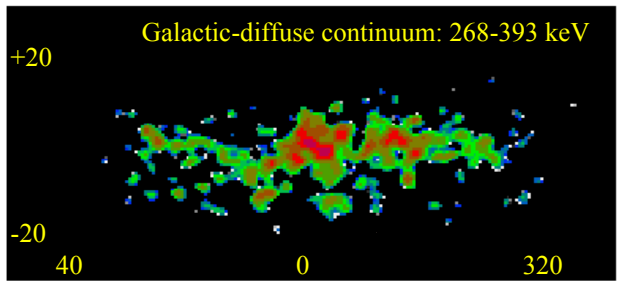
e^+ Annihilation in the Galaxy

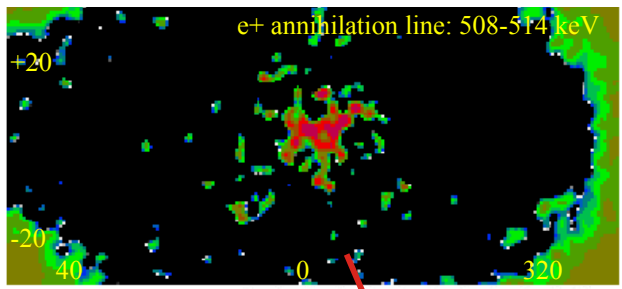
Positrons are ejected into interstellar space from sources of nucleosynthesis, but also from compact sources such as pulsars and microquasars. Through imaging, INTEGRAL/SPI is able to map the Galaxy in annihilation emission, and thus help clarify its origin. The annihilation of positrons in the interstellar medium occurs under unknown conditions of temperature and density; these conditions characteristically shape the gamma-ray emission spectum. INTEGRAL/SPI can resolve spectral detail, to study the e^+ transport from its sources and the conditions of their annihilation.

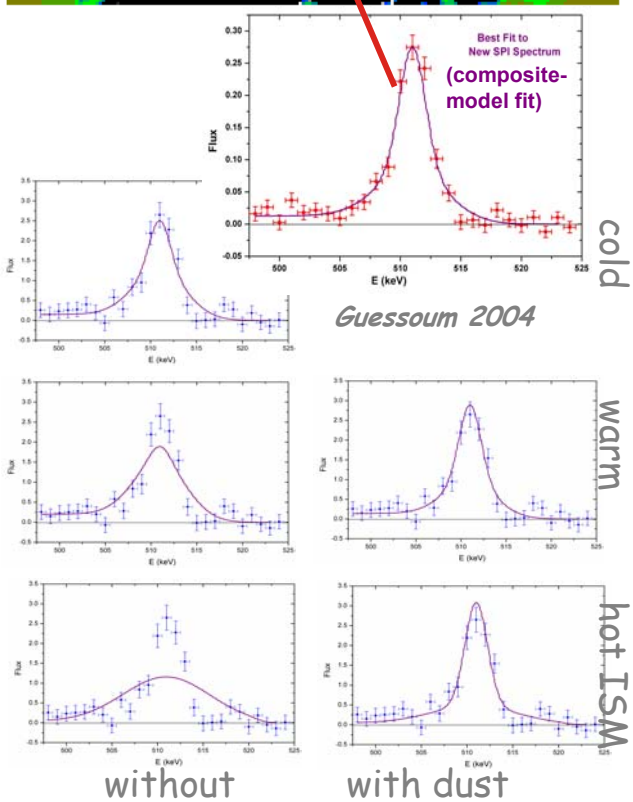
With INTEGRAL/SPI, first detailed mapping of annihilation emission is already possible. The coded-mask imaging suppresses strong instrumental-line background. First images of the inner Galaxy result from Maximum-Entropy deconvolution of ~4Ms of SPI data: The top Figure shows the general continuum emission of the Galaxy at an energy around 300(±50) keV, for reference. The e^+ emission (bottom image) clearly is more circular in appearance, and not dominated by the disk of the Galaxy - consistent with model fitting analyses. It has been suggested that such spherically-symmetric morphology may be the signature of dark-matter annihilation in the Galaxy's gravitational well.

After ejection from their sources, positrons preferentially annihilate only after they have been slowed down and thermalized, colliding with electrons either bound in atoms, or on grain surfaces, or free within the ISM. These different momentum transfers within the final annihilation process shape the 511 keV line.

The 511 keV line has now been measured with great spectral precision, even from the first year of observing (the mission will last >6 years). The line is clearly broadened beyond the instrumental resolution. Its shape does not represent any known or obvious profile, in particular it is not a simple Gaussian. Expected shapes of the annihilation lines have been determined from simulations. None of the single processes can produce the line shape as observed, hence ISM conditions are still uncertain. However, dust grains apparently play a significant role.







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