Solution found for cosmology's great pancake mystery?

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Scientists from the University of Durham may have solved a decades-old puzzle regarding the distribution of the eleven small satellite galaxies that surround the Milky Way. The Milky Way is not alone. It is surrounded by a retinue of small "dwarf galaxy" companions. Cosmological theory predicts that these galaxies should occupy a large, nearly spherical halo but observations show that the satellite galaxies have a bizarre flattened, pancake-like distribution. The Durham team used sophisticated supercomputer models to simulate the formation of these galaxies and have succeeded in predicting the pancake configuration.

All galaxies have smaller satellite galaxies in orbit around them, which inhabit pockets of dark matter. Dark matter does not interact with light and the only way that we can infer its existence is by detecting the gravitational influence it exerts on normal matter, such as stars. According to cosmological theory, soon after the Big Bang, cold dark matter formed the universe's first large-scale structures, which then collapsed under their own weight to form vast halos. The gravitational pull of these halos sucked in normal matter and provided a focus for the formation of galaxies. Galaxies are built up piece-by-piece as sub-galactic fragments merge together and, theoretically, this should lead to the formation of a tightly-bound galaxy at the core surrounded by a diffuse sphere of satellite structures. Cosmologists have been puzzled by the fact that not only do the Milky Way's satellites lie on a flat circle, approximately perpendicular to the Galactic Plane, but also there are far too few satellite galaxies to fit in with predictions. This discrepancy had

led some cosmologists to question the entire paradigm for the cold dark matter–driven process of galaxy formation.

The Durham team simulated the evolution of parts of the universe, randomly selected from a large cosmological volume, using a sophisticated supercomputer model. The model built up a complete history of all mergers between galactic building blocks, resulting in a family tree for each satellite galaxy formed. Using the powerful, "Cosmology Machine" supercomputer, they carried out six simulations in total and, in each case, found not only the correct number of satellites but also, surprisingly, that the eleven most massive satellite galaxies showed the same pancake-like distribution around the core galaxy that is observed in the satellites of the Milky Way. To find an explanation, the team made animations of the simulations and looked at the evolution of the dark matter halo in which the galaxy formed. The simulations show that the original dark matter halo began its collapse by forming a sheet-like structure that then wrapped up to form a web of filaments. The galaxies formed at dense knots of dark matter in this cosmic web and then moved along the spines of filaments towards the original halo's major axis. The team found that this axis is aligned with the elongated disc formed by the satellite galaxies and have concluded that it is this drift towards the backbone of the main halo that holds the key to the satellites' pancake-like configuration.

Far from challenging the current cosmological paradigm – the cold dark matter model – the findings of the Durham group represent a triumph of the model and indicate that a coherent picture of how galaxies like the Milky Way emerged from the Big Bang is now beginning to fall into place.

So far simulations have been confined to satellites located within 250 kiloparsecs of the galactic centre. The team are planning further simulations to investigate how widespread the formation of cosmic

pancakes is. In particular, they plan to search for evidence of pancakes in structures even larger than the Milky Way, the so-called great clusters of galaxies, This will provide a further, stringent test of the cold dark matter paradigm.

Source: Royal Astronomical Society (RAS)