H.E.S.S. Discovers Radio Galaxy Shining in Gamma Light

A nearby active galaxy is a source of very high energy gamma rays

An international team of astrophysicists, for the first time, has observed very-high-energy gamma radiation from one of the nearest active galactic nucleus in the radio galaxy Centaurus A. The weak radiation has been discovered by the H.E.S.S. telescopes in Namibia, currently one of the most sensitive instruments of high-energy astrophysics.

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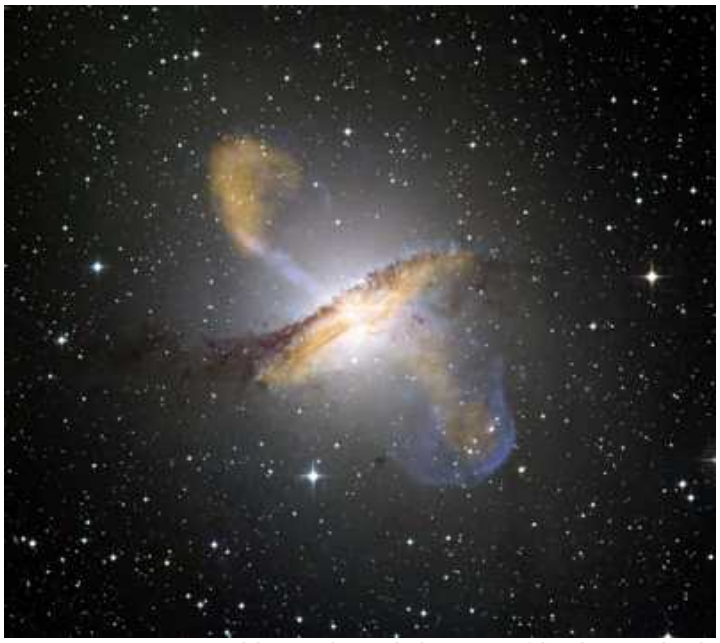

Centaurus A: Multiwavelength image of in the optical, submillimetre- and X-ray regions (not including high-energy gamma radiation).
Credits, Image: ESO/WFI (Optical); MPIfR/ESO/APEX/A.Weiss et al. (Submillimetre); NASA/CXC/CfA/R.Kraft et al. (X-ray)
Detailed explanations, higher resolution image...

Active galactic nuclei are the most energetic objects in the Universe. Around the suspected supermassive black hole they harbour at their centre, charged particles (electrons and protons) may be accelerated to velocities close to the speed of light and ejected in oppositely-directed jets. Centaurus A, located in the constellation Centaurus, is one of the brightest galaxies in the night sky. Its proximity enables unique studies of the active centre and its surrounding. Centaurus A covers an area of the sky more than 100 times the size of the area of the full moon – but this extended structure only glows in radio frequencies with only the host galaxy being visible to the naked eye.

The telescopes of the High Energy Stereoscopic System (H.E.S.S.) in Namibia have now, for the first time, observed very-high-energy gamma-ray emission from Centaurus A. H.E.S.S. consists of four identical telescopes with 13m mirror diameter, built and operated by an international collaboration. Ultrafast cameras record the flashes of weak blue light from the cascades of subatomic particles that arise when very-high-energy gamma-ray photons interact high in the atmosphere.

Gamma rays: Gamma rays resemble normal light or X-rays, but are much more energetic. Visible light has an energy of about one electronVolt (1 *eV*) of energy in physicist's terms. X-rays are thousands to millions of *eV*. H.E.S.S. detects very-high energy gamma-ray photons with an energy of a million million *eV*s, or Tera-electronVolt energies (TeV). These high energy gamma rays are quite rare; even for relatively strong astrophysical sources, only about one gamma ray per month hits a square metre at the top of the Earth's atmosphere.

The high-energy gamma radiation from Centaurus A is so weak that more than a hundred hours of observation time were needed to obtain an image. The origin of the detected emission appears to be the centre of the galaxy and the inner parts of the jets. With the current data, however, it is not yet possible to identify the exact origin of the emission. These gamma rays – a trillion times more energetic than visible light – are produced, it is thought, when particles, accelerated to extreme energies in the vicinity of a black hole, interact with radiation fields or the surrounding medium.

The detection of very-high-energy gamma rays from Centaurus A poses the more general question of whether such emission might be a common feature

of active galactic nuclei. To answer this question, further observations of Centaurus A and of other active galactic nuclei are necessary. In that case, future instruments with higher sensitivity will be able to detect many more sources than previously anticipated and so better determine the processes involved.

A very large telescope with a mirror diameter of 30m is already under construction, to improve the H.E.S.S. Experiment's performance, and will start observation in 2010. For the future, the European project Cherenkov Telescope Array (CTA) under study. This gamma-ray observatory will consist of roughly a hundred telescopes, leading to an improvement in sensitivity by a factor 10 compared to the current generation of instruments.

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Related links:

- Article - Astrophysical Journal Letters [http://www.iop.org/EJ/abstract/1538-4357/695/1/L40]
- Article - preprint server [http://arxiv.org/abs/0903.1582]
- Further details (News de l'Observatoire de Paris) [http://www.obspm.fr/actual/nouvelle/mar09/cena.en.shtml]
- H.E.S.S. experiment homepage [http://www.mpi-hd.mpg.de/hfm/HESS]

H.E.S.S. Telescopes : *The four identical telescopes of the High Energy Stereoscopic System in Namibia detect faint atmospheric flashes caused by the absorption of ultrahigh-energy gamma rays. Credit: H.E.S.S*

Notes on H.E.S.S.

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

The detector: 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 13m-diameter telescopes is currently the most sensitive detector of very high energy gamma rays. These are absorbed in the atmosphere, where they give a short-lived shower of particles. The H.E.S.S. telescopes detect the faint, short flashes of blueish light which these particles emit (named Cherenkov light, lasting a few billionths of a second), collecting the light with big mirrors which reflect onto extremely sensitive cameras. Each image gives the position on the sky of a single gamma-ray photon, and the amount of light collected gives the energy of the initial gamma ray. Building up the images photon by photon allows H.E.S.S. to create maps of astronomical objects as they appear in gamma rays.

The H.E.S.S. telescope array represent a multi-year construction effort by an international team of more than 100 scientists and engineers. The instrument was inaugurated in September 2004 by the Namibian Prime Minister, Theo-Ben Gurirab, 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.

Future plans: The scientists involved with H.E.S.S. are continuing to upgrade and improve the system of telescopes. Construction of a central telescope — a behemoth 30m in diameter — is underway. The improved system, known as H.E.S.S.-II, will be more sensitive and will cover an increased range of gamma-ray energies, so enabling the H.E.S.S. team to increase the gamma-ray source catalogue and to make new discoveries.

More H.E.S.S. Information:

Experiment homepage
Project Chronology
The H.E.S.S. Telescopes
Brochure on H.E.S.S.
(Full resolution ppt 15 MB)