Namibia Telescopes Find First "Gamma Clock" in Milky Way Galaxy

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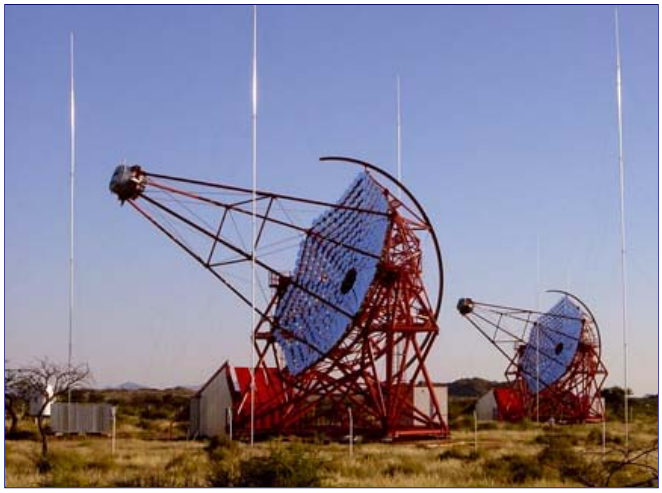
- H.E.S.S. Observatory, Namibia

High Energy Stereoscopic System (H.E.S.S.) system of Imaging Atmospheric Cherenkov Telescopes for investigation of cosmic gamma rays in the 100 GeV energy range. First operation began in Summer 2002 in Gamsberg, Namibia. Image courtesy H.E.S.S.

Gamsberg is west of Windhoek, Namibia.

November 27, 2006 Gamsberg, Namibia - Astrophysicists operating the High Energy Stereoscopic System (H.E.S.S.) gamma-ray telescopes in Namibia have announced the discovery of periodic emission of very-high-energy gamma rays from a binary system. The object which is responsible for this emission is a double system called LS 5039, comprised of a massive blue star *twenty times heavier than the Sun.*

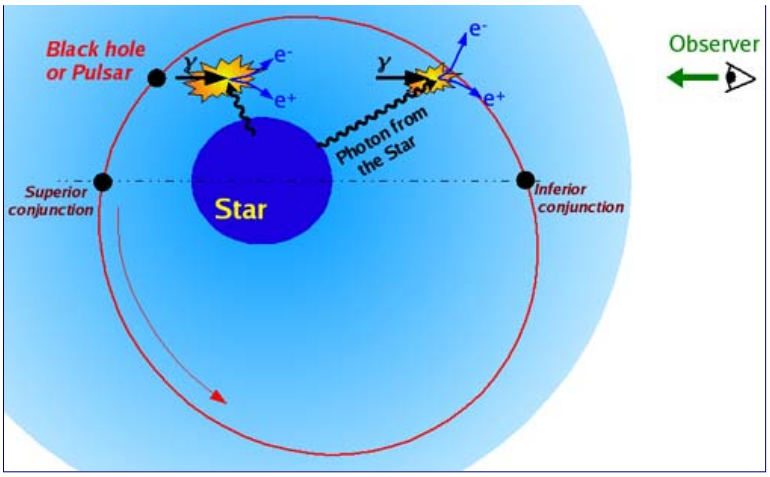
Orbiting every 3.9 days around the blue star is an unidentified, compact object - perhaps a black hole. The HESS scientists reported in the November 26, 2006, issue of *Astronomy & Astrophysics* that as the object dives towards the blue-giant star, the object is exposed to the strong stellar 'wind' and the intense light radiated by the star. Particles are accelerated to high energies, which at the same time make it increasingly difficult for gamma rays produced by these particles to escape, depending on the orientation of the system with respect to us. The interplay of these two effects is at the root of the complex modulation pattern we see from Earth. This is the highest energy at which any periodic signal has been observed, nearly 100,000 times higher than previously known.



Side view of two H.E.S.S. Imaging Atmospheric Cherenkov Telescopes, Gamsberg, Namibia. Image courtesy H.E.S.S.

In our Galaxy, more than 80% of the stars are members of multiple systems made up of two or more stars in orbit about each other. Isolated stars, such as our Sun, are in the minority. LS 5039's massive blue star and possibly orbiting black hole are in an extremely tight orbit. Their separation varies between two and four times the radius of the star, which represents about a tenth of the Earth-Sun distance. The unidentified object has an orbital period of 3.9 days, confirmed to a precision better than 0.04% by H.E.S.S.

