Unexpected interaction between dark matter and ordinary matter in mini-spiral galaxies

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Credit: ESO's OmegaCAM on the VLT Survey Telescope

Statistical analysis of mini-spiral galaxies shows an unexpected interaction between dark matter and ordinary matter. According to the SISSA study recently published in *Monthly Notices of the Royal Astronomical Society*, where the relationship is obvious and cannot be explained in a trivial way within the context of the Standard Model, these objects may serve as "portals" to a completely new form of Physics

which can explain phenomena like matter and dark energy.

They resemble a spiral galaxy like ours, only ten thousand times smaller: the mini-spiral galaxies studied by Professor Paolo Salucci of the International School for Advanced Studies (SISSA) in Trieste, and Ekaterina Karukes, who recently earned her PhD at SISSA, may prove to be "the portal that leads us to a whole new Physics, going beyond the standard model of particles to explain matter and dark energy," says Salucci. It is the first time these elements have been studied statistically, a method that can erase the "individual" variability of each object, thus revealing the general characteristics of the class. "We studied 36 galaxies, which was a sufficient number for statistical study. By doing this, we found a link between the structure of ordinary, or luminous matter like stars, dust and gas, with dark matter."

Dark matter is one of the great mysteries of Physics: since it does not emit electromagnetic radiation we cannot see it, even with the most sophisticated instruments. It was only discovered through its gravitational effects. Many believe it makes up 90% of our Universe. "Most dark matter, according to the most credible hypotheses, would be non-baryonic or WIMP. It would not interact with ordinary matter except through gravitational force," continues Karukes. "Our observations, however, disagree with this notion."

Salucci and Karukes showed that, in the objects they observed, the structure of dark matter mimics visible matter in its own way. "If, for a given mass, the luminous matter in a galaxy is closely compacted, so it is the dark matter. Similarly, if the former is more widespread than in other galaxies, so is the latter."

The "tip of the iceberg"

"It is a very strong effect that cannot be explained trivially using the

Standard Model of particles." The Standard Model is the most widely-accepted theory of Physics in the scientific community. It explains fundamental forces (and particles of matter), however it contains some doubtful points, most notably the fact that it does not include gravitational force. Phenomena such as the existence of dark matter and dark energy make it clear to scientists that there is another sort of physics yet to be discovered and explored.

"From our observations, the phenomenon, and thus the necessity, is incredibly obvious. At the same time, this can be a starting point for exploring this new kind of physics," continues Salucci. "Even in the largest spiral galaxies we find effects similar to the ones we observed, but they are signals that we can try to explain using the framework of the Standard Model through astrophysical processes within galaxies. With mini-spirals, however, there is no simple explanation. These 36 items are the tip of the iceberg of a phenomenon that we will probably find everywhere and that will help us discover what we cannot yet see. "

More information: E.V. Karukes et al. The universal rotation curve of dwarf disk galaxies, *Monthly Notices of the Royal Astronomical Society* (2016). DOI: 10.1093/mnras/stw3055

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