RAD@home Citizen scientists discover a monster blackhole spewing fire at another galaxy.

A team of scientists, led by Ananda Hota have discovered an extremely rare case of a monster black hole spewing a fiery jet at another galaxy, using GMRT and several other international telescopes. Such radio jets are almost every time two-sided, but in this case, the jet appears one-sided, which is puzzling. It is widely believed that winds and jets are also responsible for suppressing the formation of new stars in galaxies. This new discovery (RAD12) by the RAD@home Citizen Science Research Collaboratory (#RADatHomeIndia) will be an opportunity in understanding this process of suppression of star formation and a demonstration of direct public participation in research.

Galaxies, like our Milkyway comprising 100 billion stars, are the building blocks of our Universe. They are divided into two major classes, Spiral and Ellipticals. Spirals have optically blue-looking spiral arms with a lot of cold gas and dust where new stars form at an average rate of one Sun-like star every year. On the other hand, ellipticals look yellowish and are featureless. It is still puzzling to astronomers why the elliptical galaxies we see today have not been forming new stars for several billions of years. Thus the ellipticals are called “red-and-dead” galaxies. Supermassive or monster black holes are the likely culprits in stopping the formation of new stars in ellipticals. These monsters spew gigantic fiery jets or radio-emitting plasma and destroy fuels (cold molecular gas) for future star formation. Thus these red-and-dead galaxies are the “hot-and-happening” systems when we look beyond optical images in radio and X-ray bands of the electromagnetic spectrum.

With the help of citizen scientists, astronomers have discovered a unique monster black hole spewing a fiery jet at another galaxy. This monster is hosted in a galaxy named RAD12. This discovery entitled "RAD@home citizen science discovery of an AGN spewing a large unipolar radio bubble onto its merging companion galaxy" has been published recently in the Letters of the Monthly Notices of the Royal Astronomical Society (MNRAS), of the Oxford University Press of the United Kingdom.

Although the puzzling aspect of RAD12 had been spotted in 2013 using optical data from Sloan Digitised Sky Survey (SDSS) and radio data from the Very Large Array (FIRST survey), it had to wait for follow-up observation with the Giant Meterwave Radio Telescope (GMRT, India) to reveal its truly exotic nature. One of the things GMRT is good at is “black hole archaeology,” which means GMRT is most sensitive to radio radiation from the old magnetized relativistic plasma rejected by monster black holes as stars and gas get dragged in through the accretion disks.

A conical stem of young plasma (pink in the tricolour image) is seen ejected from the centre and reaches far beyond the stellar envelope of the elliptical host galaxy (RAD12). GMRT observation revealed that the fainter and older relativistic plasma extends far beyond the central conical stem and flares out like the cap of a mushroom (red in the tricolour image). The whole structure is shaped like a giant mushroom, 440 thousand light-years long, much bigger than the host galaxy itself. The MeerKAT radio telescope in South Africa confirms the mushroom structure. Compared with the GMRT image, it helped constrain regions of the young (Stem) versus old (Cap) nature of the radio mushroom.

