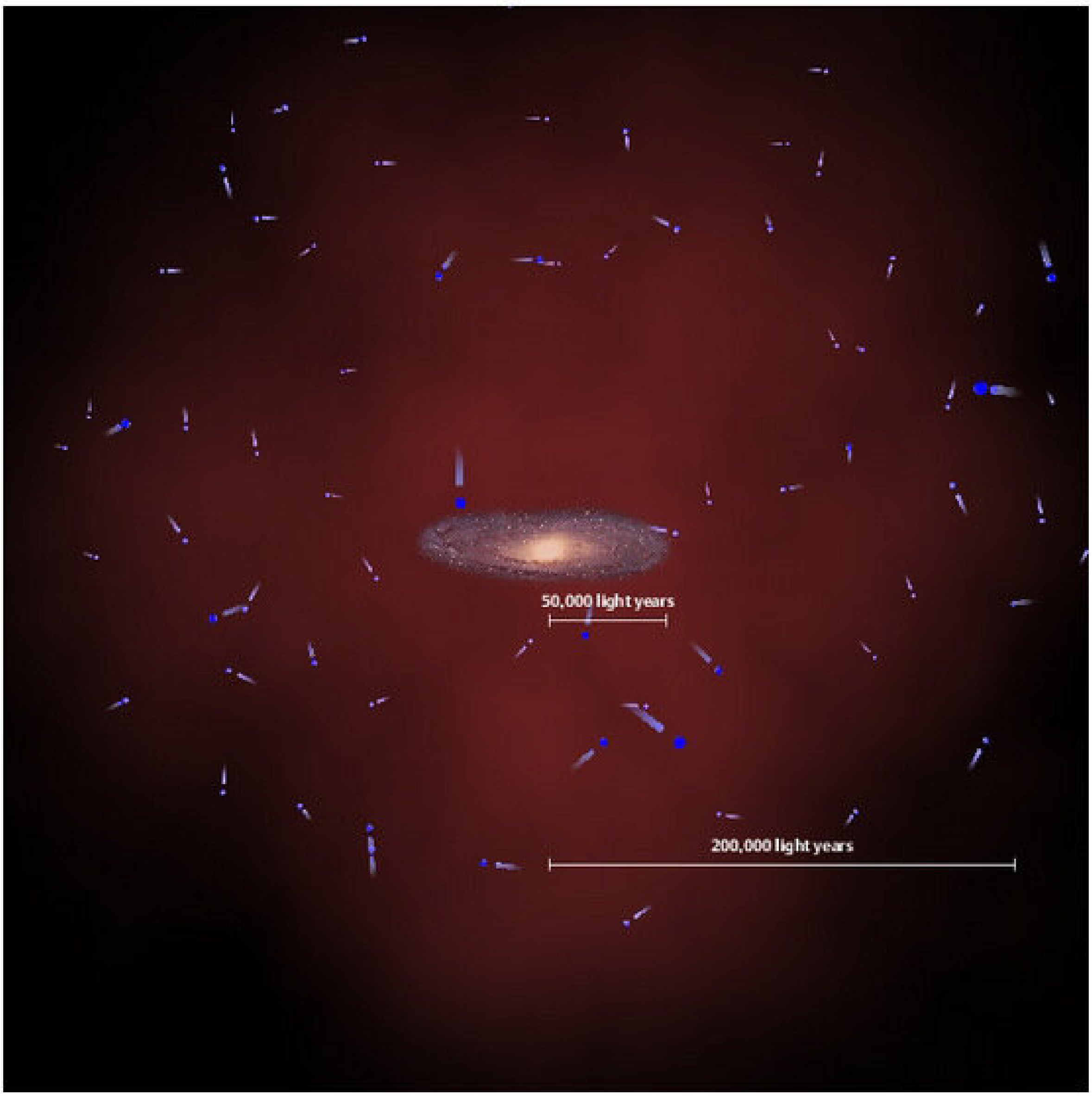
# It looks like dark matter can be heated up and moved around

January 11 2019, by Paul M. Sutter



The Milky Way and its dark matter halo. Credit: Sload Digital Sky Survey

Look at a galaxy, what do you see? Probably lots of stars. Nebulae too. And that's probably it. A whole bunch of stars and gas in a variety of colorful assortments; a delight to the eye. And buried among those stars, if you looked carefully enough, you might find planets, black holes, white dwarves, asteroids, and all sorts of assorted chunky odds and ends. The usual galactic milieu.

