Are Andromeda and the Milky Way doomed to collide? Maybe not

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This illustration shows a stage in the predicted merger between our Milky Way galaxy and the neighboring Andromeda galaxy, as it will unfold over the next several billion years. In this image, representing Earth's night sky in 3.75 billion years, Andromeda (left) fills the field of view and begins to distort the Milky Way with tidal pull. Credit: NASA; ESA; Z. Levay and R. van der Marel, STScI; T. Hallas; and A. Mellinger

Scientists discovered the Andromeda galaxy, known as M31, hundreds

of years ago, and around a century ago, we realized that it had negative radial velocity toward the Milky Way. In other words, eventually, the two galaxies would merge spectacularly. That has been common knowledge for astronomers since then, but is it really true?

A new paper from researchers at the University of Helsinki posted to the *arXiv* preprint server looks at several confounding factors, including the gravitational influence of other galaxies in our local group, and finds only a 50% chance that the Milky Way will merge with the Andromeda galaxy in the next 10 billion years.

That seems like a pretty big thing to get the physics wrong on. So, how did the authors come to that conclusion? They accounted for a problem that has been popularized in media as of late—the three-body—or in this case, four-body—problem. And with that problem comes a lot of uncertainty, which is why there's still a 50% chance that this huge event might still happen.

Thinking of Andromeda and the Milky Way in isolation doesn't account for the other galaxies in what we know as the "Local Group." This comprises approximately 100 smaller galaxies at various orientations, distances, and speeds.

The largest of the remaining galaxies is the Triangulum galaxy, M33, which is about 2.7 million light-years away and consists of upwards of a mere 40 billion stars. That's about 40% of the approximately 100 billion stars in the Milky Way but a mere 4% of the nearly 1 trillion stars estimated to exist in Andromeda. Still, they would have their own gravitational pull, contorting the simplistic dynamic between Andromeda and the Milky Way.

Further confounding that dynamic is the Large Magellanic Cloud, which is either the second or third closest galaxy to our own at a distance of

only 163,000 light years. This is slightly larger than the Milky Way's diameter, at 105,700. It also houses around 20 billion stars, so while it's even less massive than M33, it still exerts a hefty gravitational pull.

The authors accounted for the gravitational pull of both of those other galaxies in their calculations of the paths of the Milky Way and Andromeda over the next few billion years. They found that the complicated dance of astronomical giants could potentially result in a scenario where the two galaxies don't merge. However, there was another significant factor in their calculations: uncertainty.

Scientists never like uncertainty. In fact, much of their research tries to place bounds on certain parameters, like the rotational speed of galaxies or the distances between them. Unfortunately, despite their proximity, there are many uncertainties surrounding the four galaxies used in the study, and those uncertainties make precise calculations of the effects of their gravitational and rotational pull difficult.

Developing estimates rather than concrete numbers is one way scientists often deal with uncertainty, and in this case, that estimate fell right at the 50% mark in terms of whether or not the two galaxies would collide. However, there is still a lot of uncertainty in that estimate, and plenty more confounding factors, including the other galaxies in the local group, will influence the final outcome.

Ultimately, time will help solve the mystery, but that is a very long time on the scale of galaxy mergers. If it happens at all, a merger between the Milky Way and Andromeda will happen long after our own sun has burned out, and humans will either die out with it or find a way to expand to new stars. And if, at that point, we get easy access to an additional galaxy's worth of resources, it would be all the better for us.

More information: Till Sawala et al, Apocalypse When? No Certainty

of a Milky Way -- Andromeda Collision, *arXiv* (2024). DOI: 10.48550/arxiv.2408.00064

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