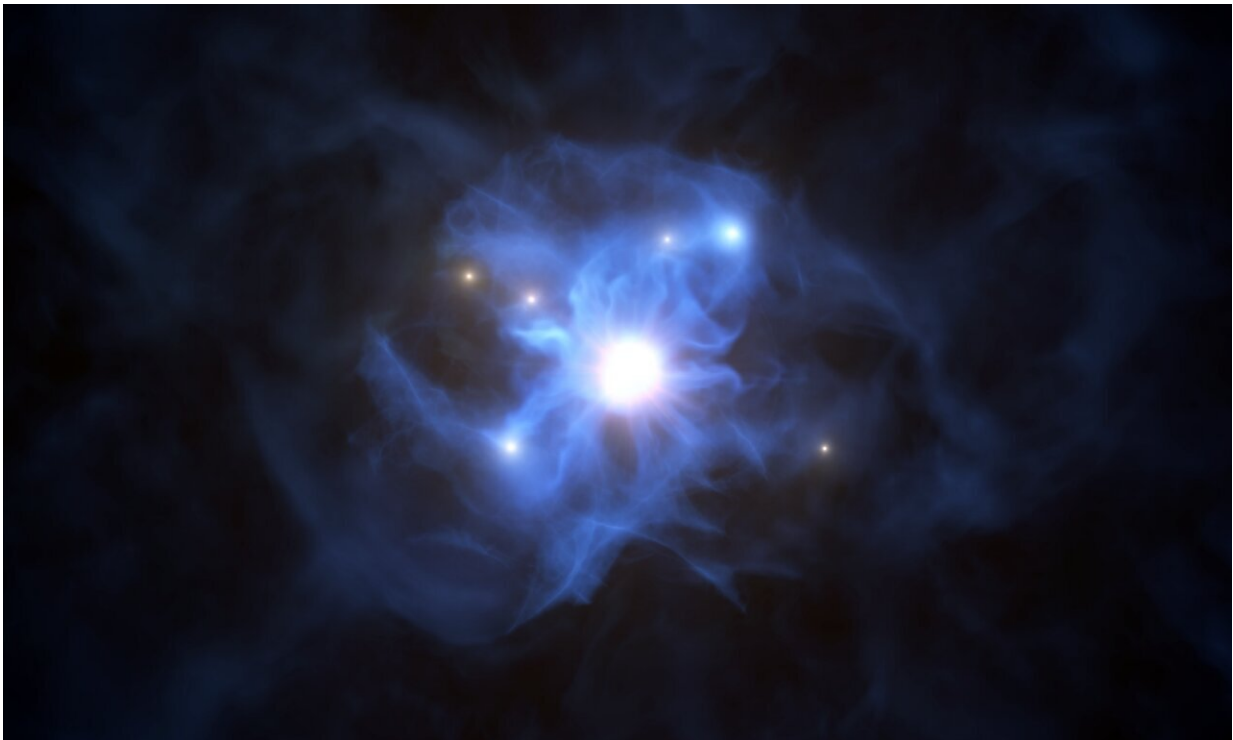


Very Large Telescope spots galaxies trapped in the web of a supermassive black hole

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With the help of ESO's Very Large Telescope (VLT), astronomers have found six galaxies lying around a supermassive black hole, the first time such a close grouping has been seen within the first billion years of the Universe. This artist's impression shows the central black hole and the galaxies trapped in its gas web. The black hole, which together with the disc around it is known as quasar SDSS J103027.09+052455.0, shines brightly as it engulfs matter around it. Credit: ESO/L. Calçada

With the help of ESO's Very Large Telescope (VLT), astronomers have found six galaxies lying around a supermassive black hole when the Universe was less than a billion years old. This is the first time such a close grouping has been seen so soon after the Big Bang and the finding helps us better understand how supermassive black holes, one of which exists at the centre of our Milky Way, formed and grew to their enormous sizes so quickly. It supports the theory that black holes can grow rapidly within large, web-like structures which contain plenty of gas to fuel them.

"This research was mainly driven by the desire to understand some of the most challenging [astronomical objects](#)—[supermassive black holes](#) in the early Universe. These are extreme systems and to date we have had no good explanation for their existence," said Marco Mignoli, an astronomer at the National Institute for Astrophysics (INAF) in Bologna, Italy, and lead author of the new research published today in *Astronomy & Astrophysics*.

The new observations with ESO's VLT revealed several galaxies surrounding a supermassive black hole, all lying in a cosmic "spider's web" of gas extending to over 300 times the size of the Milky Way. "The cosmic web filaments are like spider's web threads," explains Mignoli. "The galaxies stand and grow where the filaments cross, and streams of gas—available to fuel both the galaxies and the central supermassive black hole—can flow along the filaments."

The light from this large web-like [structure](#), with its black hole of one billion solar masses, has travelled to us from a time when the Universe was only 0.9 billion years old. "Our work has placed an important piece in the largely incomplete puzzle that is the formation and growth of such extreme, yet relatively abundant, objects so quickly after the Big Bang," says co-author Roberto Gilli, also an astronomer at INAF in Bologna, referring to supermassive black holes.

The very first black holes, thought to have formed from the collapse of the first stars, must have grown very fast to reach masses of a billion suns within the first 0.9 billion years of the Universe's life. But astronomers have struggled to explain how sufficiently large amounts of "black hole fuel" could have been available to enable these objects to grow to such enormous sizes in such a short time. The new-found structure offers a likely explanation: the "spider's web" and the galaxies within it contain enough gas to provide the fuel that the central black hole needs to quickly become a supermassive giant.

But how did such large web-like structures form in the first place? Astronomers think giant halos of mysterious dark matter are key. These large regions of invisible matter are thought to attract huge amounts of gas in the early Universe; together, the gas and the invisible dark matter form the web-like structures where galaxies and black holes can evolve.

"Our finding lends support to the idea that the most distant and massive black holes form and grow within massive dark matter halos in large-scale structures, and that the absence of earlier detections of such structures was likely due to observational limitations," says Colin Norman of Johns Hopkins University in Baltimore, US, also a co-author on the study.

The galaxies now detected are some of the faintest that current telescopes can observe. This discovery required observations over several hours using the largest optical telescopes available, including ESO's VLT. Using the MUSE and FORS2 instruments on the VLT at ESO's Paranal Observatory in the Chilean Atacama Desert, the team confirmed the link between four of the six galaxies and the black hole. "We believe we have just seen the tip of the iceberg, and that the few galaxies discovered so far around this supermassive black hole are only the brightest ones," said co-author Barbara Balmaverde, an astronomer at INAF in Torino, Italy.

These results contribute to our understanding of how supermassive black holes and large cosmic structures formed and evolved. ESO's Extremely Large Telescope, currently under construction in Chile, will be able to build on this research by observing many more fainter [galaxies](#) around massive [black holes](#) in the early Universe using its powerful instruments.

More information: M. Mignoli et al. Web of the giant: Spectroscopic confirmation of a large-scale structure around the $z=6.31$ quasar SDSS J1030+0524, *Astronomy & Astrophysics* (2020). [DOI: 10.1051/0004-6361/202039045](#)

Provided by ESO

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