Observations shed more light on the behavior of a nearby blazar

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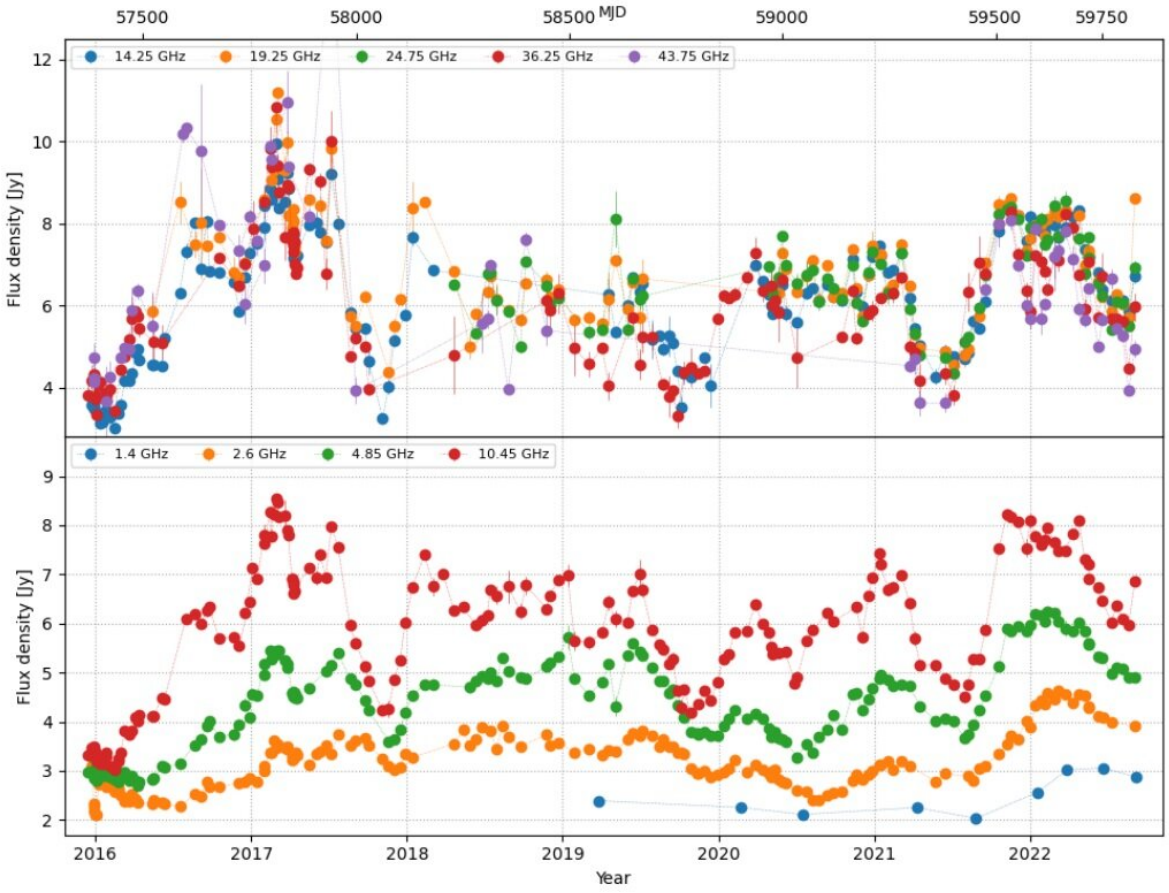

Multifrequency radio light curves of OJ 287 between December 2015 and June 2022 obtained with the Effelsberg telescope. Credit: Komossa et al, 2023

An international team of astronomers has conducted a long-term multi-

frequency radio monitoring of a nearby blazar known as OJ 287. Results of the observational campaign, published February 22 on the pre-print server *arXiv*, shed more light about the behavior of this blazar, especially regarding its radio variability.

Blazars are very compact quasars associated with supermassive black holes (SMBHs) at the centers of active, giant elliptical galaxies. They belong to a larger group of active galaxies that host active galactic nuclei (AGN), and are the most numerous extragalactic gamma-ray sources. Their characteristic features are relativistic jets pointed almost exactly toward the Earth.

Based on their optical emission properties, astronomers divide blazars into two classes: flat-spectrum radio quasars (FSRQs) that feature prominent and broad optical emission lines, and BL Lacertae objects (BL Lacs), which do not. Some blazars are high synchrotron peaked (HSP) sources as their synchrotron peak is above 1,000 THz in the rest frame. Observations show that particles are efficiently accelerated up to very high energies (VHEs) in the jets of HSPs, which makes such sources very interesting for astronomers studying extreme blazars.

At a redshift of 0.306, OJ 287 is a nearby highly variable and highly polarized blazar, classified as a BL Lac. It is very bright across the electromagnetic spectrum, exhibiting exceptional bright optical flares, repeating every 11–12 years. Recent observations have also detected OJ 287 in the gamma-ray and VHE regime.

Although OJ 287 has been comprehensively studied in the optical/ultraviolet, X-ray and gamma-ray bands, still very little is known about its behavior in the radio regime. Therefore, a group of astronomers led by Stefanie Komossa of the Max Planck Institute for Radio Astronomy in Bonn, Germany, performed multifrequency radio observations of this source using mainly the Effelsberg 100-m radio

telescope in Bad Münstereifel, Germany.

The researchers managed to characterize in detail the radio flux and spectral variability of OJ287, during the observed period between 2015 and 2022, including turn-over frequencies, spectral indices, fractional variability amplitudes and discrete correlation functions (DCFs). The long-term monitoring also allowed them to cover a large non-thermal multiwavelength outburst, which occurred in 2016–2017, accompanied by strong radio flaring (with peak in February 2017 at a flux density of 10.8 Jy at 32 GHz).

The observations found that deep low-states of OJ 287 repeat every 1–2 years in the optical and radio bands. Moreover, the results indicate that the two brightest gamma-ray flares in recent years coincide with the sharp rise and re-rise of the recent (2021–2022) bright radio flare, which suggests a causal connection.

According to the study, the so-called "precursor flare" activity in OJ 287, predicted by the precessing binary model to occur in December 2021, is absent. The astronomers speculated that one of the optical flares in the 2005 light curve of the blazar was driven by binary supermassive black hole activity in the form of a precursor flare preceding the main outburst. Based on the precessing binary model it was predicted that the precursor flare would repeat on December 23, 2021.

"Neither the flare, nor the thermal bremsstrahlung spectrum were observed; neither in 2021 December nor any other time until 2022 June," the researchers wrote.

Based on the collected data, the authors of the paper interpret the big 2016/2017 outburst as the latest of the characteristic semi-periodic double-peaked outbursts that occur in OJ 287. They predict that the next double-peaked outburst should take place between 2026 and 2028.

More information: S. Komossa et al, MOMO VI: Multifrequency radio variability of the blazar OJ 287 from 2015-2022, absence of predicted 2021 precursor-flare activity, and a new binary interpretation of the 2016/2017 outburst, *arXiv* (2023). DOI: 10.48550/arxiv.2302.11486