*NATURE* | NEWS

# Galactic collision gave Andromeda its arms

**Simulation suggests galaxy gained spiral structure after crashing into a smaller companion.**

**Katia Moskvitch**

03 June 2014

The Andromeda galaxy got its peculiar ring-like spiral arms in a collision with a dwarf galaxy around 900 million years ago, a computer simulation suggests. The insight may help astronomers to understand how spiral galaxies such as our own Milky Way form, because collisions with smaller galaxies are “a typical occurrence”, says Avi Loeb, an astrophysicist at Harvard University in Cambridge, Massachusetts, and a co-author of the study[1].

Andromeda, also known as Messier 31 (M31) is the Milky Way's closest large neighbour, just 780 kiloparsecs (2.5 million light years) away. For years, astronomers have been trying to explain its unusual structure: telescope images show that its spiral shape includes what look like several concentric rings. The most popular hypothesis assumed that the apparent rings formed when Messier 32 (M32), a compact dwarf galaxy with a supermassive black hole at its centre, crashed into Andromeda hundreds of millions of years ago.

M32 now sits inside its giant companion “like a freckle on Andromeda's face”, says Loeb.

Before being hit, Andromeda is thought to have been a disk galaxy — one with no arms. “The collision generated waves, just like a stone hitting water,” except that the effect is mediated by gravitational attraction rather than by a direct impact, says Loeb. These waves became Andromeda's spiral arms.

**Incoming!**

An earlier computer simulation of the collision, published in 2006[2] by astronomer David Block of the University of Witwatersrand in Johannesburg, South Africa, and his colleagues, assumed that M32 plunged close to the centre of Andromeda. But that is a highly unlikely trajectory for a galactic encounter, says Loeb, “because dwarf companions on such a lengthy trajectory often get kicked off centre by other companions”.

His co-author Laura Blecha, an astronomer at the University of Maryland in College Park, adds that such collisions are also unlikely “for the same reason that it is much harder to hit a bullseye on a dartboard than it is to simply hit anywhere on the dartboard: it's a very small target”.

Their simulation also suggested that Andromeda's rings were indeed concentric rings and not spiral arms.

NASA/JPL-Caltech/K. Gordon

Andromeda looks as if it has ring-like structures rather than spiral arms, but a simulation suggests that this could be merely a trick of perspective.

In the new study, Loeb, Blecha and Harvard astrophysicist Marion Dierickx simulated M32 crossing the outer edge of Andromeda's disk, rather than near its centre. Their paper, which they posted last month on the arXiv online repository, is due to appear in *Astrophysical Journal Letters*.

The simulation shows what looks like a bullet passing through Andromeda; in reality, it covers more than two billion years. It shows M32 starting at the edge of Andromeda's halo of dark matter, plunging through its disk at more than 500 kilometres per second about 1.2 billion years later, and then taking another 900 million years to swing back to arrive at its current location, where it is now in the process of crossing Andromeda once again.

**Not what it seems**

In contrast to the earlier result, Loeb, Blecha and Dierickx's simulation suggests that the galaxy's rings are actually spiral arms, which just look like rings when seen from Earth. "Spiral arms that are tightly wrapped will appear as rings when viewed at high inclination, or close to edge on," says Blecha.

The latest work also provides insight into the history of Andromeda's "freckle". Until now, astronomers believed that dwarf galaxies such as M32 were compact because their giant companions had stripped them of their outer envelopes of dark matter, gas and stars. "We find this not to be the case for M32," says Loeb. "The galaxy must have started compact, as the encounter with Andromeda is unable to reduce its size and gas mass to the observed values."

Tod Lauer, an astronomer at the US National Optical Astronomy Observatory in Tucson, Arizona, says the result implies that "highly compact ellipticals like M32 are formed by other processes".

Astrophysicist Jeremy Darling of the University of Colorado Boulder says that we know relatively little about Andromeda, so that simulations based on different premises could "reproduce the limited observations". But, he adds, each simulation will produce its own predictions that in principle could be tested with observational data.

Andromeda is thought to be on a collision course with the Milky Way. The encounter will not happen for a few billion years, but once it does, the neighbours are expected to merge to form one large elliptical galaxy.

*Nature* | doi:10.1038/nature.2014.15329

## References

1. Dierickx, M., Blecha, L. & Loeb, A. Preprint available at http://arxiv.org/abs/1405.3990 (2014).
2. Block, D. L. *et al*. *Nature* **443**, 832–834 (2006).