

Astrowatch

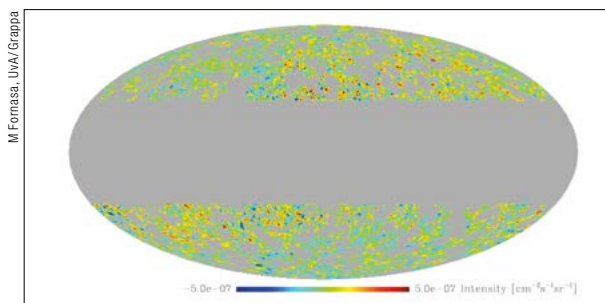
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WIMP no-show in gamma-ray background

Although the night sky appears dark between the stars and galaxies that we can see, a strong background emission is present in other regions of the electromagnetic spectrum. At millimetre wavelengths, the cosmic microwave background (CMB) dominates this emission, while a strong X-ray background peaks at sub-nanometre wavelengths. For the past 50 years it has also been known that a diffuse gamma-ray background at picometre wavelengths also illuminates the sky away from the strong emission of the Milky Way and known extra-galactic sources.

This so-called isotropic gamma-ray background (IGRB) is expected to be uniform on large scales, but can still contain anisotropies on smaller scales. The study of these anisotropies is important for identifying the nature of the unresolved IGRB sources. The best candidates are star-forming galaxies and active galaxies, in particular blazars, which have a relativistic jet pointing towards the Earth. Another possibility to be investigated is whether there is a detectable contribution from the decay or the annihilation of dark-matter particles, as predicted by models of weakly interacting massive particles (WIMPs).

Using NASA's Fermi Gamma-ray Space Telescope, a team led by Mattia Fornasa from the University of Amsterdam in the Netherlands studied the anisotropies of the IGRB in observations acquired over more than six years. This follows earlier results published in 2012 by the Fermi collaboration and shows that there are two different classes of gamma-ray sources. A specific type of blazar appears to dominate at the



Fluctuations in the isotropic gamma-ray background (IGRB), based on 81 months of Fermi data. Emissions from our own galaxy and from bright extra-galactic sources are masked in grey.

highest energies, while at lower frequencies star-forming galaxies or another class of blazar is thought to imprint a steeper spectral slope in the IGRB. A possible additional contribution from WIMP annihilation could not be identified by Fornasa and collaborators.

The first step in such an analysis is to exclude the sky area most contaminated by the Milky Way and extra-galactic sources, and then to subtract remaining galactic contributions and the uniform emission of the IGRB. The resulting images include only the IGRB anisotropies, which can be characterised by computing the associated angular power spectrum (APS) similarly to what is done for the CMB anisotropies. The authors do this both for a single image ("auto-APS") and between images recorded in two different energy regions ("cross-APS").

The derived auto- and cross-APS are found to be consistent with a Poisson distribution, which means they are constant on all angular scales. This absence of scale dependence in gamma-ray anisotropies suggests that the main contribution comes

from distant active galactic nuclei. On the other hand, the emission by star-forming galaxies and dark-matter structures would be dominated by their local distribution that is less uniform on the sky and thus would lead to enhanced power at characteristic angular scales. This allowed Fornasa and co-workers to derive exclusion limits on the dark-matter parameter space. Although less stringent than the best limits achieved from the average intensity of the IGRB or from the observation of dwarf spheroidal galaxies, they independently confirm the absence, so far, of a gamma-ray signal from dark matter.

The constraints on dark matter will improve with new data continuously collected by Fermi, but a potentially more promising approach is to complement them at higher gamma-ray energies with data from the future Cherenkov Telescope Array and possibly also with high-energy neutrinos detected by IceCube.

● Further reading

M Fornasa *et al.* 2016 *Phys. Rev. D* **94** 123005.

Picture of the month

This composite multi-wavelength image invokes thoughts of a frosty winter landscape. In reality, it is a rather hot place in our Galaxy about 5500 light-years from Earth in the constellation Scorpius. The region called NGC 6357 is an association of at least three clusters of young stars, including many hot, massive luminous stars. The purple-coded X-ray emission is based on observations from the Chandra X-ray Observatory and from the earlier ROSAT satellite, and reveals hundreds of point sources, which are young stars, as well as diffuse emission from hot interstellar gas bubbles. The orange-coded infrared observations from NASA's Spitzer Space Telescope trace dusty filaments of cold gas surrounding these cavities, while blue is used for the optical emission observed by the UK Infrared Telescope. Such star-forming clouds are called "HII" (pronounced "H-two") regions, because the intense UV emission of the newborn stars photo-ionises the hydrogen gas.

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