

Galaxy-wide echoes from the past

December 5 2012



This view from the Canada-France-Hawaii Telescope shows thousands of galaxies in the distant Universe. But the one close to the centre looks very odd -- it is bright green. This very unusual object is known as J224024.1-092748 or J2240 and it is a bright example of a new class of objects that have been nicknamed green bean galaxies. Green beans are entire galaxies that are glowing under the intense radiation from the region around a central black hole. J2240

lies in the constellation of Aquarius (The Water Bearer) and its light has taken about 3.7 billion years to reach Earth. Credit: M. Schirmer, CFHT/ESO

(Phys.org)—A new galaxy class has been identified using observations from ESO's Very Large Telescope, the Gemini South telescope, and the Canada-France-Hawaii Telescope. Nicknamed 'green bean galaxies' because of their unusual appearance, these galaxies glow in the intense light emitted from the surroundings of monster black holes and are amongst the rarest objects in the Universe.

Many [galaxies](#) have a giant black hole at their centre that causes the gas around it to glow. However, in the case of green bean galaxies, the entire galaxy is glowing, not just the centre. These new observations reveal the largest and brightest glowing regions ever found, thought to be powered by central [black holes](#) that were formerly very active but are now switching off.

[Astronomer](#) Mischa Schirmer of the [Gemini Observatory](#) had looked at many images of the [distant Universe](#), searching for clusters of galaxies, but when he came across one object in an image from the Canada-France-[Hawaii Telescope](#) he was stunned—it looked like a galaxy, but it was bright green. It was unlike any galaxy he had ever seen before, something totally unexpected. He quickly applied to use ESO's Very Large Telescope to find out what was creating the unusual [green glow](#).

"ESO granted me special observing time at very short notice and just a few days after I submitted my proposal, this bizarre object was observed using the [VLT](#)," says Schirmer. "Ten minutes after the data were taken in Chile, I had them on my computer in Germany. I soon refocused my research activities entirely as it became apparent that I had come across something really new."

The new object has been labelled J224024.1–092748 or J2240. It lies in the constellation of Aquarius (The Water Bearer) and its light has taken about 3.7 billion years to reach Earth.

After the discovery, Schirmer's team searched through a list of nearly a billion other galaxies and found 16 more with similar properties, which were confirmed by observations made at the Gemini South telescope. These galaxies are so rare that there is on average only one in a cube about 1.3 billion light-years across. This new class of galaxies has been nicknamed green bean galaxies because of their colour and because they are superficially similar to, but larger than, green pea galaxies.

In many galaxies the material around the supermassive black hole at the centre gives off intense radiation and ionises the surrounding gas so that it glows strongly. These glowing regions in typical active galaxies are usually small, up to 10% of the diameter of the galaxy. However, the team's observations showed that in the case of J2240, and other green beans spotted since, it is truly huge, spanning the entire object. J2240 displays one of the biggest and brightest such regions ever found. Ionised oxygen glows bright green, which explains the strange colour that originally caught Schirmer's attention.

"These glowing regions are fantastic probes to try to understand the physics of galaxies—it's like sticking a medical thermometer into a galaxy far, far away," says Schirmer. "Usually, these regions are neither very large nor very bright, and can only be seen well in nearby galaxies. However, in these newly discovered galaxies they are so huge and bright that they can be observed in great detail, despite their large distances."

The team's further analysis of the data soon revealed another puzzle. J2240 appeared to have a much less active black hole at its centre than expected from the size and brightness of the glowing region. The team thinks that the glowing regions must be an echo from when the central

black hole was much more active in the past, and that they will gradually dim as the remnants of radiation pass through them and out into space.

These galaxies signal the presence of a fading galactic centre, marking a very fleeting phase in a galaxy's life. In the early Universe galaxies were much more active, growing massive black holes at their centres that swallowed up surrounding stars and gas and shining brilliantly, easily producing up to 100 times more light than all the stars in the galaxy together. Light echoes like that seen in J2240 allow astronomers to study the shutdown processes of these active objects to understand more about how, when, and why they halt—and why we now see so few of them in younger galaxies. This is what the team aims to do next, by following up on this research with further X-ray and spectroscopic observations.

"Discovering something genuinely new is an astronomer's dream come true, a once-in-a-lifetime event," concludes Schirmer. "It's very inspiring!"

More information: This research was presented in a paper, "A sample of Seyfert-2 galaxies with ultra-luminous galaxy-wide NLRs - Quasar light echos?", to appear in *The Astrophysical Journal*.

Provided by ESO

Citation: Galaxy-wide echoes from the past (2012, December 5) retrieved 6 May 2024 from <https://phys.org/news/2012-12-galaxy-wide-echoes.html>

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