Cosmic eye sheds light on early galaxy formation

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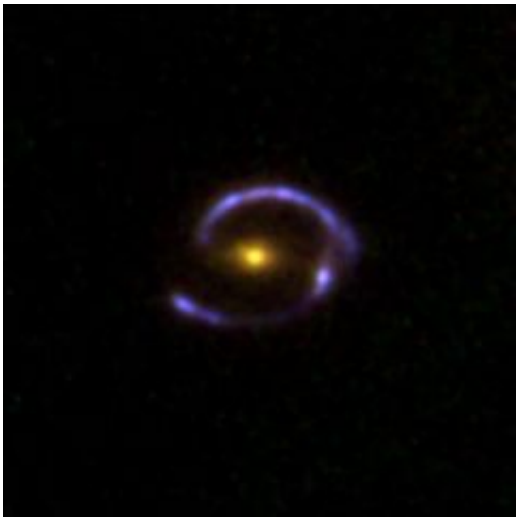

The Cosmic Eye, showing the foreground galaxy in yellow at the centre of the image surrounded by the blue arc of the distant galaxy. Credit: Mark Swinbank/Durham University

A Cosmic Eye has given scientists a unique insight into galaxy formation in the very early Universe. Using gravity from a foreground galaxy as a zoom lens the team was able to see a young star-forming galaxy in the distant Universe as it appeared only two billion years after the Big Bang.

Scientists at the California Institute of Technology (Caltech), USA, and Durham University and Cardiff University, UK, are behind the research published today in the prestigious scientific journal *Nature*.

The researchers, led by Dr Dan Stark, of Caltech, say their findings show for the first time how the distant galaxy might evolve to become a present-day system like our Milky Way.

And they say their study also provides a taste of what astronomers will be able to see in the distant Universe once projects such as the planned European Extremely Large Telescope (E-ELT) and the American Thirty Metre Telescope (TMT) come into use.

The Cosmic Eye is so called because the foreground galaxy, which is 2.2 billion light years from Earth, appears in the centre of an arc created by the distant galaxy – giving it the appearance of a human eye.

The distant galaxy, which lies 11 billion light years from Earth, was originally identified using the Hubble Space Telescope.

The team then used the ten metre Keck telescope, on Hawaii, which is equipped with laser-assisted guide star adaptive optics (AO) to correct for blurring in the Earth's atmosphere, to carry out their observations.

By coupling the telescope with the magnifying effect of the gravitational field of the foreground galaxy – a technique called gravitational lensing - they were able to study the distant star system.

Gravitational lensing, the distortion of light rays by massive objects as predicted by Einstein, enlarged the distant galaxy by eight times.

This allowed the scientists to determine the galaxy's internal velocity structure and compare it to later star systems such as the Milky Way.

Research co-author Dr Mark Swinbank, in The Institute for Computational Cosmology, at Durham University, said: "This is the most detailed study there has been of an early galaxy. Effectively we are

looking back in time to when the Universe was in its very early stages.

"This technique of using gravitational lensing provides us with a glimpse of what we will commonly achieve when the next generation of telescopes, which are still a decade away, come on-line."

Dr Dan Stark, of Caltech, said: "Gravity has effectively provided us with an additional zoom lens, enabling us to study this distant galaxy on scales approaching only a few hundred light years.

"This is ten times finer sampling than previously. As a result for the first time we can see that a typical-sized young galaxy is spinning and slowly evolving into a spiral galaxy much like our own Milky Way."

Data from the Keck Observatory was combined with millimetre observations from the Plateau de Bure Interferometer, in the French Alps, which is sensitive to the distribution of cold gas destined to collapse to form stars.

Dr Swinbank added: "Remarkably the cold gas traced by our millimetre observations shares the rotation shown by the young stars in the Keck observations.

"The distribution of gas seen with our amazing resolution indicates we are witnessing the gradual build up of a spiral disk with a central nuclear component."

Source: Durham University