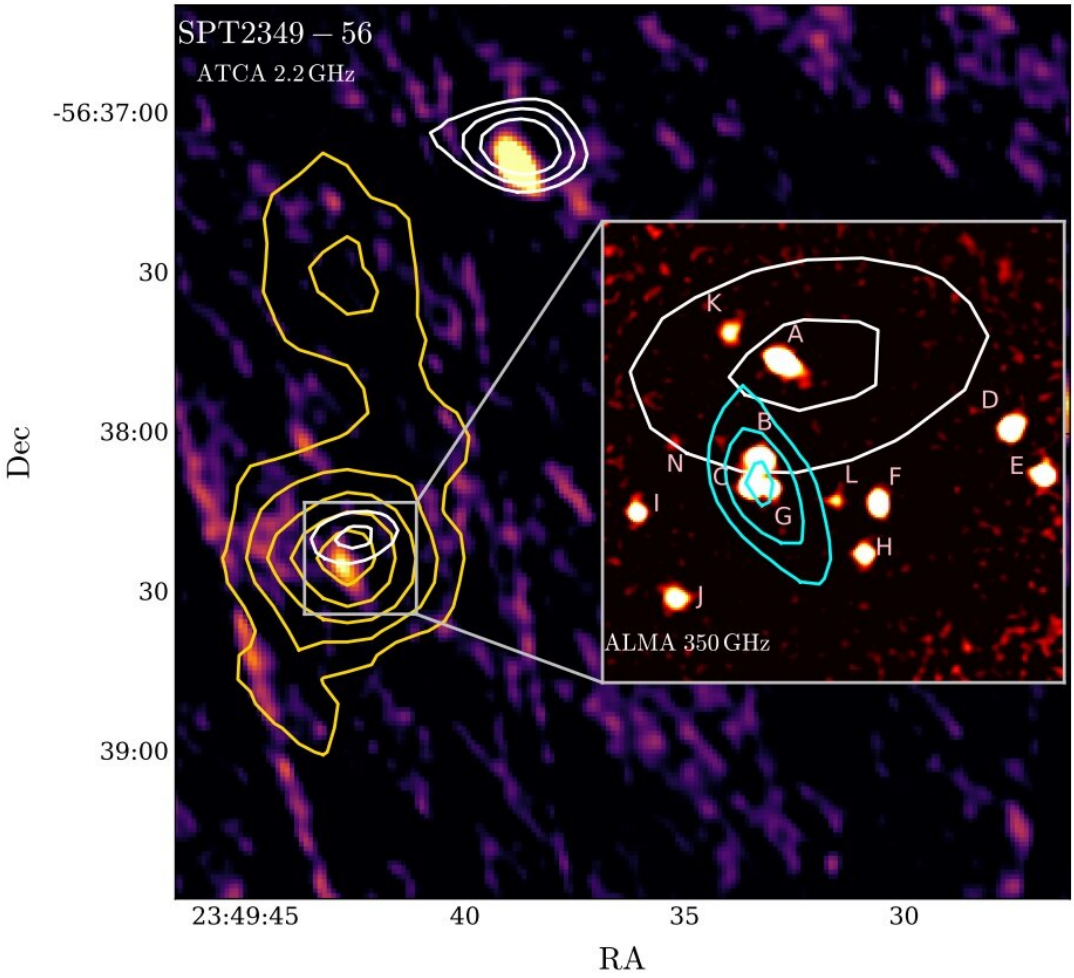

ATCA 2.2 GHz imaging of the SPT2349−56 region, with gold contours highlighting the 106 mJy extended LABOCA source at 870μm. A 20'' × 20'' zoom-in of ALMA 350 GHz continuum imaging (Hill et al. 2022) with overlays of ATCA 2.2 GHz (cyan), ASKAP 888 MHz (white). Credit: Chapman et al,

Using the Australia Telescope Compact Array (ATCA), an international team of astronomers has observed the population of submillimeter galaxies in a protocluster known as SPT 2349-56. As a result, they found a radio-loud active galactic nucleus in the protocluster's central region. The discovery was detailed in a paper published January 3 on the *arXiv* preprint server.

Galaxy clusters contain hundreds to thousands of galaxies bound together by gravity. They are the largest known gravitationally bound structures in the universe, which could serve as excellent laboratories for studying galaxy evolution and cosmology.

Astronomers are especially interested in studies of protoclusters of galaxies, the progenitors of clusters. Such objects, found at high redshifts (over 2.0), could provide essential information about the universe at its early stages.

Active galactic nuclei (AGNs) are accreting, supermassive black holes (SMBHs) residing at the centers of some galaxies, emitting powerful, high-energy radiation as they accrete gas and dust. These nuclei can form jets, having mostly cylindrical, conical or parabolic shapes, which are observed even on megaparsec scales.

A group of astronomers led by Scott P. Chapman of the Dalhousie University in Halifax, Canada, has employed ATCA to observe SPT 2349-56 with the main aim of detecting radio-loud AGNs in the population of its submillimeter galaxies (SMGs). SPT 2349-56 is a protocluster at a redshift of 4.3, containing one of the most actively star-forming cores known. The protocluster hosts at least 30 SMGs.

"We have observed the z = 4.3 protocluster SPT2349-56 with the Australia Telescope Compact Array with the aim of detecting radio-loud active galactic nuclei amongst the ~ 30 submillimeter (submm) galaxies identified in the structure," the researchers wrote in the paper.

The observations detected in SPT2349-56 a single radio source at 2.2 GHz, spatially coincident with the central three luminous member galaxies of the protocluster, designated B, C, and G. The astronomers noted that while this radio source lies close to C, it cannot be ruled out that the radio emission is coming from B or G, or even a combination of the galaxies.

The results suggest that an AGN is driving the newly detected radio emission in the central region of SPT2349-56. This radio-loud AGN has a steep spectrum, with an index of −1.58, and its luminosity density at 2.2 GHz was measured to be about 44 YW/Hz. The power of the radio jet of this AGN is estimated to be around 100 trillion YW.

Summing up the results, the astronomers added that no other clear signs of AGN activity have yet been detected in SPT2349-56. They underlined that their finding may help us better understand the formation and evolution of this protocluster.

"The fact that the radio AGN is detected in the hypothesized central seed of a growing BCG [brightest cluster galaxy] with significant stellar mass already in place makes this discovery an important new ingredient in understanding the formation and evolution of the cluster," the authors of the paper concluded.

More information: Scott C. Chapman et al, Brightest Cluster Galaxy Formation in the z=4.3 Protocluster SPT2349-56: Discovery of a Radio-Loud AGN, *arXiv* (2023). DOI: 10.48550/arxiv.2301.01375