The H.E.S.S. team showed that the LS 5039 system emits gamma rays with a certain periodicity, with the highest emission when the compact object is in front of the star, and the lowest (but not zero) emission when it is behind. "Additionally, we discovered that the energy distribution of gamma rays varies strongly along the orbit, with an excess of the highest-energy gamma rays in the high-emission state," says H.E.S.S. researcher, Gavin Rowell, formerly with the Max Planck Institute for Nuclear Physics.



LS 5039 massive blue star. Red line is orbit of an unidentified compact object, perhaps a black hole, every 3.9 days, creating a "gamma clock," the first ever detected at this high energy state in our Milky Way Galaxy. Graphic courtesy H.E.S.S.

This gamma-ray emission could be produced by the violent interaction between the compact object and the stellar wind. This wind is the flux of particles accelerated in the star's atmosphere. In our Sun the solar wind causes magnetic storms and the *aurora borealis* or "Northern lights" seen near the Earth's poles. The compact object, in moving along its orbit, acts like a probe of the star's electromagnetic environment. That includes the intensity of the star's wind and its optical and ultraviolet radiation and the magnetic field which changes, depending on the distance to the star and particle acceleration influence near the compact object. Another implication of this discovery is that the particle acceleration responsible for the emission takes place at a short distance from the star, at distances similar to the Earth-Sun distance.

HESS scientists report that in addition, "a geometrical effect adds a further modulation to the flux of gamma rays observed from the Earth. We know since Einstein derived his famous equation ($E=mc^2$) that matter and energy are equivalent, and that pairs of particles and antiparticles can mutually annihilate to give light. Symmetrically, when very energetic gamma rays meet the light from a massive star, they can be converted into matter (an electron-positron pair in this case). So, the light from the star acts like a fog for gamma rays, absorbing them especially when their source — the compact object — is behind the

star, and so is partially eclipsed. 'The periodic absorption of gamma-rays is a nice illustration of the production of matter-antimatter pairs by light, though it also obscures the view to the particle accelerator in this system,' explains Guillaume Dubus, Astrophysical Laboratory of Grenoble, LAOG.

"The modulation seen with H.E.S.S. is therefore likely to be caused both by a variation in the particle-acceleration process along the orbit and also by the geometric effect due to the light-fog. 'This is the first time in the history of very high energy gamma-ray astronomy that we can observe a repeating, evolving, particle-acceleration experiment in a well-determined environment,' says Mathieu de Naurois, Nuclear and High-Energy Physics Laboratory, LPNHE, Paris.

"The discovery by the H.E.S.S. collaboration of this orbital clock, thanks to the precision of the measurements, will open the way to a better understanding of the environment of black holes, neutron stars, and more generally of the sites of particle acceleration in the Universe."

More Information:

The University of Namibia reports that H.E.S.S. uses three or more telescopes to observe gamma-ray induced air shower from different angles to obtain a 3-dimensional "view" of the showers - or "stereoscopic." This acronym also honors the famous Austrian Physicist, Victor F. Hess who is credited with the discovery of cosmic radiation (energetic particles and photons from outer space) in 1911.

"The array of telescopes being built in Namibia will be a next-generation instrument consisting of four 12-meter-diameter concentrators that will be used to focus faint Cherenkov light flashes caused by incoming gamma-ray photons onto a sophisticated detector (or camera). This instrument will be capable of detecting the effects of gamma-ray photons from a photon energy of 40 GeV upwards (hence, the reference to "High Energy"). The instrument will be able to detect gamma-ray sources with a spatial resolution of about 0.1 o and an energy resolution of about 20%.

"During a second phase, the four telescopes of the first phase will be expanded to a total of 12 to 16 telescopes which will increase the capabilities of the project considerably. This will make the H.E.S.S. Project the largest of its kind in the world.

"The purpose of this project is to study the so-called non-thermal universe - processes taking place in interstellar and intergalactic space that can be traced back to populations of energetic particles whose energy spectra are power laws, not the well-known Maxwellian distributions. In more concrete terms, the project will be used to study exotic phenomena like black holes, quasars, pulsars, supernova remnants, exotic heavy particles left over from the creation of the universe, and much more."

For further information about astronomical bodies, please see reports below in the **Earthfiles Archives:**

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• 08/16/2002 -- Did CONTOUR Probe Break Apart Or Disappear Into Space?
• 07/11/2002 -- Hubble Telescope Photographs 7 Objects Traveling In Pairs Beyond Pluto
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• 01/10/1999 -- Updates: Astronomy and Rufus Baughn, Nevada Test Site

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Websites:

H.E.S.S. Project: http://www.mpi-hd.mpg.de/hfm/HESS/HESS.html

University of Namibia: http://www.unam.na/research/hess/index.html

Journal of Astrophysics and Astronomy: **http://www.ias.ac.in/jaa/**

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