What you wouldn't see is what most of that galaxy is really made of. You wouldn't see the invisible, the hidden. You wouldn't see the bulk of that galactic mass. You wouldn't see the dark matter.

## Dark Matters Most

Dark matter is a hypothetical form of matter, and in that hypothesis you are swimming in it right now. As far as we can tell, based on decades of careful, meticulous observations of everything from the movement of stars within galaxies to the movement of galaxies within clusters to the early moments of the big bang to the growth of structure across the entire universe (i.e., we've worked really hard on this), our cosmos is not what is seems at the surface.

The main result: most of the raw stuff in our universe simply doesn't interact with light. Its usual name is "dark matter," but a better name might be invisible matter. We're not exactly sure what it is (we're still working on that bit), but the dark matter seems to be some sort of microscopic particle that floods every galaxy, imbuing them with extra mass. Because this dark matter doesn't interact with light, it doesn't feel anything to do with the electromagnetic force, meaning it simply passes through normal matter without noticing or caring a single bit.

## The Weight of Nothing

As powerful as this dark matter is in terms of explaining deep and perplexing problems of the universe, it does have some weaknesses. Most notably, when astrophysicists run computer simulations of the growth of galaxies – tracking their formation and evolution over the course of billions of years using all the known physics that go into making a galaxy a galaxy – they find that the dark matter tends to really, really clump up to obscenely high densities in the center of those galaxies.

That's a fine and dandy prediction on its own, but it doesn't quite match up with observations. While we can't directly see the dark matter (remember: invisible) we can see its effects on everything else, including normal matter. The dark matter may not play the electromagnetic game, but it does talk to gravity, because gravity is super-friendly and is able to talk to every shred of mass and energy in the entire universe.

So if you fill up a galaxy with dark matter, and the dark matter tends to clump a lot in the center, then there will be a lot of weight in the center of the galaxy, drawing in the surrounding gas. As that gas compresses onto the core, it will shrink and collapse, triggering massive star formation events, popping out litters of new stars.

In other words, the cores of galaxies should have heaps upon molecular heaps of gas and stars. And though galactic centers are very rich places indeed, they're not that rich.

The galactic core, observed using infrared light and X-ray light. Credit: NASA, ESA, SSC, CXC, and STScI

The conclusion of that the banal prediction about the behavior of dark matter in galactic cores isn't the full story. Since we have so many other good reasons to believe that dark matter is a thing, the question becomes: what kicks it out of the core?

## Shaking Things Up

Give ten theoretical physics a problem and they'll come up with a dozen solutions. And in the case of the "cuspiness" of dark matter cores, they've managed to pop out all sorts of fun explanations. Perhaps dark matter is more exotic than we thought, able to slightly interact with itself through a new fifth force of nature, smoothing itself out in the core. Maybe dark matter is just a tad naturally warm and energetic, and has a hard time bundling up in the center.

As cool as those options are, maybe the explanation is something more mundane. The dark matter can influence the behavior of normal matter via gravity, and the same is true in reverse. While substantially less bulky than their dark counterparts, the regular matter of our universe can tug and pull and spread everything else, even if just a tiny bit.

Recently a team of astronomers studied several populations of dwarf galaxies, where the link between dark and normal matter could most easily be examined. They used these samples to hunt for any relationships between star formation and central density. In this scenario, if a galaxy experienced a lot of recent star formation, triggering explosive supernova winds and other temperamental outbursts, then that would drive lots of normal matter out of the core, and gravity would do its thing and pull some of the dark matter along with the normal stuff.

The study found an intriguing result: Dwarf galaxies with a lot of recent star formation ("recent" being within the past six billion years) had smoother central densities, while their less active siblings were much more cuspy in their centers, favoring this hypothesis that normal matter can indeed influence the dark. While this doesn't completely solve the riddle of the nature of dark matter, it is a substantial step forward.

Source Universe Today

Citation: It looks like dark matter can be heated up and moved around (2019, January 11) retrieved 26 June 2024 from https://phys.org/news/2019-01-dark_1.html