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What if dark matter particles aren't WIMPs?

(PhysOrg.com) -- For years, many physicists have accepted that dark matter is composed of weakly interacting massive particles (WIMPs). The fact that WIMPs can naturally explain the amount of dark matter in the universe – left over from the Big Bang – has been described as the "WIMP miracle."

Not everyone, though, thinks that this phenomenon represents an ironclad prediction that dark matter is made of WIMPs. "We know little about dark matter, since we can't measure it directly," Jonathan Feng tells PhysOrg.com. "But there are theories and models. WIMPs are attractive because they happen to appear in many popular theories of new particles and interactions. But what if there are other well-motivated possibilities for dark matter besides WIMPs?"

Feng, a physicist at the University of California, Irvine, worked with Jason Kumar (now at the University of Hawaii) to re-examine physics models to find additional possibilities for dark matter. Their work, published in Physical Review Letters and titled "Dark-Matter Particles without Weak-Scale Masses or Weak Interactions," suggests that dark matter could be composed of heavier, strongly interacting particles, or even particles that are lighter and more weakly interacting than WIMPs.

"WIMPs are a very specific example of dark matter," Feng continues, "but there is a broader class of particles. We found that some of the models also predicted the right amount of dark matter for the universe, but with dark matter that was much more strongly or weakly interacting than WIMPs. We are wondering if almost-exclusive attention for WIMPs is really warranted."

Feng says that WIMPs are thought to be right around 100 GeV in mass. However, there is evidence that dark matter particles could be as light as 1 GeV. This puts them far below WIMP range. "An experiment called DAMA has been recording dark matter signals, and there is evidence that they are seeing light dark matter particles. We have perfectly good 1 GeV candidates," he says, "and now we can accommodate such light particles."

Some models seem to support a stronger degree of interaction between particles, Feng believes. In order to get to the level of dark matter we have in the universe now, though, these particles would have to be annihilating each other now. "These models imply that experiments looking for very energetic photons may be very promising."

But the idea of WIMP-less dark matter gets a little more interesting than simply considering weaker or stronger dark matter candidates. Feng says that WIMP-less dark matter could provide some support for the idea of a hidden sector – a so-called shadow world. "There are theories that there is a shadow world behind ours. It is a mirror world that is like ours, but doesn't interact with ours. With WIMP dark matter, that possibility is remote."

"WIMP-less dark matter requires new forces that we don't really know much about. If you could have evidence of this type of dark matter, it might be a hint that this shadow world exists."

Mirror worlds and hidden sectors aside, Feng believes that his and Kumar's findings warrant a close look. "Perhaps the millions of dollar spent on WIMPs is not the most productive way to use the money. This opens up a whole bunch of different avenues for discovering what dark matter is."

More information: Jonathan L. Feng and Jason Kumar. "Dark-Matter Particles without Weak-Scale Masses or Weak Interactions." *Physical Review Letters* (2008). Available online: http://link.aps.org/doi/10.1103/PhysRevLett.101.231301.