# Lightening up dark galaxies

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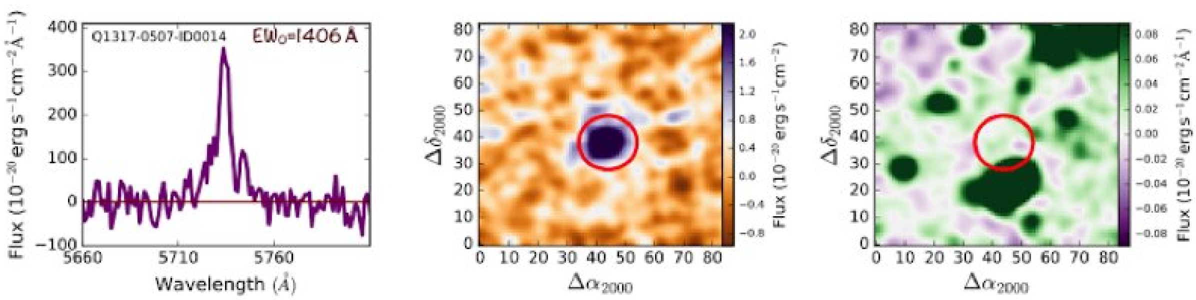


One of the new dark-galaxy candidates, identified through a combination of spectral information (left) and images reflecting the emission of gas (middle) and stars (right). The position of the dark-galaxy candidate is marked by the red circle. Credit: R. A. Marino / MUSE

Despite substantial progress over the past half-century in understanding how galaxies form, important open questions remain regarding how precisely the diffuse gas of the intergalactic medium is converted into stars. One possibility, suggested in recent theoretical models, is that the early phase of galaxy formation involves an epoch when galaxies contain a great amount of gas but are still inefficient at forming stars. Direct proof of such a dark phase has been so far elusive, however—after all, dark galaxies do not emit much visible light. The observational discovery of such galaxies would therefore fill an important gap in our understanding of galaxy evolution.

There are ways to identify dark galaxies, however. An international team led by Dr. Raffaella Anna Marino and Prof. Sebastiano Cantalupo from the Department of Physics at ETH Zurich has now done just that, and was able to search the sky for potential dark galaxies with unprecedented efficiency. They report their results in a paper published today in *The Astrophysical Journal*, and have identified at least six strong candidates for dark galaxies.

To overcome the obstacle that their target objects are dark, the team used quasars as a flashlight of sorts. These emit intense ultraviolet light, which in turn induces fluorescent emission in hydrogen atoms known as the Lyman-alpha line. As a result, the signal from any dark galaxies in the vicinity of the quasar gets a boost, making them visible. Such fluorescent illumination has been used before in searches for dark galaxies, but Marino et al. searched the neighbourhood of quasars at greater distances than has been possible in earlier observations.

They acquired the full spectral information for each of the dark-galaxy candidates. Deep observations—10 hours for each of the six quasar fields they studied—enabled Marino and her colleagues to efficiently discern dark-galaxy candidates from other sources. From initially 200 Lyman-alpha emitters, a half-dozen regions remained that are unlikely to be normal star-forming stellar populations, making them robust candidates for dark galaxies.

The advances in observational capability have become possible thanks to the Multi Unit Spectroscopic Explorer (MUSE) instrument at the Very Large Telescope (VLT) of the European Southern Observatory (ESO) in Chile. In essence, previous studies were limited to imaging a relative narrow band of frequencies, for which specific filters had to be designed. The MUSE instrument instead allowed hunting 'blindly'—without filters—for dark galaxies around quasars at larger distances from Earth than had been possible so far.

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