Unexpected phenomenon in a merger of a cluster of galaxies

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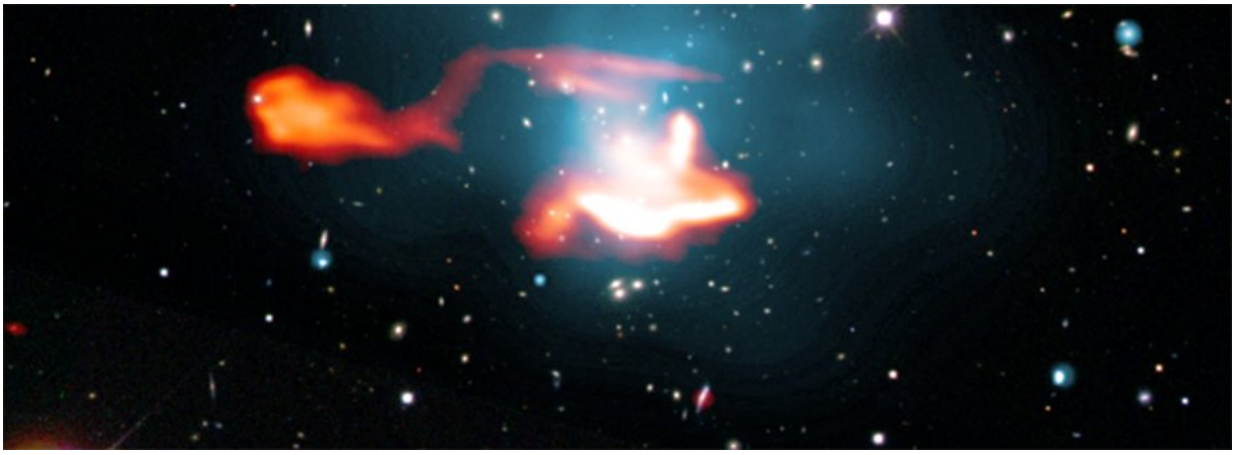

A galaxy (in orange) moves to the left and leaves a gas trail. The trail seems to extinguish slowly, but lightens up again near the second, white-yellow galaxy. Most white dots in the image are complete galaxies. Credit: Leiden University

An international team of astronomers led by Francesco de Gasperin has witnessed a gas tail of a galaxy that slowly extinguished, but then reignited. It is unclear where the energy for the rejuvenation comes from. The researchers have published their findings in *Science Advances*.

The astronomers were investigating Abell 1033. This is a cluster that consists of two smaller, merging clusters. Abell 1033 is located in the northern constellation of Leo Minor (near Ursa Major). Clusters of

galaxies are the largest structures in the universe. They can contain hundreds to thousands of galaxies similar to the Milky Way. Smaller clusters can merge together to form a larger cluster.

The astronomers observed that an individual galaxy in one cluster of Abell 1033 left a trail of gas as it traveled through the other cluster. On an astronomical scale, such a trail resembles the trail of coloured smoke behind a stunt plane.

The astronomers had expected that the gas trail, like the ones behind a stunt plane, would slowly die and eventually disappear. To their astonishment, they saw that the end of the gas trail was brighter than the middle.

"This was totally unexpected," says Francesco de Gasperin. "As these clouds of electrons radiate away their energy over time, they should become fainter and disappear. Instead, in this case, after more than a hundred million years, the tail of electrons is brightly glowing."

There is no precise explanation for the phenomenon, yet. It seems that the trail brightens near the centre of the other cluster of galaxies. De Gasperin says, "Part of the energy released in the merger event must have been transferred to rejuvenate the cloud of electrons."

The research on merging clusters of galaxies is complicated because astronomers only see a snapshot of the process that in total takes billions of years. In addition to that, the telescopes that are needed for the investigation have to receive signals with extremely low frequencies.

The astronomers combined data from the Indian Giant Metrewave Radio Telescope and LOFAR, the Low Frequency Array. LOFAR was designed and built by the Dutch research institute ASTRON. The telescope consists of thousands of antennas spread across eight countries.

The heart of LOFAR is in Drenthe in the north-east of the Netherlands.

"It's like being among the last explorers. As soon as we move into uncharted territories, or in this case, unexplored frequencies, our universe is still full of surprises," says De Gasperin. "And this is just a first step. Much is still to be done to understand the complexity of galaxy clusters, and find what is lurking at low radio frequencies."

More information: Francesco de Gasperin et al. Gentle reenergization of electrons in merging galaxy clusters, *Science Advances* (2017). DOI: 10.1126/sciadv.1701634

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