Signs of dark matter may point to mirror matter candidate

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(PhysOrg.com) -- Dark matter, which contains the "missing mass" that's needed to explain why galaxies stay together, could take any number of forms. The main possible candidates include MACHOS and WIMPS, but there is no shortage of proposals. Rather, the biggest challenge is finding some evidence that would support one or more of these candidates. Currently, more than 30 experiments are underway trying to detect a sign of dark matter. So far, only two experiments claim to have found signals, with the most recent observations coming just a month ago. Now, physicist Robert Foot from the University of Melbourne has shown that the results of these two experiments can be simultaneously explained by an intriguing dark matter candidate called mirror matter.

As it name implies, mirror matter is basically a spatial reflection of ordinary matter. Matter particles can be either left-handed or right-handed, so if an ordinary matter particle were left-handed, its mirror particle would be right-handed, but exactly identical in every other way. In the theory of mirror matter, every ordinary matter particle (e.g. protons, electrons, etc.) would have a mirror particle, thus doubling the number of particles in the universe.

The inspiration for mirror matter came from an experiment performed in 1956 that showed that the laws of nature are not left-right symmetrical (also called parity-symmetrical, or p-symmetrical). Specifically, the experiment showed that particles in weak interactions display a preference for left-handedness, so that in a way, the Universe is left-handed. Since the other two forms of symmetry - rotational and translational - do seem to be symmetrical everywhere in nature, scientists wonder why nature doesn't have p-symmetry as well. But if mirror matter exists, it would solve this problem by having slight right-handedness and restoring the Universe's p-symmetry.

At first, mirror matter may sound a bit like antimatter (which is ordinary matter with an opposite charge). In both theories, the number of known particles would double. However, while antimatter interacts very strongly with ordinary matter, annihilating itself into photons, mirror matter would interact very weakly with ordinary matter. For this reason, some physicists have speculated that mirror particles could be candidates for dark matter. Even though mirror matter would produce light, we would not see it, and it would be very difficult to detect.

However, mirror matter would not be impossible to detect, and Foot thinks that the DAMA experiment and the CoGeNT experiment may have detected mirror matter. In DAMA, scientists observed a piece of sodium iodide, which should generate a photon when struck by a dark matter particle. Since the experiment is Earth-based, the scientists predicted that they would observe more photons during the time of year that the Earth is moving toward the dark matter background than away from it - and they did. The more recent CoGeNT experiment is similar, where scientists found evidence of dark matter collisions in a germanium crystal. Interestingly, both DAMA's and CoGeNT's results involve particles of a similar mass range.

In Foot's model, if ordinary and mirror particles interact with each other via a process called photon-mirror photon kinetic mixing, then mirror particles could explain both results. In Foot's theory, a mirror particle plasma would be the predominant ingredient in galactic halos, where dark matter seems to be "hiding" based on observations of its gravity's effects. While this proposal supports the possibility of mirror matter as dark matter, Foot added that experiments in the near future will further test this idea.

More information: Robert Foot. "A CoGeNT confirmation of the DAMA signal." arXiv:1004.1424v1 [hep-ph]
via: Technology Review

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