Astronomers discover a trio of quasars

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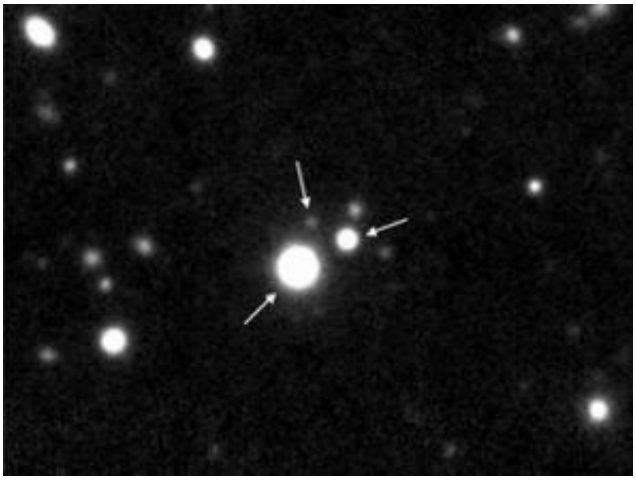

Keck Observatory image of a triple quasar. Arrows mark the location of three physically distinct quasars in a compact galaxy cluster. Credit: Caltech, EPFL and Keck Observatory

Using ESO's Very Large Telescope and the W.M. Keck Observatory, astronomers at the Ecole Polytechnique Fédérale de Lausanne in Switzerland and the California Institute of Technology, USA, have discovered the first known triplet of quasars. This close trio of supermassive black holes lies about 10.5 billion light-years away towards the Virgo (The Virgin) constellation.

"Quasars are extremely rare objects," says George Djorgovski, from Caltech and leader of the team that made the discovery. "To find two of them so close together is very unlikely if they were randomly distributed

in space. To find three is un-precedented."

The findings are being reported at the winter 2007 meeting of the American Astronomical Soci-ety in Seattle, USA. Quasars are extraordinary luminous objects in the distant universe, thought to be powered by supermassive black holes at the heart of galaxies. A single quasar could be a thousand times brighter than an entire galaxy of a hundred billion stars, and yet this remarkable amount of energy originates from a volume smaller than our solar system. About a hundred thousand quasars have been found to date, and among them several tens of close pairs, but this is the first known case of a close triple quasar system.

Quasars (QUAsi StellAR Sources) were first discovered in 1963 by the Dutch-American as-tronomer Maarten Schmidt at the Palomar Obser-vatory (California, USA) and the name refers to their 'star-like' appearance on the images ob-tained at that time. Distinguishing them from stars is thus no easy task and discovering a close trio of such objects is even less obvious.

The feat could only be accomplished by combining images from two of the largest ground-based telescopes, ESO's 8.2-m Very Large Tele-scope at Cerro Paranal, in Chile, and the W. M. Keck Observatory's 10-m telescope atop Mauna Kea, Hawaii, as well as using very sophisticated and efficient image sharpening method.

The distant quasar LBQS 1429-008 was first discovered in 1989 by an international team of astronomers led by Paul Hewett of the Institute of Astronomy in Cambridge, England. Hewett and his collaborators found a fainter companion to their quasar, and proposed that it was a case of gravitational lensing. According to Einstein's gen-eral theory of relativity, if a large mass (such as a big galaxy or a cluster of galaxies) is placed along the line of sight to a distant quasar, the light rays are bent,

and an observer on Earth will see two or more close images of the quasar – a cosmic mi-rage. The first such gravitational lens was discov-ered in 1979, and hundreds of cases are now known.

However, several groups over the past several years cast doubts that this system is a gravitational lens, and proposed instead that it is a close physical pair of quasars.

What the Caltech-Swiss team has found is that there is a third, even fainter quasar associated with the previously known two. The three quasars have the same redshift, hence, are at the same distance from us.

The astronomers performed an extensive theo-retical modeling, trying to explain the observed geometry of the three images as a consequence of gravitational lensing. "We just could not repro-duce the data," says Frédéric Courbin of Lausanne. "It is essentially impossible to account for what we see using reasonable gravitational lensing models." Moreover, there is no trace of a possible lens-ing galaxy, which would be needed if the system were a gravitational lens. The team has also docu-mented small, but significant differences in the properties of the three quasars. These are much easier to understand if the three quasars are physically distinct objects, rather than gravita-tional lensing mirages. Combining all these pieces of evidence effectively eliminated lensing as a possible explanation.

"We were left with an even more exciting pos-sibility that this is an actual triple quasar," says Georges Meylan, also from Lausanne. The three quasars are separated by only about 100,000 to 150,000 light-years, which is about the size of our own Milky Way.

Gravitational lensing can be used to probe the distribution of dark and visible mass in the uni-verse, but quasar pairs -and now a triplet- provide astronomers with a different kind of insight.

"Quasars are believed to be powered by gas falling into supermassive black holes," says Djor-govski. "This process happens very effectively when galaxies collide or merge, and we are ob-serving this system at the time in the cosmic his-tory when such galaxy interactions were at a peak."

If galaxy interactions were responsible for the quasar activity, having two quasars close together would be much more likely than if they were ran-domly distributed in space. This may explain the unusual abundance of binary quasars, which have been reported by several groups. "In this case, we are lucky to catch a rare situation where qua-sars are ignited in three interacting galaxies," says Ashish Mahabal, one of the Caltech scientists in-volved in the study. Discoveries of more such systems in the future may help astronomers understand better the fun-damental relationship between the formation and evolution of galaxies, and the supermassive black holes in their cores, now believed to be common in most large galaxies, our own Milky Way in-cluded.

This work is also described in a paper submitted to the Astrophysical Journal Letters. The team is com-posed of S. George Djorgovski, Ashish Mahabal, and Eilat Glikman of Caltech (USA), Frédéric Courbin, Georges Meylan and Dominique Sluse of the Ecole Polytechnique Fédérale de Lausanne (Switzerland), and David Thompson of the University of Arizona's Large Binocular Telescope Observatory (USA).

Source: ESO