Unveiling the high energy Milky Way reveals 'dark accelerators'

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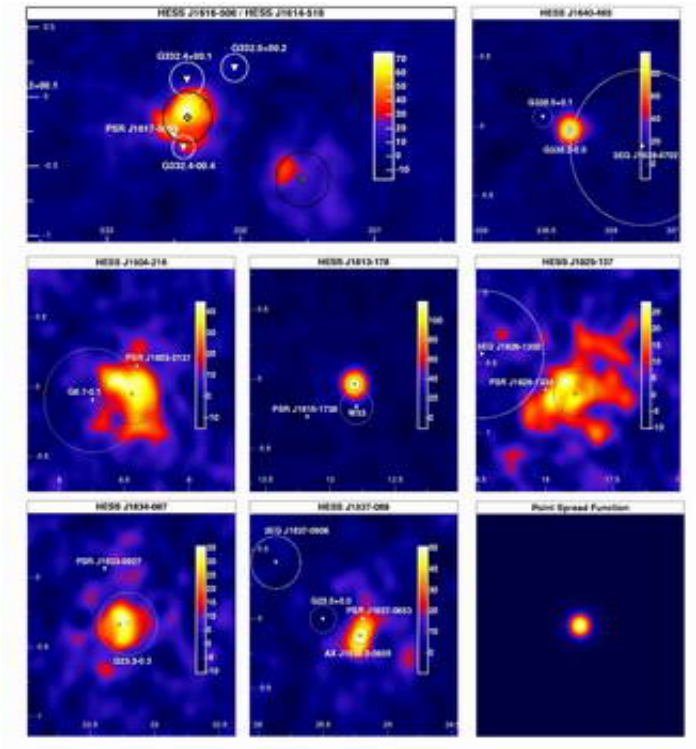

In the March 25th 2005 issue of Science Magazine, the High Energy Stereoscopic System (H.E.S.S.) team of international astrophysicists, including UK astronomers from the University of Durham, report results of a first sensitive survey of the central part of our galaxy in very high energy (VHE) gamma-rays. Included among the new objects discovered are two 'dark accelerators' - mysterious objects that are emitting

energetic particles, yet apparently have no optical or x-ray counterpart.

Image: Image: Close-up view of the new sources are, discovered in the Galactic plane scan. Shown as white circles are close-by supernova remnants, that are known to be sources of very high energy gamma-rays (with the radius of the circle representing the size of the supernova remnant). Also shown in white are close-by pulsars, another class of sources of very high energy gamma-rays. Hi-res image is available here.

This survey reveals a total of eight new sources of VHE gamma-rays in the disc of our Galaxy, essentially doubling the number known at these energies. The results have pushed astronomy into a previously unknown domain, extending our knowledge of the Milky Way in a novel wavelength regime thereby opening a new window on our galaxy.

Gamma-rays are produced in extreme cosmic particle accelerators such as supernova explosions and provide a unique view of the high energy processes at work in the Milky Way. VHE gamma-ray astronomy is still a young field and H.E.S.S. is conducting the first sensitive survey at this energy range, finding previously unknown sources.

Particularly stunning is that two of these new sources discovered by H.E.S.S. have no obvious counterparts in more conventional wavelength bands such as optical and X-ray astronomy. The discovery of VHE gamma-rays from such sources suggests that they may be `dark accelerators', as Stefan Funk from the Max-Planck Institut in Heidelberg affirms: "These objects seem to only emit radiation in the highest energy bands. We had hoped that with a new instrument like H.E.S.S. we would detect some new sources, but the success we have now exceeds all our expectations."

Dr Paula Chadwick of the University of Durham adds "Many of the new objects seem to be known categories of sources, such as supernova

remnants and pulsar wind nebulae. Data on these objects will help us to understand particle acceleration in our galaxy in more detail; but finding these 'dark accelerators' was a surprise. With no counterpart at other wavelengths, they are, for the moment, a complete mystery."

Cosmic particle accelerators are believed to accelerate charged particles, such as electrons and ions, by acting on these particles with strong shock waves. High-energy gamma rays are secondary products of the cosmic accelerators and are easier to detect because they travel in straight lines from the source, unlike charged particles which are deflected by magnetic fields. The cosmic accelerators are usually visible at other wavelengths as well as VHE gamma rays.

The H.E.S.S. array is ideal for finding these new VHE gamma ray objects, because as well as studying objects seen at other wavelengths that are expected to be sources of very high energy gamma rays, its wide field of view (ten times the diameter of the Moon) means that it can survey the sky and discover previously unknown sources.

Another important discovery is that the new sources appear with a typical size of the order of a tenth of a degree; the H.E.S.S. instrument for the first time provides sufficient resolution and sensitivity to see such structures. Since the objects cluster within a fraction of a degree from the plane of our Galaxy, they are most likely located at a significant distance - several 1000 light years from the sun - which implies that these cosmic particle accelerators extend over a size of light years.

The results were obtained using the High Energy Stereoscopic System (H.E.S.S.) telescopes in Namibia, in South-West Africa. This system of four 13 m diameter telescopes is currently the most sensitive detector of VHE gamma-rays, radiation a million million times more energetic than the visible light. These high energy gamma rays are quite rare - even for relatively strong sources, only about one gamma ray per month hits a

square meter at the top of the earth's atmosphere. Also, since they are absorbed in the atmosphere, a direct detection of a significant number of the rare gamma rays would require a satellite of huge size. The H.E.S.S. telescopes employ a trick - they use the atmosphere as detector medium. When gamma rays are absorbed in the air, they emit short flashes of blue light, named Cherenkov light, lasting a few billionths of a second. This light is collected by the H.E.S.S. telescopes with big mirrors and extremely sensitive cameras and can be used to create images of astronomical objects as they appear in gamma-rays.

The H.E.S.S. telescopes represent several years of construction effort by an international team of more than 100 scientists and engineers from Germany, France, the UK, Ireland, the Czech Republic, Armenia, South Africa and the host country Namibia. The instrument was inaugurated in September 2004 by the Namibian Prime Minister, Theo-Ben Guirab, and its first data have already resulted in a number of important discoveries, including the first astronomical image of a supernova shock wave at the highest gamma-ray energies.

The H.E.S.S. collaboration

The High Energy Stereoscopic System (H.E.S.S.) team consists of scientists from Germany, France, the UK, the Czech Republic, Ireland, Armenia, South Africa and Namibia.

Over the last few years, the H.E.S.S. collaboration have been building a system of four telescopes in the Khomas Highland region of Namibia, to study very-high-energy gamma rays from cosmic particle accelerators. The telescopes, known as Cherenkov telescopes, image the light created when high-energy cosmic gamma rays are absorbed in the atmosphere, and have opened a new energy domain for astronomy. The H.E.S.S. telescopes each feature mirrors of area 107 square metres, and are equipped with highly sensitive and very fast 960-pixel light detectors in

the focal planes. Construction of the telescope system started in 2001; the fourth telescope was commissioned in December 2003. Observations were being made even while the system was being built, first using a single telescope, then with two and three telescopes. While only the complete four-telescope system provides the full performance, the first H.E.S.S. telescope alone was already superior to any of the instruments operated previously in the southern hemisphere.

H.E.S.S. project website is at www.mpi-hd.mpg.de/hfm/HESS/

Source: PPARC