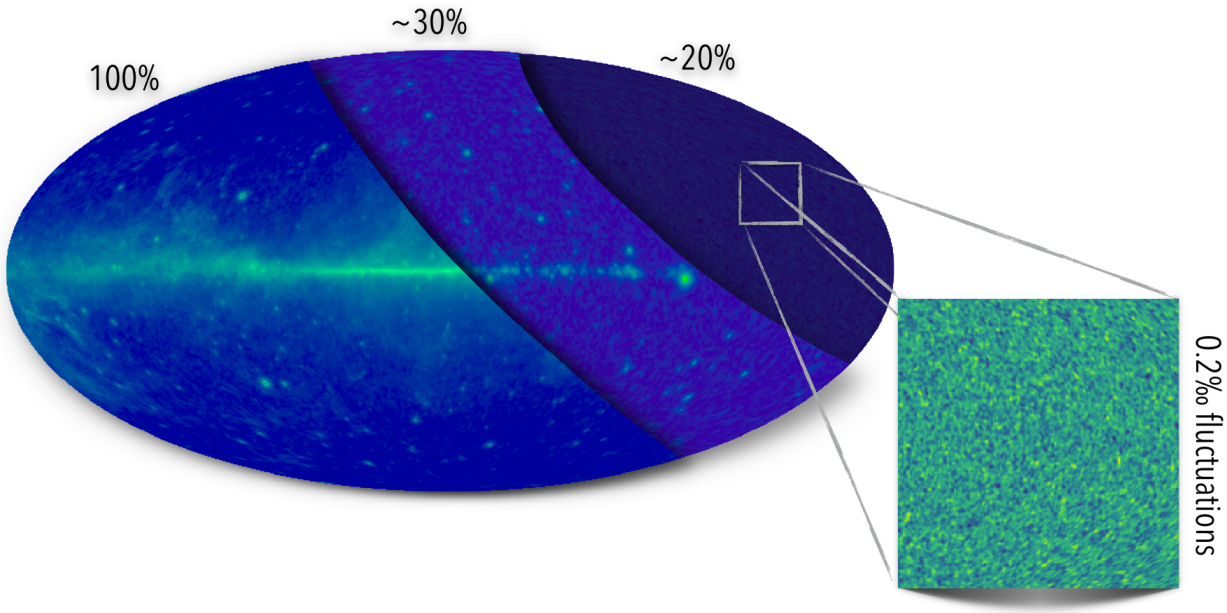
The Power of the Unresolved

The faintest edge of the violent Universe revealed through its tiny fluctuations

The deepest view of the gamma-ray sky ever obtained unveils subtle features of the unresolved emission and shows clear evidence for a transition between different astrophysical source populations.



The faintest glow of the violent Universe has been revealed through its tiny intensity fluctuations: the deepest view ever obtained of the gamma-ray sky unveils subtle features of the so-called “unresolved” emission, which represents 20% of the total gamma-ray emission.

Thanks to a sophisticated analysis of spatial autocorrelation and the Fermi LAT (Large Area Telescope) data, researchers mapped the global distribution of gamma-rays in the unresolved gamma-ray sky, clearly identifying the presence of two different classes of source emerging in different energy ranges.

The Universe has a network of structures that formed by gravitational instabilities, starting from primordial tiny density fluctuations, and evolving into structures at very different scales, from stars to galaxies, up to galaxy clusters and filaments. This texture nurtures the formation of astronomical sources which emit the gamma rays detected by Fermi.

The gamma-ray sky has been observed with unprecedented depth and detail in the last decade by the Fermi-LAT, allowing us to identify the vast majority of this emission produced by some of the most violent processes occurring in the Universe, detecting a bright diffuse Galactic component and resolving individually the most luminous sources of the classes responsible for this emission.

However, the brightest end of the violent Universe represents just the tip of the iceberg: dimmer but much more numerous sources are hidden in a diffuse glow coming from any direction of the sky, a consequence of the cumulative emission of all these sources. The analysis published on Physical Review Letters digs deeper into this faint, unresolved gamma-ray sky.

“Because the source at the origin of the unresolved emission are too faint to be detected individually, - explains Michela Negro - we employed a sophisticated autocorrelation techniques which allowed us to recognise the presence of at least two different source populations emerging at different energy intervals, and our analysis also reveals a transition between the two populations at ~4 GeV”, concludes Negro.

It’s a bit like realizing, when watching a Christmas tree, that it has a mix of bright, white spots from brand new LED lights, and a fainter, yellow glow from the dear old filaments.

“Studying the sky at every wavelength of the electromagnetic spectrum, it is evident that a number of sources shine against a diffuse background which is due to sources that are too faint to be resolved individually”, says Patrizia Caraveo, INAF manager for Fermi. "For this reason, astrophysicists try to use the characteristics of the diffused background radiation to guess what kind of sources contribute to that emission. A priori, we do not know which family the unresolved sources belong to. For this reason it is particularly interesting to note that this study highlights the presence of at least two components characterized by a markedly different spectrum. It's a promising start to understand more about these classes of sources", concludes Caraveo.

"Thanks to the superior performances of the LAT telescope, on board the Fermi satellite, which is capable of collecting data with continuity and consistency, we managed to make such a thorough and solid study of the unresolved gamma-ray background", comments Elisabetta Cavazzuti, ASI manager for Fermi.] "The LAT is a unique instrument for its unprecedented sensitivity and the surveying the sky with a very wide field of view. This allows to provide a uniform, complete (ie without unexplored zones) and very deep view of the high-energy Universe. All this provided a fundamental basis for the conclusions of this study ", concludes Cavazzuti.

These results brings new and deeper insights on the properties of the most energetic astrophysical sources of the Universe during its evolution", explains Luca Latronico, national INFN manager for Fermi] and co-author of the paper. “The unresolved gamma-ray background - continues Latronico - hides, in fact, the deepest secrets of the violent universe and could also carry the long sought after signal of a particle dark matter.

“Understanding where the gamma-ray emitters stand in terms of epochs in the Universe evolution, - explains Nicolao Fornengo - will be investigated through cross-correlations with other maps tracing the cosmic large scale structures, such as catalogs of sources detected in other wavelength bands and at different distances from us, galaxy clusters catalogs, and also exploiting information coming from other cosmic messengers, like neutrinos”. “Those are all studies with very interesting future developments of the results carried out with this fine analysis lead by Michela Negro”, concludes Fornengo.