NCRA Press NOTE

Pune astronomers lead the discovery of a new, rare type of radio sources using the GMRT

Using the Giant Metrewave Radio Telescope (GMRT) of the National Centre for Radio Astrophysics (NCRA-TIFR), Pune, a team largely consisting of Pune based radio astronomers has recently announced the discovery of a new, rare class of radio sources. This has been named as 'EISERS', which stands for 'Extremely Inverted Spectrum Extragalactic Radio Sources'. This discovery has the potential to challenge the current understanding that a universal mechanism can explain the emission of radio waves in all radio sources. This research has been published in the international journal, Monthly Notices of the Royal Astronomical Society (MNRAS), London.

During the past 70 years, radio astronomy has revolutionised our vision of the cosmos. One of the foremost radio astronomy facilities is the Giant Metrewave Radio Telescope (GMRT), near Pune, built and operated by the National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research. The GMRT consists of 30 antennas, each of 45 metre diameter, spread over about 30 kms around Khodad village, near Narayangaon in the Junnar Taluka. The GMRT has been upgraded recently, maintaining its position amongst the most sensitive radio telescopes in the world today.

A small subset of galaxies which emits exceptionally powerful emission at radio frequencies, are referred to as "radio galaxies". The powerful radio emission is produced due to free electrons moving at speeds close to the speed of light in the presence of magnetic fields. This mechanism is called "synchrotron mechanism" and the electrons producing the synchrotron radio waves, occur over a wide range of energies, such that their distribution across the energy range is believed to follow a specific shape which is a "power-law" in the logarithmic space. The power-law distribution of electron energies has in fact been confirmed for numerous radio galaxies observed by radio astronomers since the 1960s. This has led to the belief that the power-law distribution of electrons is universal.

The question remains whether the power-law energy distribution is indeed universal, or non-power-law energy distributions arise under certain circumstances? The test

requires **accurate** measurement of the radio spectra of the compact radio sources mainly at low radio frequencies. A key prediction from the standard synchrotron theory is that the logarithmic slope of the declining radio spectrum cannot be larger than +2.5, so long as the energy distribution of the radiating charged particles has a power-law shape. An even steeper spectral slope, if ever found, would signal a deviation from a power-law energy distribution. And discovery of such galaxies would put a serious question mark on the popular hypothesis of the existence of a universal power-law mechanism.

A few years ago, a team led by Prof. Gopal Krishna initiated the first systematic search for radio galaxies having a radio spectrum with a slope greater than +2.5. The team included S. K. Sirothia, M. Mhaskey, P. Ranadive, P. J. Wiita, A. Goyal, N. G. Kantharia and C. H. Ishwara-Chandra. They christened such rare radio galaxies as `EISERS' (`Extremely Inverted Spectrum Extragalactic Radio Sources') and isolated 7 radio sources as potential EISERS. Follow-up measurements of these objects with the GMRT, have confirmed one of them as EISERS, while a second candidate is also found to be very likely a genuine EISERS. These findings have been published in the same journal (MNRAS) in February 2019, by a team consisting of Mukul Mhaskey (SP Pune University), Gopal Krishna (ARIES, Nainital), Surajit Paul (SP Pune University), Pratik Dabhade (IUCAA), Sameer Salunkhe (SP Pune University) and Sandeep Sirothia (SKA-South Africa). This discovery re-opens the key question whether the highly energetic electrons responsible for radio-wave emission in radio galaxies are accelerated by a single universal mechanism.

The Team

Mukul Mhaskey:8087267295, Gopal-Krishna:9850415719, Surajit Paul:9405510226

Pratik Dabhade: 7875534695, Sameer Salunke : 8668287219, Ishwara Chandra : 9403136630

NCRA contact persons :

Ishwara Chandra: 9403136630, J K Solanki: 9890447888, Anil Raut : 8605525945