# Reseachers find out why a supermassive black hole appears to move

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Credit: Instituto de Astrofísica de Canarias

Researchers often assume that massive galaxies host supermassive black holes (SMBHs) in their nuclei. In recent years, observers have sought galaxies that might contain an SMBH that is displaced from its equilibrium position. Among the scenarios that could cause such a displacement are the merger of two SMBHs or the existence of a binary pair of SMBHs, and finding an example would give astronomers information about the evolution of galaxies and the frequency of the formation and mergers of this type of object.

One of the candidates for a displaced SMBH is the giant elliptical galaxy M87, which contains one of the nearest and most studied galactic nuclei (AGN). Previous studies on the displacement of the SMBH of M87 produced conflicting results. However a new study by Elena López Návas, a student at the University of La Laguna, has produced new data suggesting that the SMBH in this galaxy is in its equilibrium position, and that the displacements found previously were due to variations in the centre of production of light, the "photocentre" caused by outbursts from its relativistic jet, a flow of material expelled from near the surface of the black hole at velocities close to light speed.

To perform this research, it was necessary to analyze a large number of high-resolution images of M87 taken at different times and with different instruments on the NASA/ESA Hubble Space Telescope (HST) and on ESA's Very Large Telescope (VLT) (Cerro Paranal, Chile).

"In our work, we have found that the SMBH has been in a very stable position for the past 20 years. What has changed is the centre of light production, the"'photocentre,"" explains López, the author of this study, which has just been published in the journal *Monthly Notices of the Royal Astronomical Society* (*MNRAS*).

"As a result of what we have found, we realised that the images which appeared to show a displacement of the centre of the galaxy were taken at an epoch when M87 had a major outburst, which could be measured over the whole range of the electromagnetic spectrum," says Almudena Prieto Escudero, co-author of the article and a researcher at the Instituto de Astrofísica de Canarias (IAC).

This outburst took place between the years 2003 and 2007 in a knot within the jet known as HST-1, the closest knot to the nucleus of M87. While this outburst lasted, this knot increased in brightness so much that it even outshone the nucleus itself.

"A time series analysis of the displacements of the centre of the galaxy show that this outburst is related to the change in the position of the photocentre," explains the astrophysicist. "But afterward, the photocentre and the nucleus were in the same place, so that we inferred that the nucleus and the black hole were always in the same place, which is the potential mínimum at the centre of the

galaxy."

These new data have inspired much interest in the astrophysical community, because studying the position of the SMBH in M87 is critical for understanding the evolution of the galaxy, and for the analysis of jets in other AGNs. "In addition, this research reminds us that we must be very careful when we study variable sources that show irregularities,such as this enormous jet," says Lopez, who is now working with a training research contract at the IAC.

**More information:** E López-Navas et al. The photocentre-AGN displacement: is M87 actually harbouring a displaced supermassive black hole?, *Monthly Notices of the Royal Astronomical Society* (2018). DOI: 10.1093/mnras/sty2148

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