Invisible hand in invisible matter

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Credit: Conejero, Misti & Mazlin

(PhysOrg.com) -- An international team of astronomers have found an unexpected link between mysterious 'dark matter' and the visible stars and gas in galaxies that could revolutionise our current understanding of gravity.

One of the astronomers, Dr Hongsheng Zhao of the SUPA Centre of Gravity, University of St Andrews, suggests that an unknown force is acting on dark matter. The findings are published this week in the scientific journal *Nature*.

Only 4% of the universe is made of known material. Stars and gas in galaxies move so fast that astronomers have speculated that the gravity from a hypothetical invisible halo of dark matter is needed to keep galaxies together. However, a solid understanding of dark matter as well as direct evidence of its existence has remained elusive.

Now the team believes that the interactions between dark and ordinary matter could be more important and more complex than previously thought, and even speculate that dark matter might not exist and that the anomalous motions of stars in galaxies are due to a modification of gravity on extragalactic scales.

Dr. Benoit Famaey (Universities of Bonn and Strasbourg) explains: "The dark matter seems to 'know' how the visible matter is distributed. They seem to conspire with each other such that the gravity of the visible matter at the characteristic radius of the dark halo is always the same. This is extremely surprising since one would rather expect the balance between visible and dark matter to strongly depend on the individual history of each galaxy."

Dr. Zhao at the SUPA Centre of Gravity notes, "The pattern that the data reveal is extremely odd. It's like finding a zoo of animals of all ages and sizes miraculously having identical, say, weight in their backbones or something. It is possible that a non-gravitational fifth force is ruling the dark matter with an invisible hand, leaving the same fingerprints on all galaxies, irrespective of their ages, shapes and sizes."

Such a force might solve an even bigger mystery, known as 'dark energy', which is ruling the accelerated expansion of the Universe. A more radical solution is a revision of the laws of gravity first developed by Isaac Newton in 1687 and refined by Albert Einstein's theory of General Relativity in 1916. Einstein never fully decided whether his equation should add an omnipresent constant source, now called dark energy.

Dr Famaey added, "If we account for our observations with a modified law of gravity, it makes perfect sense to replace the effective action of hypothetical dark matter with a force closely related to the distribution of visible matter."

The implications of the new research could change some of the most widely held scientific theories about the history and expansion of the universe.

Lead researcher Dr. Gianfranco Gentile at the University of Ghent concludes, "Understanding this puzzling conspiracy is probably the key to unlock the formation of galaxies and their structures."

More information: Universality of galactic surface densities within one dark halo scale-length, *Nature* 461, 627-628 (1 October 2009), doi:10.1038/nature08437

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