

Astrowatch

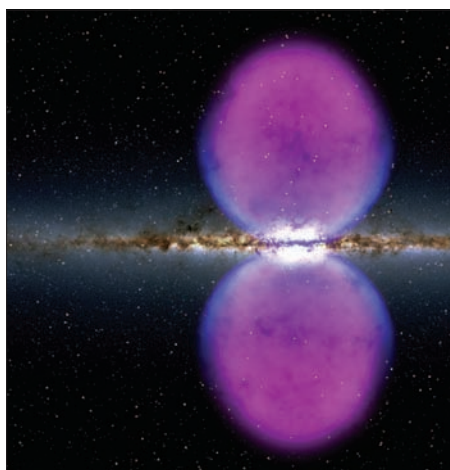
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Fermi sees giant bubbles in the Milky Way

The Fermi gamma-ray space telescope has detected high-energy emission from two giant lobes on both sides of the plane of the Galaxy. This unexpected finding suggests that the Milky Way was more active in the past, either through a phase of intense stellar formation or of much higher activity of the central black hole.

The launch of a new facility with much higher sensitivity than its predecessor always raises the hope of finding something unexpected. The Fermi satellite, observing in the relatively unexplored area of giga-electron-volt photons, is especially suited for such discoveries (*CERN Courier* November 2008 p13). Having already found pulsars emitting pulsed radiation only in gamma-rays (*CERN Courier* December 2008 p9) and evidence for intergalactic magnetic fields (*CERN Courier* June 2010 p10), it has now detected mysterious gamma-ray bubbles in the Milky Way.

The two gamma-ray-emitting bubbles extend 50° above and below the Galactic plane with a width of about 40°. They have been revealed by Meng Su and two colleagues from the Harvard-Smithsonian Center for Astrophysics. The features were hidden in the diffuse galactic gamma-ray emission that arises mainly from inverse-Compton radiation of relativistic electrons and from π decay induced by cosmic-ray interactions with interstellar gas. The distinct characteristic of the bubbles is their hard spectrum, i.e. with more high-energy gamma-rays, which allows them to be disentangled more easily from the other diffuse emission features. Su and colleagues use different ways to remove the latter from



The two giant bubbles detected by the Fermi satellite are illustrated here in purple on an infrared view of the disc of the Milky Way. Associated X-ray emission observed by ROSAT in blue. (Image credit: NASA.)

the all-sky Fermi images to reveal the faint glow of the two bubbles.

The emission of the gamma-ray bubbles is remarkably uniform, with no significant change of intensity over their 25 000 light-years extent or between the north and south bubbles. They must therefore have been produced by a powerful process near the Galactic centre. Further indications as to the origin of the giant features comes from apparently associated X-ray emission from the rim of the bubbles, which has been identified in all-sky maps from the early 1990s by the Germany-led Roentgen Satellite (ROSAT), and from a spatially consistent haze of radio emission detected

by the Wilkinson Microwave Anisotropy Probe (WMAP). The presence of these lower-energy counterparts disfavors the annihilation or decay of dark matter as the origin for the gamma-ray emission. The association of the radio signal with the high-energy gamma-ray emission suggests instead emission by relativistic electrons. The WMAP signal would then come from synchrotron radiation in the Galactic magnetic field, while Fermi would have recorded the inverse-Compton gamma-rays from electrons scattering off photons from the Galaxy or the cosmic microwave background. The X-ray signal from the edge of the bubbles further suggests a shock-wave interaction of expanding gas with the surrounding medium.

According to the authors of the paper, published in the *Astrophysical Journal*, the most likely origin of the bubbles is a large episode of energy injection from the Galactic centre. This could consist either of past accretion events on the now quiescent supermassive black hole at the centre of the Milky Way or a nuclear starburst event in the past 10 million years or so. However, both explanations have some difficulties in accounting for the observations. While a simple jet explanation would not easily produce the smooth surface brightness and north-south symmetry, an intense and prolonged star formation period is not suggested by recent observations of radioactive decay of aluminium-26 (*CERN Courier* January/February 2006 p10).

● Further reading

M Su *et al.* 2010 *ApJ* **724** 1044.

Picture of the month

Serenely floating in space, this delicate shell is reminiscent of the “soap bubble” planetary nebula (*CERN Courier* September 2009 p11). However, its calm is only illusory because the shell is lit up by a blast wave that is smashing into the interstellar medium at more than 5000 km/s. Called SNR 0509, the bubble is the remnant of a stellar explosion that should have been visible in the Large Magellanic Cloud to observers in the southern hemisphere around 1600 AD. This neighbouring galaxy – only 160 000 light-years away – was also the site of the most recent naked-eye supernova, SN 1987A (*CERN Courier* February 2007 p11 and p23). The image is a composite of visible light (red shell) and X-rays (blue-green glow) from the Hubble and Chandra Space Telescopes, respectively. (Image credits: NASA, ESA, the Hubble Heritage Team (STScI/AURA), and NASA/CXC/SAO/J Hughes.)

