Warm white dwarfs could reveal 'inelastic' dark matter

Feb 11, 2010 7 comments

White dwarf star: could inelastic dark matter be keeping it warm?

Direct observations of dark matter – the substance thought to account for 80% of matter in the universe – are sketchy, at best. Some experiments have found what seem like dark-matter signals, while others looking within the same parameter range have found nothing. Yet there is a hypothetical candidate for dark matter, known as "inelastic" dark matter, that could reconcile such results – and now two teams of physicists have proposed new ways to see if it exists.

The story of inelastic dark matter begins over a kilometre beneath Gran Sasso mountain in Italy, which is home to the underground DAMA experiment. Here, a bank of detectors watches out for the flash of light that is expected when a dark-matter particle strikes a nucleus within the experiment. Although such collisions are very rare, in theory there should be more flashes in summer, when the Earth is orbiting against the prevailing "wind" of dark matter in our galaxy.

The DAMA team claimed the first such signature in 2000, and over the subsequent decade has steadily increased its precision. In its most recent analysis (available at *arXiv*:1002.1028), the researchers claim evidence for dark-matter particles at a statistical significance of 8.9 sigma – or, to put it another way, about as precise as one can hope to expect.

No matching signals

These results have failed to convince many physicists, however. Part of the problem is that there could be some other factor that modulates with the seasons, thereby imitating the much sought-after dark-matter signal. But more troubling is that several other direct-detection experiments – CDMS in the US or ZEPLIN in the UK, for instance – have found no matching signals using different detectors. To get round this, some physicists have proposed different types of dark matter that would interact only with

Regardless of the details of

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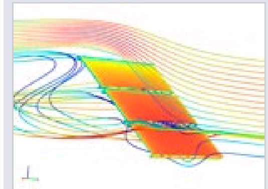

DAMA's detectors. One of these, inelastic dark matter, was put forward in 2001 by David Smith at the University of California at Berkeley and Neal Weiner at the University of Washington. Unlike normal, "elastic" dark matter, inelastic dark matter would get heavier when it hits an atomic nucleus of sufficient mass. So because sodium iodide has the most massive nuclei, only DAMA would be able to give inelastic dark matter the mass jump to enable it to scatter and produce the tell-tale flashes.

estimating the amount of dark matter, it's quite an interesting scenario for looking for evidence of inelastic dark matter

Matthew McCullough, University of Oxford

Now, two independent groups have tried to find ways to spot evidence for inelastic dark matter somewhere far outside the lab – namely in old white dwarf stars. White dwarves are the dim, compact forms that the vast majority of stars adopt in their latter years, and as they get older they cool down. The oldest and coolest ones tend to reside in the centres of galaxies, or in regions of high dark-matter density.

Warming old white dwarfs

The two groups – one comprising Dan Hooper and colleagues at Fermilab in the US; and the other being Matthew McCullough at the University of Oxford and Malcolm Fairbairn at King's College London in the UK – have calculated how dark matter should interact with an old white dwarf's atomic nuclei as it is accelerated inwards by the star's huge gravitational forces. According to their calculations, inelastic dark matter should interact much more strongly than elastic dark matter, which means that much more of it would end up being absorbed by the star. And this added mass would in turn mean that the star's temperature is held a little higher, at around 7000 K as opposed to 3000 K.

"If you looked at [a dense dark matter region] and, instead of seeing very cold white dwarves, you saw white dwarves at nothing below, say, six or seven thousand Kelvin, then you might say, huh, maybe these white dwarves are cooling but they've hit this bottom floor where they can't cool any further, because inelastic dark matter is heating them up," explains Hooper. "And that would be evidence of the [inelastic dark matter] picture."

It may be that the true importance of these works will come *after* we know what the dark matter is, which is a truly exciting prospect

Neal Weiner, New York University

Both groups suggest a search for unusually warm white dwarves as a means to find evidence for inelastic dark matter, although there are differences between their studies. Whereas McCullough and Fairbairn have focused on close regions of tightly bound stars known as globular clusters, Hooper's group believes that there are higher densities of dark matter in galactic centres, which would make the search for the white dwarves easier. Still, as McCullough point out, the issue isn't settled. "Regardless of the details of estimating the amount of dark matter, it's quite an interesting scenario for looking for evidence of inelastic dark matter," he adds.

Weiner – now at New York University – agrees with Hooper's group that galactic centres present the most promising region to test the hypothesis. However, he also thinks that observations of old white dwarves could instead be used to map distributions of dark matter once direct-detection experiments have found the true nature of dark-matter particles. "Rather than being tests of theories of dark matter, [white dwarves] may become excellent probes of the structure of the galaxy's dark matter halo," he says. "It may be that the true importance of these works will come *after* we know what the dark matter is, which is a truly exciting prospect."

Preprints of the studies can be found at *arXiv*: 1001.2737 and *arXiv*:1002.0005.

