Verlinde's new theory of gravity passes first test

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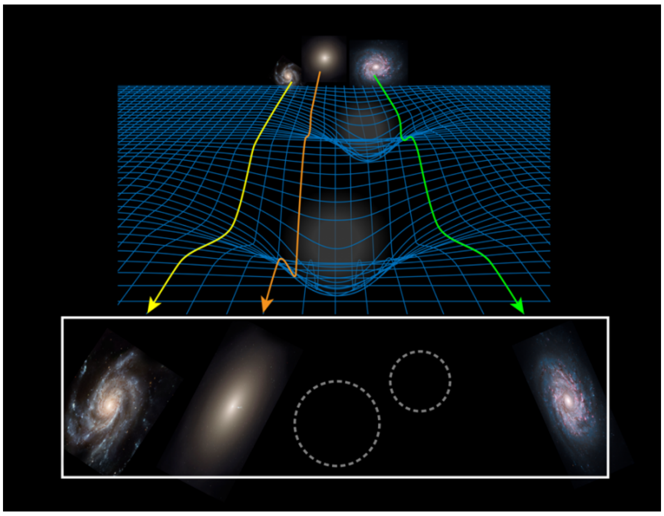

The gravity of galaxies bends space, such that the light traveling through this space is bent. This bending of light allows astronomers to measure the distribution of gravity around galaxies, even up to distances a hundred times larger than the galaxy itself. Credit: APS/Alan Stonebraker; galaxy images from STScI/AURA, NASA, ESA, and the Hubble Heritage Team

A team led by astronomer Margot Brouwer (Leiden Observatory, The Netherlands) has tested the new theory of theoretical physicist Erik Verlinde (University of Amsterdam) for the first time through the lensing effect of gravity. Brouwer and her team measured the distribution of gravity around more than 33,000 galaxies to put Verlinde's prediction to the test. She concludes that Verlinde's theory agrees well with the measured gravity distribution. The results have been accepted for publication in the British journal *Monthly Notices of the Royal Astronomical Society*.

The gravity of galaxies bends space, such that the light traveling through this space is bent, as through a lens. Background galaxies that are situated far behind a foreground galaxy (the lens), thereby seem slightly distorted. This effect can be measured in order to determine the distribution of gravity around a foreground-galaxy. Astronomers have measured, however, that at distances up to a hundred times the radius of the galaxy, the force of gravity is much stronger than Einstein's theory of gravity predicts. The existing theory only works when invisible particles, the so-called dark matter, are added.

Verlinde now claims that he not only explains the mechanism behind gravity with his alternative to Einstein's theory, but also the origin of the mysterious extra gravity, which astronomers currently attribute to dark matter. Verlinde's new theory predicts how much gravity there must be, based only on the mass of the visible matter.

Brouwer calculated Verlinde's prediction for the gravity of 33,613 galaxies, based only on their visible mass. She compared this prediction to the distribution of gravity measured by gravitational lensing, in order to test Verlinde's theory. Her conclusion is that his prediction agrees well with the observed gravity distribution, but she emphasizes that dark matter could also explain the extra gravitational force. However, the mass of the dark matter is a free parameter, which must be adjusted to the observation. Verlinde's theory provides a direct prediction, without free parameters.

The new theory is currently only applicable to isolated, spherical and static systems, while the universe is dynamic and complex. Many observations cannot yet be explained by the new theory, so dark matter is still in the race. Brouwer: "The question now is how the theory develops, and how it can be further tested. But the result of this first test definitely looks interesting."

More information: Margot M. Brouwer et al. First test of Verlinde's theory of Emergent Gravity using Weak Gravitational Lensing measurements, *Monthly Notices of the Royal Astronomical Society*

(2016). DOI: 10.1093/mnras/stw3192 , On *Arxiv*: https://arxiv.org/abs/1612.03034

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