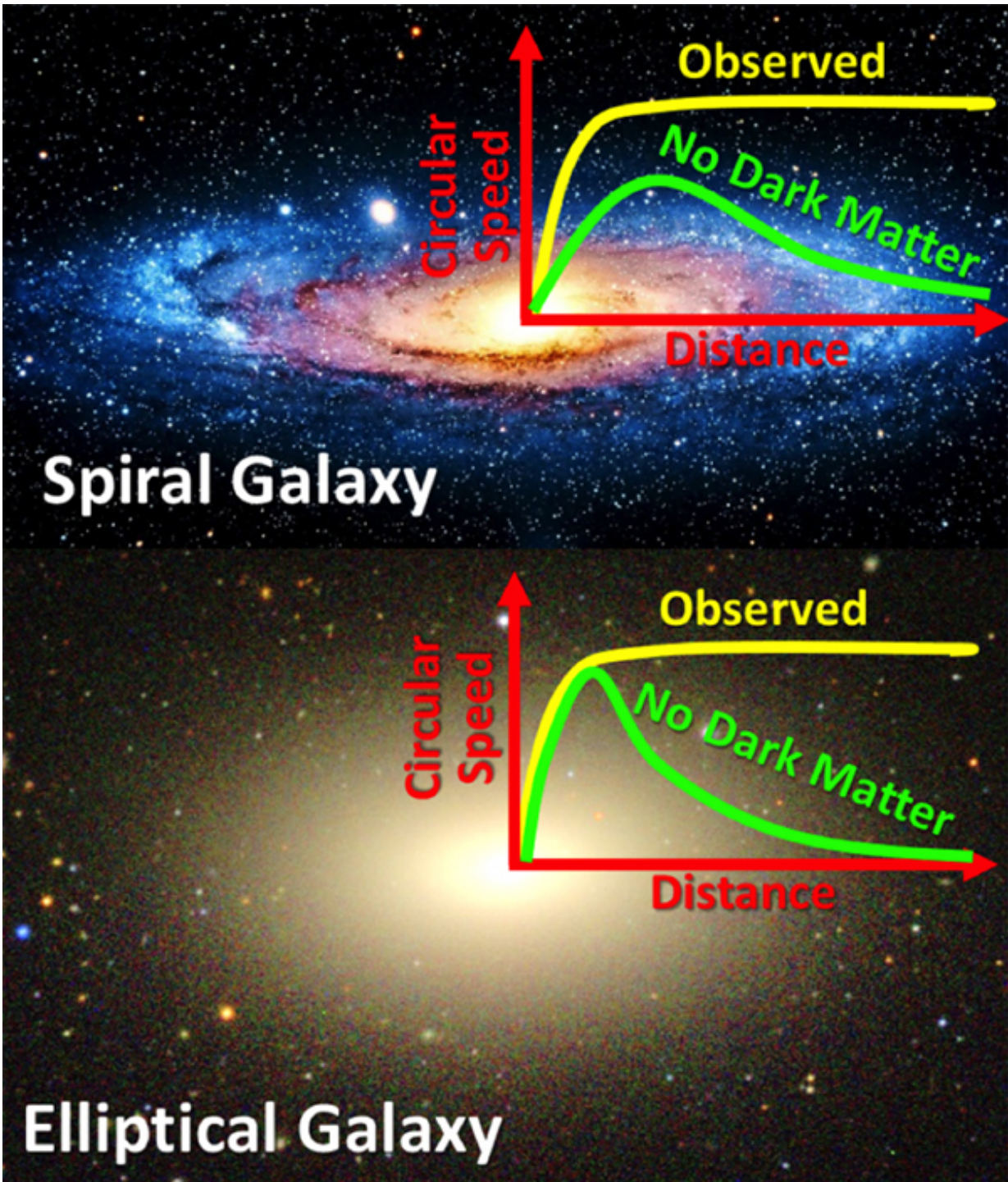


# The Dark Matter 'conspiracy'

April 30 2015, by Lea Kivivali

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The speeds of stars on circular orbits have been measured around both spiral and elliptical galaxies. Without dark matter, the speeds should decrease with distance from the galaxy, at different rates for the two galaxy types. Instead, the dark matter appears to conspire to keep the speeds steady. Credit: M. Cappellari and

the Sloan Digital Sky Survey

Surprising gravitational similarities between spiral and elliptical galaxies have been discovered by an international team, including astronomers from Swinburne University of Technology, implying the influence of hidden forces.

In the first such survey to capture large numbers of these [galaxies](#), researchers have mapped out the motions of stars in the outer parts of elliptical galaxies using the world's largest optical telescope at W M Keck Observatory in Hawaii.

"By combining Keck telescope time from Swinburne and the University of California, we were able to investigate a larger number of galaxies which allowed us to make this important discovery," Swinburne's Professor Duncan Forbes said.

The team, led by Michele Cappellari from the University of Oxford, used the powerful DEIMOS (DEep Imaging and Multi-Object Spectrograph) to conduct a major survey of [nearby galaxies](#) called SLUGGS, which mapped out the speeds of their stars.

