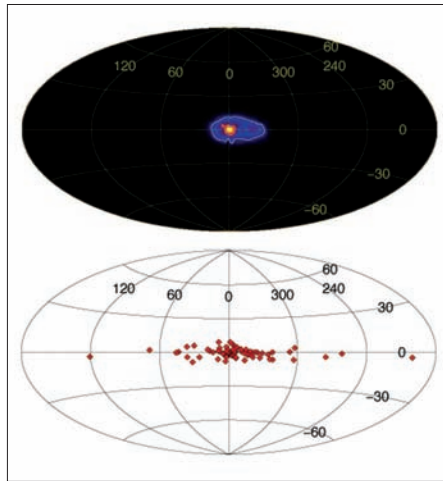


Positrons prefer one side of the galaxy

A new study of the gamma-ray emission of positron annihilation in the Milky Way reveals an asymmetric distribution in the galactic disc. The only sources known to have a similar asymmetry are low-mass X-ray binaries that emit energetic X-rays. This suggests that they are the main producers of positrons in the disc of our galaxy.

After five years in orbit, the imaging spectrometer SPI of the European Space Agency's INTEGRAL satellite has accumulated a great deal of data from the central region of the galaxy, revealing with increasing detail the spatial distribution of an emission-line at 511 keV. This line is emitted by the annihilation of electrons with positrons, which produces a pair of gamma-ray photons each with an energy of 511 keV, equivalent to the rest-mass of the electron. Previous studies have shown that the 511 keV emission is roughly circular around the galactic centre, with an extension consistent with the bulge of the Milky Way. This simple and smooth distribution raised the idea that the positrons could come from the annihilation of lightweight dark-matter particles (*CERN Courier* November 2004 p13). A subsequent study, however, showed that the allowed range of masses for these elusive particles is very limited (*CERN Courier* December 2006 p14).

The new map of positron annihilation obtained by Georg Weidenspointner from the Centre d'Etude Spatiale des Rayonnements in Toulouse, France, and colleagues is



All-sky map of the distribution of annihilating positrons (top) and of energetic low-mass X-ray binaries (bottom). The galactic centre is in the middle and both images show an asymmetry in the galactic disc towards the right side. (Courtesy ESA/Integral/MPE/G Weidenspointner et al.)

consistent with previous results, but shows an additional asymmetric galactic-disc component. Surprisingly, the emission on one side of the galaxy is 1.8 times stronger than on the other side, with a significance of 3.8σ . The effect becomes even bigger – by a factor of 2.2 – if account is taken of the fact that about 30% of the observed emission can be ascribed to positrons from the decay of radioactive aluminium (^{26}Al), which is observed to be roughly symmetric in this region of the galaxy (*CERN Courier* January/

February 2006 p10). The difference of about 10% in observing time on both sides of the galaxy cannot lead to the asymmetry, nor can it be ascribed to instrumental background variations or to the presence of the galactic stellar bar, which is oriented in a way that would yield an opposite asymmetry.

The peculiar distribution of positrons in the galaxy is an important clue to understanding their origin. The only other known population of galactic sources having an asymmetry matching the 511 keV observations is that of low-mass X-ray binaries detected at photon energies above 20 keV. These systems, which are composed of a low-mass star – like the Sun – and a neutron star or a black hole, have already been proposed as good candidates for the production of positrons through photon-photon interactions in the disc of plasma surrounding the compact object.

Assuming X-ray binaries produce the 511 keV emission in the galactic disc, Weidenspointner and collaborators estimate that these sources would also produce half of the observed emission in the galactic bulge. Type Ia supernovae and the supermassive black hole at the galactic centre (*CERN Courier* April 2007 p10) could account for the remainder of the emission, without the need to invoke the more exotic scenario of dark matter annihilation.

Further reading

G Weidenspointner et al. 2008 *Nature* **451** 159.

Picture of the month



What is it? Tinker Bell, Peter Pan's fairy? A cosmic bird, a dragonfly or an angel? Whatever your preference, this is an amazing view of three interacting galaxies at a distance of 650 million light-years. The image is a combination of near-infrared observations with the NACO instrument mounted on the Very Large Telescope (VLT) of the European Southern Observatory (ESO) and of optical images from the Hubble Space Telescope.

Hidden behind this graceful view is a rare and dramatic collision of three galaxies of roughly similar sizes. The "head" of the creature is violently forming stars at a rate of nearly 200 solar masses per year and is flying by the other galaxies at a speed of 400 km/s. (Courtesy ESO.)