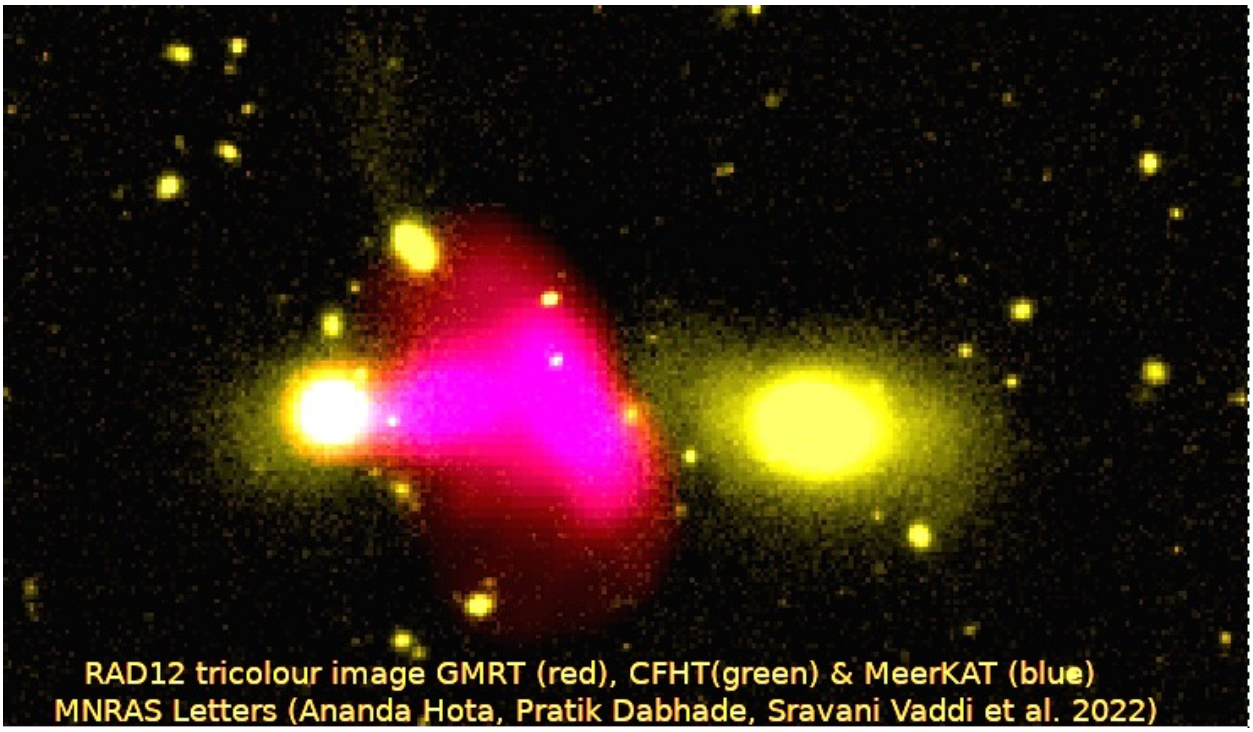
On the other hand, deep optical data from the Canada-France Hawaii Telescope revealed that the host galaxy of the monster is disturbed due to gravitational interaction with a companion galaxy which is a more massive elliptical galaxy. The redshift measurement from SDSS informs that both

galaxies are at a distance of 1 billion light years. Thus CFHT and SDSS data confirm the close companionship and predict a merger of these two galaxies in the next one billion years.
We are one step closer to understanding the impact of such fiery interactions on the ellipticals, where they are left with little cold gas for any future star formation. Instant bursts of star formation can be seen if such jets hit a small gas-rich galaxy, like in the famous Minkowski's Object. But RAD12 is unlike anything known so far. It is the first time a jet hits a really big galaxy. Probably due to this, the jet is taking a U-turn and forming a mushroom bubble. The interaction does not show signs of young star formation either, likely because the ellipticals are gas-poor. (Please see the animation of the interaction, a video is linked at the end.)
The cherry on the Cake: The monster appears to be ejecting the jet only towards its neighbour; what happened to the counter-jet in RAD12? In all cases, jets are ejected in pairs, moving in opposite directions at relativistic speeds. Why only one jet is seen in RAD12, despite sensitive observations with the GMRT and MeerKAT, still remains a puzzle.

The RAD@home Collaboratory welcomes collaboration with other astronomers for future investigation in multiple wavelength campaigns with multiple telescopes. The Collaboratory invites not only professional astronomers but also interested citizens with university-level science degrees to participate in this citizen Science research program. RAD12 Discovery is a beautiful example of how the public (particularly University science students) can directly participate in real astronomy discovery sitting at home.

The team of astronomers has been led by Dr. Ananda Hota (UM-DAE Centre for Excellence in Basic Sciences, University of Mumbai, India), Dr Pratik Dabhade (Observatoire de Paris, France), Dr Sravani Vaddi (Arecibo Observatory, USA). Dr Hota is the Founder, Director and Principal Investigator of the RAD@home Astronomy Collaboratory, which made this citizen science discovery possible (#CitizenScience #RADatHomeIndia https://radathomeindia.org/.) The ODI link to the published MNRAS Letters Journal is here https://doi.org/10.1093/mnrasl/slac116
An animation video explaining the interaction of the radio jet and the galaxy has been creaated and made available for the Public at the link https://youtu.be/BwnfUq5mCEE

Other than Drs. Hota, Dabhade and Vaddi the team includes Indian astronomers Dr. Chiranjib Konar (Amity University), Dr. Sabyasachi Pal (Midnapore City College), Dr. Mamta Gulati (Thapar Institute of Engineering and Technology), Dr. C S. Stalin (Indian Institute of Astrophysics) and Mr Ck. Avinash, Mr Avinash Kumar, Ms Megha Rajoria, Ms Arundhati Purohit from RAD@home Collaboratory.



Caption: Tricolour image of the newly discovered RAD12, showing the optical image from CFHT (in yellow) and radio images from GMRT (325 MHz in red) and MeerKAT (900 MHz in blue). During the merger of these two galaxies, the supermassive blackhole at the centre of the smaller galaxy shoots out a relativistic magnetised plasma jet hitting the bigger companion galaxy.

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