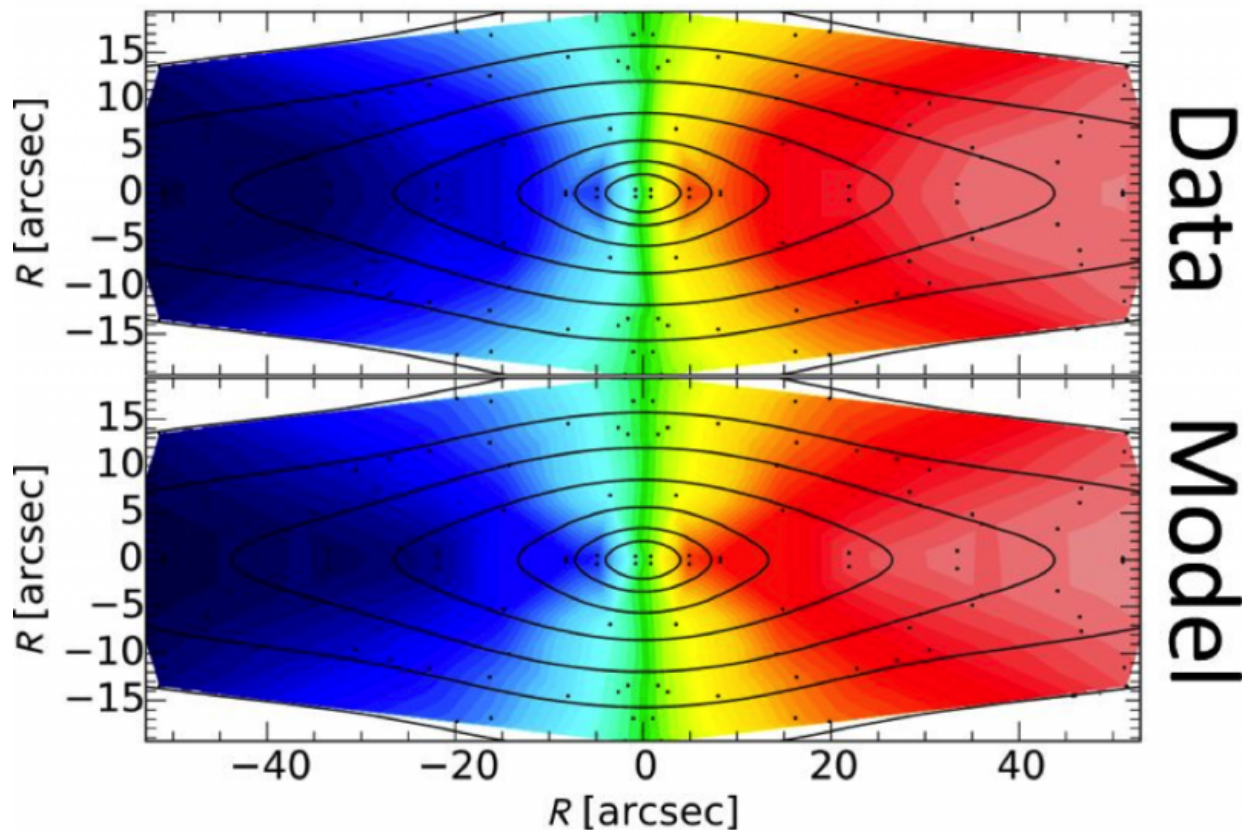
The scientists used Newton's law of gravity to translate these speed measurements into the amounts of matter distributed within the galaxies.

One of the most surprising scientific discoveries of the 20th century was that spiral galaxies, such as our own Milky Way, rotate much faster than expected, powered by an extra gravitational force of invisible 'dark matter'.

Since this discovery 40 years ago, we have learned this mysterious

substance, which is probably an exotic elementary particle, makes up about 85 per cent of the mass in the known Universe, leaving only 15 per cent to be the ordinary stuff encountered in our everyday lives.

## Stellar velocities



Example of mapping out and analyzing the speeds of stars in an elliptical galaxy. Blue colors show regions where the stars are hurtling toward the observer on Earth, and red colors show regions that are moving away, in an overall pattern of coherent rotation. The top panel shows the original data, as collected using the DEIMOS spectrograph at the W.M. Keck Observatory. The bottom panel shows a numerical model that matches the data remarkably well, from using the combined gravitational influence of luminous and dark matter. Credit: W. M. Keck Observatory



Dark matter is central to our understanding of how galaxies form and evolve and is ultimately one of the reasons for the existence of life on Earth – yet we know almost nothing about it.

"One of the surprising findings of this study was that spiral galaxies maintain a remarkably constant rotation speed throughout their disks," Dr Cappellari said. "This means stars and dark matter conspire to redistribute themselves to produce this effect, with stars dominating in the inner regions of the galaxies, and a gradual shift in the outer regions to dark matter dominance."

But the 'conspiracy' does not come out naturally from the models, and some fine-tuning is required to explain the observations. For this reason, some astronomers have suggested that, rather than being due to dark matter, it may be due to Newton's law of gravity becoming progressively less accurate at large distances.

Remarkably, decades after it was proposed, this alternative theory (without dark matter) still could not be conclusively ruled out.



Computer simulation of a galaxy, with the dark matter colorized to make it visible. The dark matter surrounds and permeates the galaxy, holding it together and allowing stars and planets to form. Credit: W. M. Keck Observatory

Spiral galaxies constitute less than half of the stellar mass in the Universe, which is dominated by elliptical and [lenticular galaxies](#). These have puffier configurations of stars and lack the flat disks of gas that spiral galaxies have. Until now it has been technically difficult to measure the masses of elliptical galaxies and to find out how much dark matter they have, and how this is distributed.

Because [elliptical galaxies](#) have different shapes and formation histories than spiral galaxies, the newly discovered conspiracy is even more profound and will lead experts in [dark matter](#) and galaxy formation to think carefully about what has happened in the 'dark sector' of the

Universe.

The study is published in *The Astrophysical Journal Letters*.

**More information:** *Astrophysical Journal Letters*,  
[iopscience.iop.org/2041-8205/804/1/L21/article](https://iopscience.iop.org/2041-8205/804/1/L21/article)

Provided by Swinburne University of Technology

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