Black hole research could aid understanding of how small galaxies evolve

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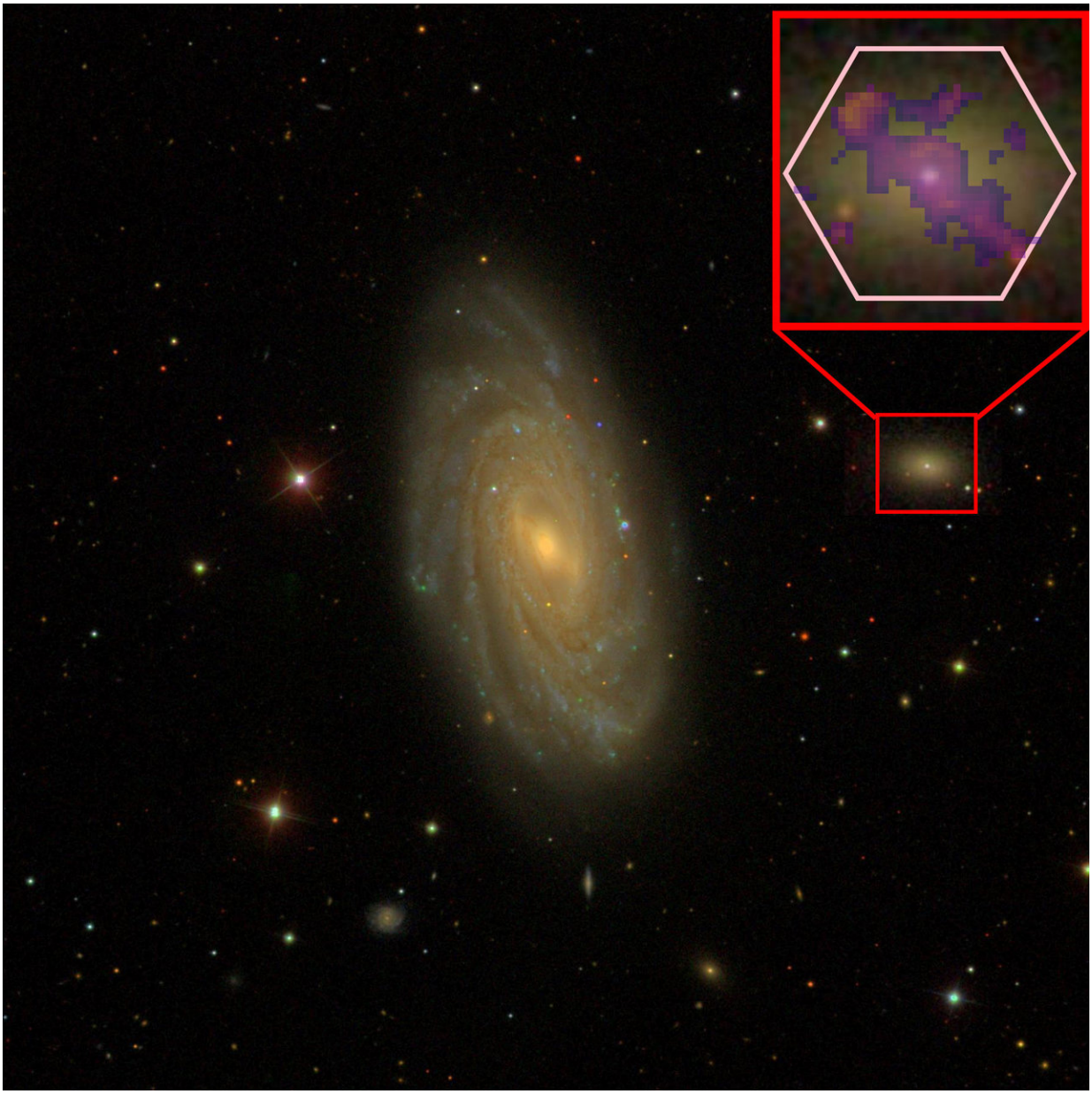

Size comparison of a dwarf galaxy (right inset, bottom) with a larger galaxy in the centre. Top inset: Dwarf galaxy overlain with some of the MaNGA data, revealing the winds from the supermassive black hole. Credit: Samantha Penny (Institute of Cosmology and Gravitation, University of Portsmouth) and the SDSS collaboration

Scientists have solved a cosmic mystery by finding evidence that supermassive black holes prevent stars forming in some smaller galaxies.

These giant black holes are over a million times more massive than the sun and sit in the centre of galaxies sending out powerful winds that quench the star-making process. Astronomers previously thought they had no influence on the formation of stars in dwarf galaxies but a new study from the University of Portsmouth has proved their role in the process.

The results, presented today at a meeting of the American Astronomical Society, are particularly important because dwarf galaxies (those composed of up to 100 million to several billion stars) are far more numerous than bigger systems and what happens in these is likely to give a more typical picture of the evolution of galaxies.

"Dwarf galaxies outnumber larger galaxies like the Milky Way 50 to one," says lead researcher Dr Samantha Penny, of the University's Institute of Cosmology and Gravitation. "So if we want to tell the full story of galaxies, we need to understand how dwarf systems work."

In any galaxy stars are born when clouds of gas collapse under the force of their own gravity. But stars don't keep being born forever - at some point star formation in a galaxy shuts off. The reason for this differs in different galaxies but sometimes a supermassive black hole is the culprit.

Supermassive black holes can regulate their host galaxy's ability to form new stars through a heating process. The black hole drives energy through powerful winds. When this wind hits the giant molecular clouds in which stars would form, it heats the gas, preventing its collapse into new stars.

Previous research has shown that this process can prevent star formation in larger galaxies containing hundreds of billions of stars - but it was believed a different process could be responsible for dwarf galaxies ceasing to produce stars. Scientists previously thought that the larger galaxies could have been interacting gravitationally with the dwarf systems and pulling the star-making gas away.

Data, however, showed the researchers that the dwarf galaxies under observation were still accumulating gas which should re-start star formation in a red, dead galaxy but wasn't. This led the team to the supermassive black hole discovery.

Dr Penny said: "Our results are important for astronomy because they potentially impact how we understand galaxy evolution. Supermassive black holes weren't thought to influence dwarf systems but we've shown that isn't the case. This may well have a big influence on future research as simulations of galaxy formation don't usually include the heating effect of supermassive black holes in low-mass galaxies, including the dwarf systems we have examined in this work."

The team of international scientists used data from the Sloan Digital Sky Survey (SDSS), which has a telescope based in New Mexico, to make their observations. Using SDSS's Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) survey, they were able to map the processes acting on the dwarf galaxies through the star systems' heated gas, which could be detected. The heated gas revealed the presence of a central supermassive black hole, or active galactic nucleus (AGN), and

through MaNGA the team were able to observe the effect that the AGN had on their host dwarf galaxies.

Provided by University of Portsmouth

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