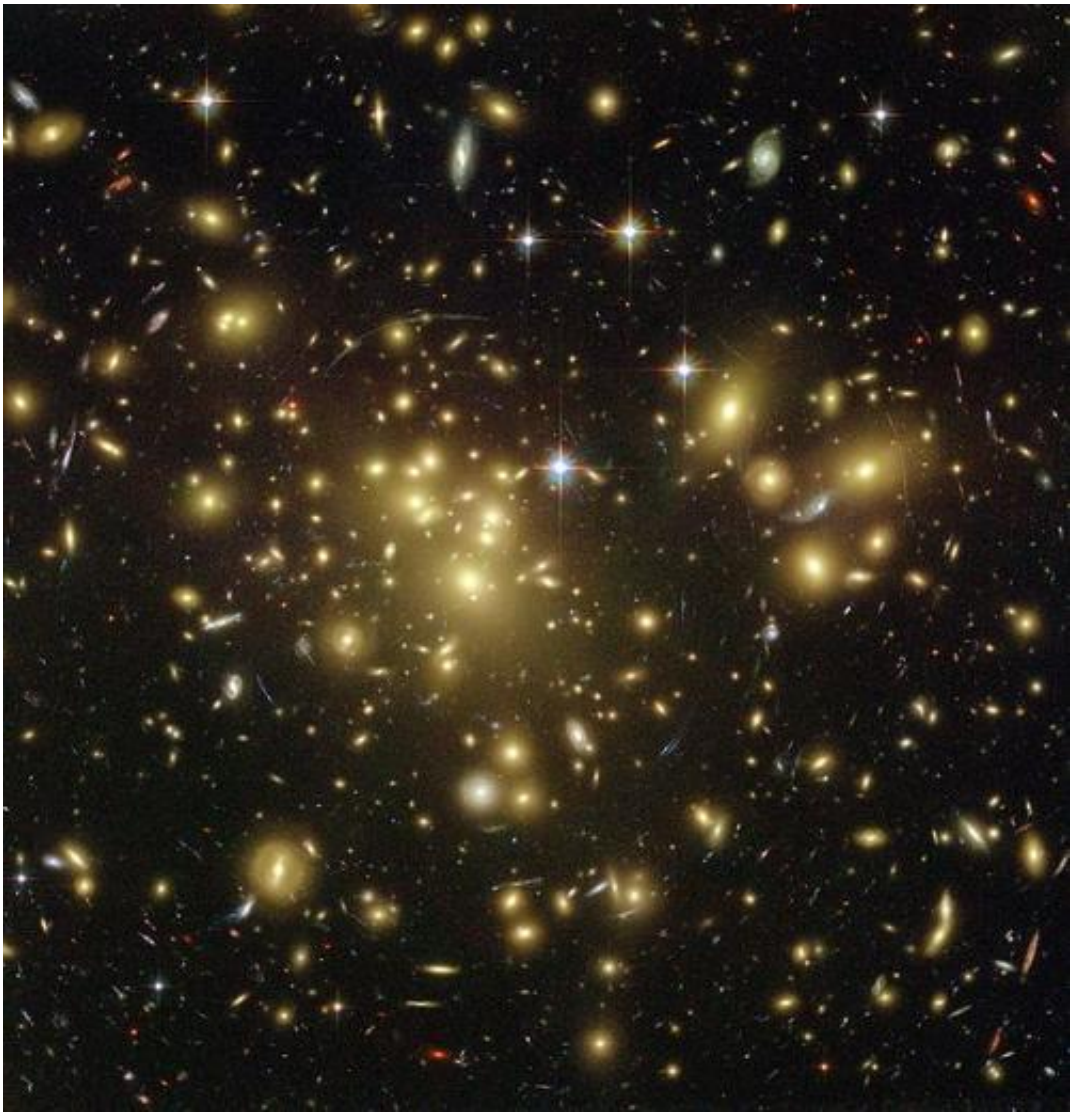
Researchers detect possible signal from dark matter

December 11 2014



A massive cluster of yellowish galaxies, seemingly caught in a red and blue spider web of eerily distorted background galaxies, makes for a spellbinding picture from the new Advanced Camera for Surveys aboard NASA's Hubble

Space Telescope. To make this unprecedented image of the cosmos, Hubble peered straight through the center of one of the most massive galaxy clusters known, called Abell 1689. The gravity of the cluster's trillion stars — plus dark matter — acts as a 2-million-light-year-wide lens in space. This gravitational lens bends and magnifies the light of the galaxies located far behind it. Some of the faintest objects in the picture are probably over 13 billion light-years away (redshift value 6). Strong gravitational lensing as observed by the Hubble Space Telescope in Abell 1689 indicates the presence of dark matter. Credit: NASA, N. Benitez (JHU), T. Broadhurst (Racah Institute of Physics/The Hebrew University), H. Ford (JHU), M. Clampin (STScI),G. Hartig (STScI), G. Illingworth (UCO/Lick Observatory), the ACS Science Team and ESA

Could there finally be tangible evidence for the existence of dark matter in the Universe? After sifting through reams of X-ray data, scientists in EPFL's Laboratory of Particle Physics and Cosmology (LPPC) and Leiden University believe they could have identified the signal of a particle of dark matter. This substance, which up to now has been purely hypothetical, is run by none of the standard models of physics other than through the gravitational force.

Their research will be published next week in *Physical Review Letters*.

When physicists study the dynamics of galaxies and the movement of stars, they are confronted with a mystery. If they only take visible matter into account, their equations simply don't add up: the elements that can be observed are not sufficient to explain the rotation of objects and the existing gravitational forces. There is something missing. From this they deduced that there must be an invisible kind of matter that does not interact with light, but does, as a whole, interact by means of the gravitational force. Called "dark matter", this substance appears to make up at least 80% of the Universe.

Andromeda and Perseus revisited

Two groups have recently announced that they have detected the much sought after signal. One of them, led by EPFL scientists Oleg Ruchayskiy and Alexey Boyarsky, also a professor at Leiden University in the Netherlands, found it by analyzing X-rays emitted by two celestial objects - the Perseus galaxy cluster and the Andromeda galaxy. After having collected thousands of signals from the ESA's XMM-Newton telescope and eliminated all those coming from known particles and atoms, they detected an anomaly that, even considering the possibility of instrument or measurement error, caught their attention.

The signal appears in the X-ray spectrum as a weak, atypical photon emission that could not be attributed to any known form of matter. Above all, "the signal's distribution within the galaxy corresponds exactly to what we were expecting with dark matter, that is, concentrated and intense in the center of objects and weaker and diffuse on the edges," explains Ruchayskiy. "With the goal of verifying our findings, we then looked at data from our own galaxy, the Milky Way, and made the same observations," says Boyarsky.

A new era

The signal comes from a very rare event in the Universe: a photon emitted due to the destruction of a hypothetical particle, possibly a "sterile neutrino". If the discovery is confirmed, it will open up new avenues of research in particle physics. Apart from that, "It could usher in a new era in astronomy," says Ruchayskiy. "Confirmation of this discovery may lead to construction of new telescopes specially designed for studying the signals from dark matter particles", adds Boyarsky. "We will know where to look in order to trace dark structures in space and will be able to reconstruct how the Universe has formed."

More information: arxiv.org/abs/1402.4119

Provided by Ecole Polytechnique Federale de Lausanne