Finding quasars: Rare extragalactic objects are now easier to spot

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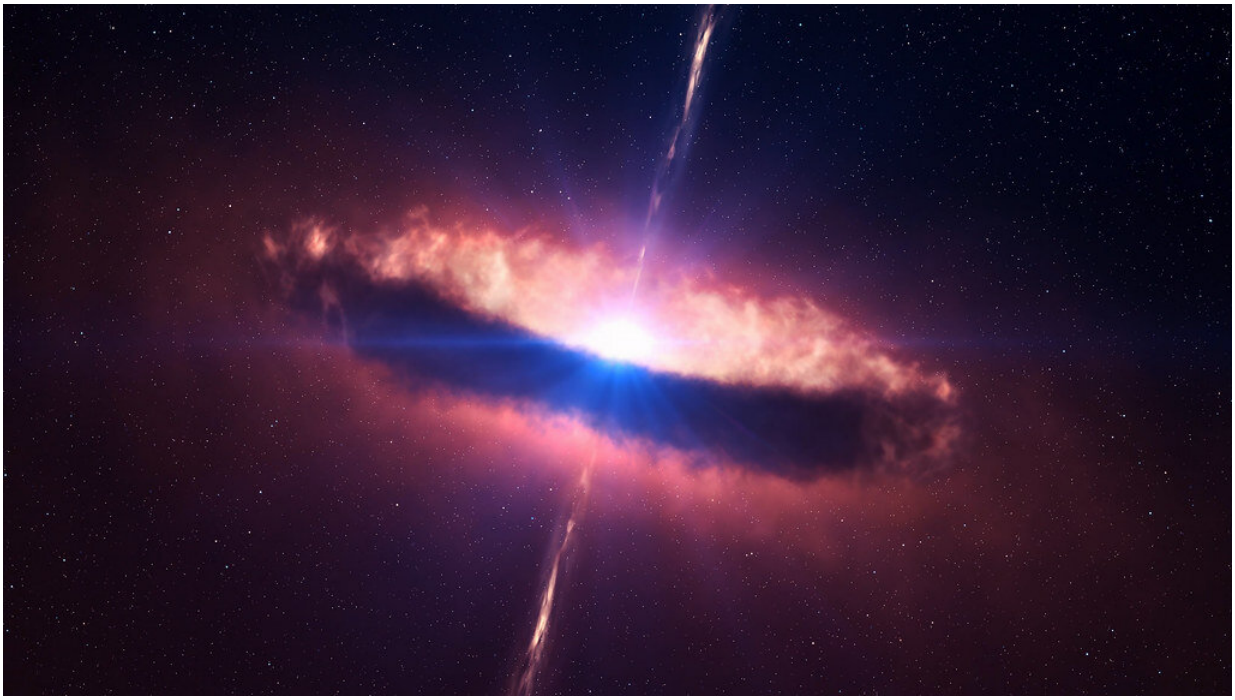

A quasar—the most luminous persistent source of light in the universe. Credit: NASA

Astrophysicists from the University of Bath have developed a new method for pinpointing the whereabouts of extremely rare extragalactic objects. They hope their technique for finding 'changing-look quasars' will take scientists one step closer to unraveling one of greatest mysteries of the universe—how supermassive black holes grow. Quasars are

believed to be responsible for regulating the growth of supermassive black holes and their host galaxies.

A quasar is a region of spectacular luminosity at the center of a galaxy, powered by a supermassive black hole—the largest type of black hole, with a mass that exceeds that of our sun by millions or billions. There is a supermassive black hole at the center of the Milky Way.

Changing-look quasars switch rapidly between a state of high luminosity and one of low luminosity, and scientists are yet to work out why. When the brightness is dialed down, a quasar is too faint to be seen against the backdrop of the host galaxy, making it hard for space scientists to find either it or the supermassive black hole it is connected to.

The new detection method will enable researchers to find quasars undergoing extreme changes in luminosity, and therefore to create a more comprehensive census of supermassive blackholes. The next step will be to study the causes of the luminosity switches, to give scientists a better understanding of how supermassive black holes grow. From this, clues are likely to emerge about the chain of events that give rise to the growth of galaxies, as the energy output from supermassive black holes can affect the fate of galaxies.

Astrophysicist Dr. Carolin Villforth, who was involved in the research, said: "These quasars and supermassive blackholes are extremely important for galaxy evolution—the more we learn about them, the more we understand how they influence the growth of galaxies."

What exactly are quasars?

Quasars are the most luminous persistent source of light in the universe. Many galaxies, including our own, are thought to have one, and astrophysicists have identified more than a million in total.

Quasars are formed when gaseous matter is drawn by gravitations forces towards a supermassive black hole. As this gas approaches the black hole, it forms an 'accretion disk' which orbits the black hole. Energy is released from the disk in the form of electromagnetic radiation, and it is this radiation that produces the quasar's luminosity.

The accretion disk is surrounded by a thick, dusty donut that obscures much of the quasar's emission. Because the dusty structure is very large, the level of obscuration should not change on human timescales, however a changing-look quasar can appear to switch from bright to dark quickly (within a human year), which would be highly surprising if true. Creating a more comprehensive list of changing-look quasars would be a major step towards understanding the reasons behind these apparent transitions.

Previous efforts to identify changing-look quasars have relied on variability in a wide range of wavelengths—a technique called photometric variability, which is known to miss lower luminosity quasars. The Bath researchers used spectroscopic data to assess the changes in very small wavelength ranges, allowing them to detect changing-look quasars that had been missed by photometric searches. Using this technique, they spotted four changing-look quasars millions of lightyears from earth. All four were too dim to be picked up by photometric searches. Earlier identification efforts had only found two of these quasars in the same area.

Former MPhys student at Bath, Bart Potts, who led the research, explained: "We took a previous dataset and applied our new method to see if we could identify any new changing quasars that others had missed. This gave us a bigger set of changing-look quasars for further study, and validated that our methodology was more sensitive than others, which was great. It shows that our methodology is more sensitive to weaker luminosity."

He added: "Ultimately, this finding will give something to the academic community that studies quasars. It will help others further their research into why this specific type of quasar goes through luminosity switches. We are helping our community find important answers to big questions."

"A systematic search for changing-look quasars in SDSS-II using difference spectra" is published in *Astronomy & Astrophysics*.

More information: A systematic search for changing-look quasars in SDSS-II using difference spectra. arXiv:2104.14225v1 [astro-ph.GA] arxiv.org/abs/2104.14225

B. Potts et al, A systematic search for changing-look quasars in SDSS-II using difference spectra, *Astronomy & Astrophysics* (2021). DOI: 10.1051/0004-6361/202140597

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