Two studies show possibility of some cosmic rays existing due to dark matter collisions

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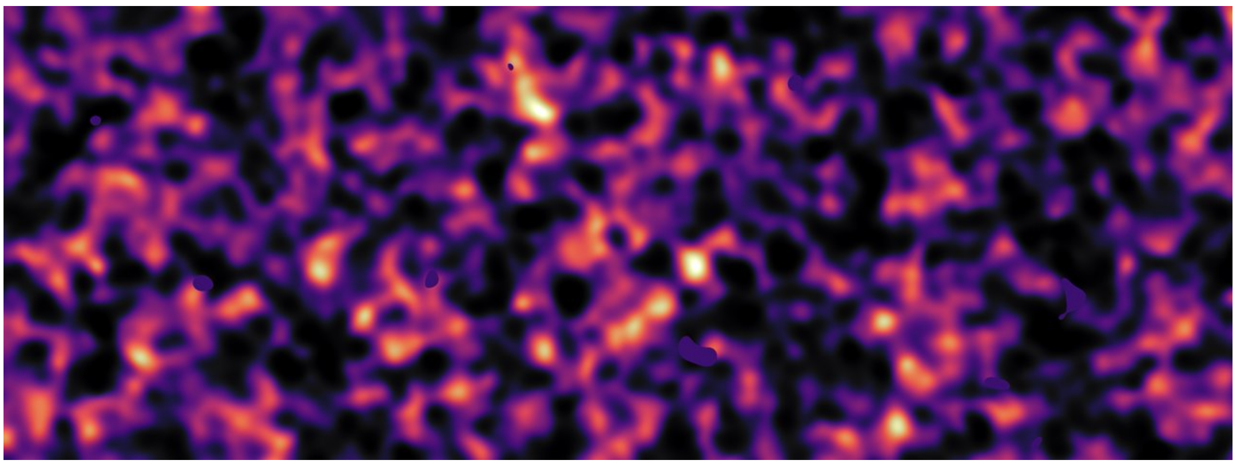

Dark matter map of KiDS survey region (region G12). Credit: KiDS survey

(Phys.org)—Two teams working independently have conducted studies with similar results suggesting the possibility that some of the cosmic rays striking the Earth arise from dark matter particles colliding with one another. One group, a trio of researchers with RWTH Aachen University in Germany, created models simulating conditions both with and without dark matter-produced particles. The other group, a team with the Chinese Academy of Sciences, conducted a study involving the boron-to-carbon ratio in cosmic particles. Both teams have published their results in *Physical Review Letters*.

Part of the theory surrounding dark matter is the likelihood that if it does, indeed, exist, then it is likely that at least some of it is moving very fast, and if that is the case, then it seems logical to conclude that some of those particles might collide, causing them to break apart. If they do, the thinking goes, then it might be possible that other particles could result, some of which might be detectable. If scientists could detect such particles and were able to attribute them to dark matter, then they could prove that dark matter exists. To that end, the two teams involved in this latest research used data from the Alpha Magnetic Spectrometer (AMS) aboard the International Space station to conduct independent studies of possible dark matter particles.

The team in Germany created models meant to depict two very different scenarios, one in which some of the particles detected by the AMS originated with dark matter collisions and the other in which no such particles exist. After making adjustments, the researchers report that the best fit for the observations came from assuming that dark matter particles did exist and that they were likely 80 GeV/c^2.

Meanwhile, the team in China took another approach using the same data. They looked at boron-to-carbon ratios, which can be used to measure how far cosmic rays have traveled before reaching the AMS. Using that data, they created their own model that showed the best explanation for the observations was dark matter particles of approximately 40 and 60 GeV/c2GeV/c^2 striking the sensor.

Both teams, it should be noted, took certain liberties or made certain assumptions when creating their models, which may or may not be accurate; thus, the work is still purely theoretical.

More information: Alessandro Cuoco et al. Novel Dark Matter Constraints from Antiprotons in Light of AMS-02, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.191102 , On *Arxiv*:

arxiv.org/abs/1610.03071

Abstract
We evaluate dark matter (DM) limits from cosmic-ray antiproton observations using the recent precise AMS-02 measurements. We properly take into account cosmic-ray propagation uncertainties fitting at the same time DM and propagation parameters, and marginalizing over the latter. We find a significant (~4.5 sigma) indication of a DM signal for DM masses near 80 GeV, with a hadronic annihilation cross-section close to the thermal value, sigma v ~3e-26 cm3s-1. Intriguingly, this signal is compatible with the DM interpretation of the Galactic center gamma-ray excess. Confirmation of the signal will require a more accurate study of the systematic uncertainties, i.e., the antiproton production cross-section, and modelling of the solar modulation effect. Interpreting the AMS-02 data in terms of upper limits on hadronic DM annihilation, we obtain strong constraints excluding a thermal annihilation cross-section for DM masses below about 50 GeV and in the range between approximately 150 and 500 GeV, even for conservative propagation scenarios. Except for the range around 80 GeV, our limits are a factor 4 stronger than the limits from gamma-ray observations of dwarf galaxies.

Ming-Yang Cui et al. Possible Dark Matter Annihilation Signal in the AMS-02 Antiproton Data, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.191101 , On *Arxiv*: arxiv.org/abs/1610.03840

Abstract
Using the latest AMS-02 cosmic ray antiproton flux data, we search for potential dark matter annihilation signal. The background parameters about the propagation, source injection, and solar modulation are not assumed {it a priori}, but based on the results inferred from the recent B/C ratio and proton data measurements instead. The possible dark matter signal is incorporated into the model self-consistently under a

Bayesian framework. Compared with the astrophysical background only hypothesis, we find that a dark matter signal is favored. The rest mass of the dark matter particles is ∼20–80 GeV and the velocity-averaged hadronic annihilation cross section is about (0.2–5)×10−26 cm3s−1, in agreement with that needed to account for the Galactic center GeV excess and/or the weak GeV emission from dwarf spheroidal galaxies Reticulum 2 and Tucana III. Tight constraints on the dark matter annihilation models are also set in a wide mass region.

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