About the author

Jon Cartwright is a freelance journalist based in Bristol, UK

7 comments

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1 **John Duffield**
Feb 12, 2010 2:23 AM
United Kingdom

Interesting. If anybody wants a little more excitement, see Einstein's The Foundation of The General Theory of Relativity and look at page 185 where he says:

"the energy of the gravitational field shall act gravitatively in the same way as any other kind of energy."

Then look at what he said in his 1920 Leyden address:

"..the recognition of the fact that 'empty space' in its physical relation is neither homogeneous nor isotropic, compelling us to describe its state by ten functions (the gravitation potentials gμν)..."

So, a gravitational field is a region of inhomogeneous space with a non-uniform energy density that itself causes gravity. This gravity is not caused by dark matter particles. Now, since space expands between the galaxies but not within, as per the raisins-in-the cake analogy, the result will be... inhomogeneous space.

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2 **Ragtime**
Feb 13, 2010 1:33 AM
Prague, Czech Republic

Quote:

> *Originally posted by **John Duffield***
> .."the energy of the gravitational field shall act gravitatively in the same way as any other kind of energy."

Unfortunatelly, he just said it - Einstein didn't really put this equivalence into derivation of Einstein field equations from aparent reason: it leads into recursivelly nested, very complex implicit solution of fractal geometrodynamics. Such solution was handled in works of Cartan, Yilmaz, Heim and Beckenstein and some others.

Quote:

> *Originally posted by **John Duffield***
> a gravitational field is a region of inhomogeneous space with a non-uniform energy density that itself causes gravity..

In Le Sage theory gravity is a product of tachyon shielding and tachyons are manifesting like CMB noise. In water surface analogy: when the water surface is completelly calm, no attractive force appears in it. It means, gravity requires tachyon noise in similar way, like Casimir force requires photon noise - and CMB noise provides them both (in AWT transversal portion of CMB noise forms the photons, longitudinal one gravitational waves).

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3 **John Duffield**
Feb 14, 2010 9:57 AM
United Kingdom

One takes an integral, Ragtime. No problem re Einstein-Cartan theory, and whilst I could take issue with fractals, tachyons, and LeSage, this is not the place to discuss them. The moot point is that like Einstein-said, it's a non-uniform energy distribution that causes gravity. Matter only causes gravity because of its energy content. Space has vacuum energy, and like Einstein also said, it is not homogeneous. And it's dark, and there's a lot of it.

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4 **qraal**
Feb 12, 2010 3:07 AM
Brisbane, Australia

Long term future

I wonder if this means that suitably placed white-dwarfs will remain relatively hot until the Dark Matter has been radiated away as annihilation products perhaps 10 million trillion years from now?

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5 **Ragtime**
Feb 13, 2010 1:47 AM
Prague, Czech Republic

The article could be understood quite easily at conceptual level, if we imagine particles of matter like wet lumps of sand, which are held together by forces of surface tension (analogy of strong nuclear force mediated by meson fluid). When these lumps are placed into more dense environment, they will dissolve into their components in similar way, like particles of matter would decompose into radiation inside of dense cloud of dark matter.

Similar mechanism was proposed in 2012 disaster movie, when increased flux of neutrinos from Sun increased decay speed of radioactive elements, which heated Earth core and destroyed Earth by volcanism (we can observe annual changes in radioactive decay speed of many elements).

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6 **John Duffield**
Feb 15, 2010 1:50 PM
United Kingdom

Not sure about that concept, Zeph, but yes, I'm surprised nobody mentioned the seasonal neutrino flux. See www.google.co.uk…search and this 2001 iDM paper that mentions the "sneutrino" as a candidate: arxiv.org…0101138. I suppose since inelastic dark matter is not WIMPs it's a step in the right direction, but I do wish they'd look beyond particles at relativity. I suppose it's a particle physics thing, what with gravity not being in the standard model. C'est la vie.

Edited by John Duffield on Feb 15, 2010 1:51 PM.

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7 **Imre von Soos**
Feb 18, 2010 6:35 PM

The existence of "dark matter" was conjectured quite a few decades back, to explain with it the gravitational equilibrium existing in spite of far too great intergalactic distances. These distances were calculated with simple triangulation on the base of the distances of the galaxies from the earth, which, however, were established on the conjecture that the observed redshift of their light is due to the Doppler effect; the same conjecture as used in the theory of the big bang.
In spite of not even the slightest observational proof was found for the existence of "dark matter", or for "dark energy", these became canonised into the scientific belief-system of the cosmological mainstream; and heretics, who happen to interpret the observational results differently and dared to propose a different theory, were and are banned from any further observation possibilities, from publishing their thoughts and from funding.
See: en.wikipedia.org…Halton_Arp and, in particular:
www.cosmologystatement.org

Imre von Soos

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