

Dark matter link to regular matter's dominance fails to show up

Enlarge / Given how messy a typical physics lab is, CERN is just as likely to lose the antimatter it intends to store.

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Matter, despite being omnipresent here on Earth, is a bit of a mystery. Most of the matter in the Universe comes in the form of dark matter, which doesn't seem to have significant interactions with light or other matter. Meanwhile, the more familiar form of matter shouldn't be here at all. It should have been created in equal amounts to antimatter, allowing the two to annihilate each other following the Big Bang.

Physicists have found a few ways of breaking the matter/antimatter symmetry, but they aren't sufficient to account for matter's vast predominance. So, there are lots of ideas floating around to handle it, and some of them are even testable. One of the more intriguing categories of solution links the two big problems with matter: tying the prevalence of matter to the existence of a specific dark matter particle.

Now, scientists have made some antimatter in a lab and used that to test one of these ideas. The test came up blank, putting limits on the possible link between dark matter and antimatter's absence.

Meet the axion

For many years, research has focused on a class of potential dark matter particles called WIMPs, for weakly interacting massive particles. These heavy, relatively slow-moving particles are the best fits for the properties of dark matter inferred from the behavior of our Universe. But searches for WIMPs—including those conducted at the Large Hadron Collider as well as dedicated detectors—have all failed to find them. This has caused many researchers to start considering alternatives to WIMPs when it comes to dark matter.

One of those alternatives is the axion, a particle first proposed as a way of solving problems in an unrelated area of physics called quantum chromodynamics. Axions would be lighter than WIMPs but still present in large enough numbers to account for dark matter without the need for additional particles. Because their properties have already been defined by their role in quantum chromodynamics, there are a lot of ideas to test for the axion's existence. Some of those tests are currently in progress.

The new study goes well beyond simply testing whether axions exist. Instead, it explores whether they might interact differently with antimatter than with regular matter. Not only would this provide evidence of the axion's existence, but it could hint at why antimatter ended up so rare in our Universe.

Or rather, fail to meet it

So how do you go about looking for axion-antimatter interactions? Like regular particles, antimatter particles have a spin that will align with external magnetic fields. Like a top, however, that spin can undergo precession, in which it wobbles around a direct alignment with the magnetic field. If axions exist and interact with antimatter, they should do so in a way that alters this wobbling. And, if

axions are dark matter, those interactions should be frequent enough that we should see them.

The big “if” to getting this experience to work is that you not only need to get ahold of some antimatter, but you need to keep it from running in to regular matter for long enough to do repeated measurements on its spin. Conveniently, CERN has just the ticket for grabbing some antimatter and holding it still.

That allowed them to measure the antimatter’s precession, which produced a result that was indistinguishable from what you’d expect if axions didn’t exist. That doesn’t mean the interaction doesn’t take place. It does, however, mean that any interaction that occurs happens with axions that have different properties than the ones assumed in this experiment. By gradually excluding possible axion properties, experiments like this and others could eventually push them out of consideration—for example, if axion masses that would work as dark matter end up being excluded, there’s much less point to considering their existence.

Of course, this is only for axions that also happen to interact with antimatter differently from how they interact with regular matter. There’s no particular reason to think these exist other than optimism—specifically optimism that we could tie up two annoying problems in physics at the same time.

Nature, 2019. DOI: 10.1038/s41586-019-1727-9 (About DOIs).

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