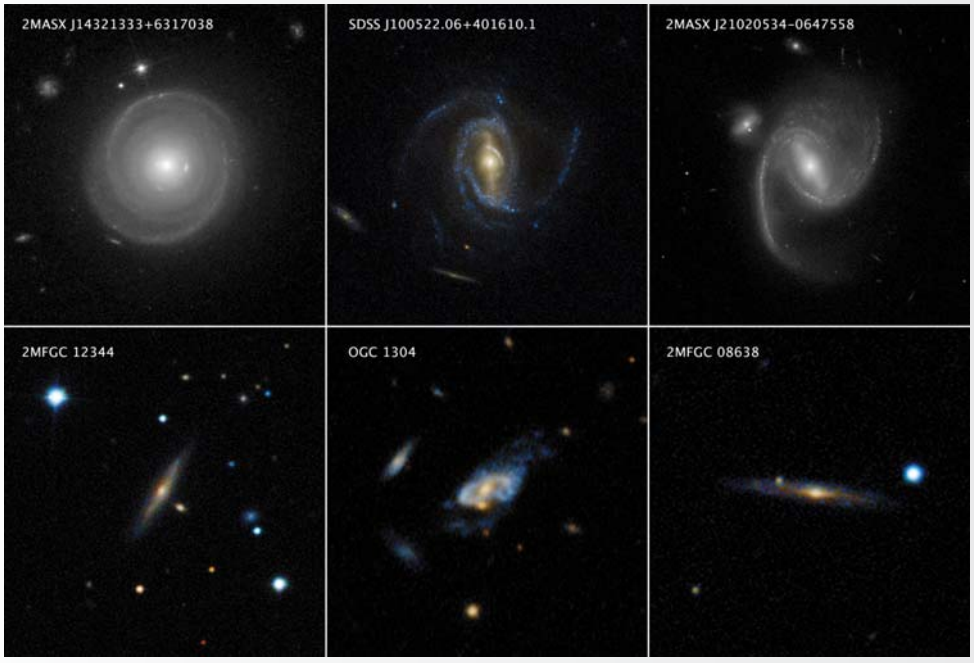
SALT observes super fast spirals

Astronomers using the Southern African Large Telescope (SALT) have measured the rotation rates of massive spiral galaxies



NASA, ESA, P. Ogle and J. DePasquale (STScI)

SDSS, P. Ogle and J. DePasquale (STScI)

The top row of this mosaic features Hubble images of three spiral galaxies, each weighing several times as much as the Milky Way. The bottom row shows three even more massive spiral galaxies qualifying as 'super spirals', which were observed by the ground-based Sloan Digital Sky Survey. The galaxy at lower right, 2MFGC 08638, is the most massive super spiral known to date, with a dark matter halo weighing at least 40 trillion times the mass of our Sun.

When it comes to galaxies, how fast is fast? The Milky Way, an average spiral galaxy, spins at a speed of 210 km per second in our Sun's neighbourhood. New research has found that the most massive spiral galaxies spin faster than expected. These 'super spirals', the largest of which weigh about 20 times more than our Milky Way, spin at a rate of up to 570 km per second!

Only about 100 super spirals are known to date, and they are exceptional in almost every way. In addition to being much more massive than the Milky Way, they're also brighter and larger in physical size. The largest span some 450 000 light-years compared to the Milky Way's 100 000-light-year diameter.

A recent paper in the *Astrophysical Journal Letters* presents new data on super spiral rotation rates collected with the Southern African Large Telescope (SALT). Situated at the South African Astronomical Observatory (SAAO) field station near Sutherland in the Northern Cape, SALT is the largest single optical telescope in the southern hemisphere.

Theory suggests that super spirals spin rapidly because they are located within incredibly large clouds – or halos – of dark matter. Astronomer Vera Rubin pioneered work on galaxy rotation rates some decades ago, showing that spiral galaxies rotate faster than if their gravity were solely due to the constituent stars and gas. An additional, invisible substance known as dark matter must influence galaxy rotation.

A spiral galaxy of a given mass in stars is expected to rotate at a certain speed, but the team behind the recent paper found that super spirals significantly exceed the expected rotation rate. What's more, the most massive halo measured by the team contains enough dark matter to weigh at least 40 trillion times as much as our Sun. That amount of dark matter would normally contain a group of galaxies, rather than a single galaxy.

"It appears that the spin of a galaxy is set by the mass of its dark matter halo," explains the paper's first author, Patrick Ogle of the Space Telescope Science Institute in Baltimore, Maryland.

Yet given the amount of dark matter they contain, super spirals are actually underweight in stars. This suggests that the sheer amount of dark matter inhibits star formation. There are two possible causes: 1) Any additional gas that is pulled into the galaxy crashes together and heats up, preventing it from cooling down and forming stars, or 2) The fast spin of the galaxy makes it harder for gas clouds to collapse against the influence of centrifugal force.

Despite these disruptive influences, super spirals are still able to form stars. Although the largest elliptical galaxies formed all or most of their stars more than 10 billion years ago, super spirals are still forming stars today. They convert about 30 times the mass of the Sun into stars every year, which is normal for a galaxy of that size. By comparison, our Milky Way forms about one solar mass of stars per year.

- Ogle et al. 2019. A break in spiral galaxy scaling relations at the upper limit of galaxy mass. *Astrophysical Journal Letters*, 884 (1). DOI: 10.3847/2041-8213/ab459e

2019

Quest Volume 15 Number 4 2019

Academy of Science of South Africa (ASSAf)

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