

Chance microlensing events probe galactic cores

July 1 2016



Artist's rendering of ULAS J1120+0641, a very distant quasar (an extreme AGN) powered by a black hole with a mass two billion times that of the Sun.
Credit: ESO/M. Kornmesser

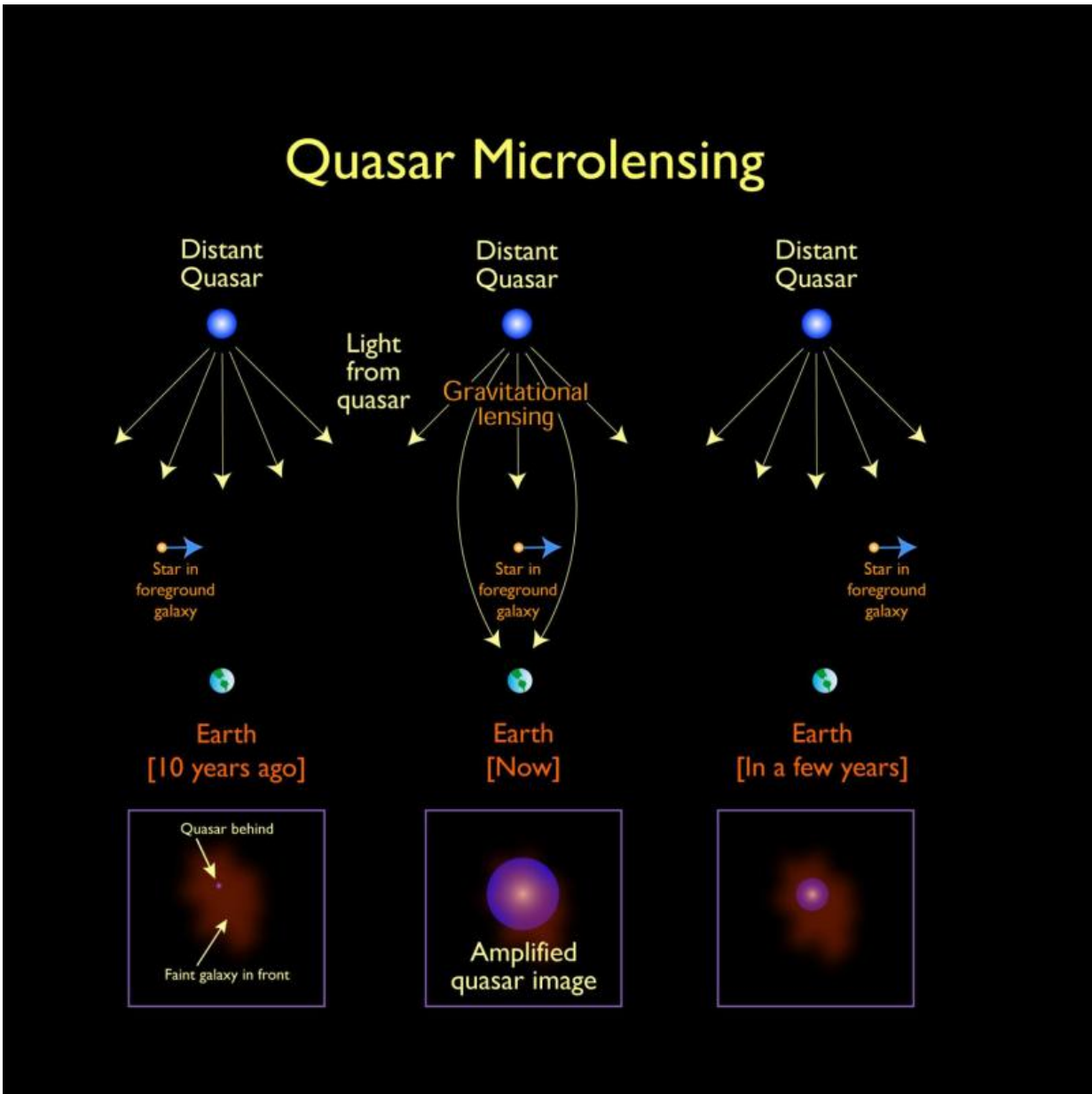
Some galaxies pump out vast amounts of energy from a very small volume of space, typically not much bigger than our own solar system. The cores of these galaxies, so called Active Galactic Nuclei or AGNs,

are often hundreds of millions or even billions of light years away, so are difficult to study in any detail. Natural gravitational 'microlenses' can provide a way to probe these objects, and now a team of astronomers have seen hints of the extreme AGN brightness changes that hint at their presence. Leading the microlensing work, PhD student Alastair Bruce of the University of Edinburgh presents their work today (Friday 1 July) at the National Astronomy Meeting in Nottingham.

The energy output of an AGN is often equivalent to that of a whole galaxy of stars. This is an output so intense that most [astronomers](#) believe only gas falling in towards a [supermassive black hole](#) – an object with many millions of times the mass of the Sun - can generate it. As the gas spirals towards the black hole it speeds up and forms a disc, which heats up and releases energy before the gas meets its demise.

Scientists are particularly interested in seeing what happens to the gas as it approaches the black hole. But studying such small objects at such large distances is tricky, as they simply look like points of light in even the best telescopes. Observations with spectroscopy (where light from an object is dispersed into its component colours) show that fast moving clouds of emitting material surround the disc but the true size of the disc and exact location of the clouds are very difficult to pin down.

Bruce will describe how astronomers can make use of cosmic coincidences, and benefit from a phenomenon described by Einstein's general theory of relativity more than a century ago. In his seminal theory, Einstein described how light travels in curved paths under the influence of a gravitational field. So massive objects like black holes, but also planets and stars, can act to bend light from a more distant object, effectively becoming a lens.



A schematic diagram showing how microlensing affects our view of quasars (the most luminous AGNs). Credit: A. Bruce / Edinburgh

This means that if a planet or star in an intervening galaxy passes directly between the Earth and a more distant AGN, over a few years or so they act as a lens, focusing and intensifying the signal coming from near the

black hole. This type of lensing, due to a single star, is termed microlensing. As the lensing object travels across the AGN, emitting regions are amplified to an extent that depends on their size, providing astronomers with valuable clues.

Bruce and his team believe they have already seen evidence for two microlensing events associated with AGN. These are well described by a simple model, displaying a single peak and a tenfold increase in brightness over several years. Microlensing in AGNs has been seen before, but only where the presence of the galaxy was already known. Now Bruce and his team are seeing the extreme changes in brightness that signifies the discovery of both previously unknown microlenses and AGNs.

Bruce says: "Every so often, nature lends astronomers a helping hand and we see a very rare event. It's remarkable that an unpredictable alignment of objects billions of light years away could help us probe the surroundings of [black holes](#). In theory, microlensing could even let us see detail in accretion discs and the clouds in their vicinity. We really need to take advantage of these opportunities whenever they arise."

There are expected to be fewer than 100 active AGN microlensing events on the sky at any one time, but only some will be at or near their peak brightness. The big hope for the future is the Large Synoptic Survey Telescope (LSST), a project the UK recently joined. From 2019 on, it will survey half the sky every few days, so has the potential to watch the characteristic changes in the appearance of the AGNs as the lensing events take place.

Provided by Royal Astronomical Society

Citation: Chance microlensing events probe galactic cores (2016, July 1) retrieved 25 April 2024

from <https://phys.org/news/2016-07-chance-microlensing-events-probe-galactic.html>

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