Could dark baryons explain dark matter?

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(PhysOrg.com) -- "The prevailing belief about dark matter particles is that they should be about 100 or more times heavier than protons," Subir Sarkar tells *PhysOrg.com*. "However, we were thinking about the possibility of lighter particles that can constitute dark matter, which may be more easily detectable with current experiments."

Sarkar is a Professor at the University of Oxford in England. Along with Mads Frandsen, he has been working to show that asymmetric "dark baryons" can be a candidate for cold dark matter. This is a different approach, since dark matter is assumed to be heavy 'supersymmetric' particles that are very weakly interacting. Sarkar and Frandsen suggest though that dark matter could be much lighter, asymmetric (i.e. just particles and no antiparticles) and interact more strongly. Their work is published in Physical Review Letters: "Asymmetric Dark Matter and the sun."

“We have known for some time that most of the matter in the universe is not the (baryonic) matter that we are are made of. However, we know, from various measurements that dark matter is what holds different structures together through gravity,” Sarkar says. “We don’t know what it is, but we know it is out there.”

For years, it has been thought that dark matter particles must be relatively heavy, and that they do not interact at all with other dark matter particles and only very weakly with ordinary matter. Thus the origin of dark matter is totally unrelated to that of baryons, which is in itself a mystery. If there had been equal amounts of (baryonic) matter

and antimatter in the early universe, everything should have annihilated. “Clearly the universe is not empty so there must have been some matter-antimatter destruction, but there is an excess of matter that has survived,” Sarkar points out.

“So there must have been an initial excess of matter over antimatter”. If baryon asymmetry makes it possible for matter to exist in the universe, could it be the same for dark matter? “If there is a new “dark baryon” which is five times as heavy as a baryon and has the same relic asymmetry, then dark matter would contribute five times as much as ordinary matter in the universe, as is indeed observed,” Sarkar explains. He adds that this was first proposed by the physicist David B Kaplan.

Modeling this idea isn’t too hard, Sarkar says. “Various physicists have constructed models for a new particle that would acquire the same excess of particles over anti-particles as baryons have.”

Sarkar and Frandsen point out that gravity would affect these dark baryons, and that they would even interact with each other, although not very strongly, thus influencing the formation of galaxies. In order to test the idea of dark baryons, Sarkar and Frandsen suggest an experiment using the sun.

“There is a simple point made 15 years ago, that dark matter will be captured when it comes close to the sun, just like ordinary matter. If these particles exist, then they will inevitably fall into the sun, and begin orbiting inside it, thus transporting heat outward, through their occasional collisions,” Sarkar says.

He goes on to explain that, because we know a great deal about the sun, it is possible to work out how much heat should be transferred out, and calculate the change in the flux of solar neutrinos, particles that are very sensitive to the core temperature. “If dark matter particles are

asymmetric, they can build up in the sun to higher levels since they aren't annihilating, and we could see a measurable reduction in the flux of solar neutrinos."

Sarkar says that it should be possible to test this relatively soon. "There are already experiments looking for dark matter - however, they are looking for much higher masses. If detectors could be redesigned to be sensitive to lower masses, then they will find it soon. Another way is to measure solar neutrino fluxes with high accuracy to determine if dark matter has slightly cooled the solar core."

Sarkar admits that so far, this is just a theory. "We don't know what dark matter is, but scientists would very much like to find out, since it has profound implications for the nature and origin of the universe."

"This is an idea we're putting out there, to say it is a possibility. It predicts signals to look for, and provides an explanation for some puzzling features of the sun. We hope that experimenters will check this out, even if only to prove us wrong."

More information: Mads T. Frandsen and Subir Sarkar, "Asymmetric Dark Matter and the Sun," Physical Review Letters (2010). Available online: link.aps.org/doi/10.1103/PhysRevLett.105.011301

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