

## Cosmic mystery 'solved' after decades

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The most energetic particles known, called ultra-high-energy cosmic rays, probably come from super massive black holes in the hearts of bright nearby galaxies, a new study concludes. If correct, that solves a decades-long mystery: the source of these subatomic particles, which can slam into our atmosphere with the energy of a speeding baseball.

Centaurus A, an active galaxy. (Courtesy European Southern Observatory)

Galaxies which host violent black holes, also called active galaxies, now seem to be the culprit, said Miguel Mostafa, a University of Utah physicist collaborating in the work. This puts scientists one step closer to knowing what physical process can accelerate particles so powerfully, he added. "Right now, we don't know." Mostafa is part of a 17-nation collaboration that operates the \$54 million Pierre Auger Observatory in Argentina, which was used for the study. The findings are to appear in the Nov. 9 issue of the research journal Science. Black holes are extremely compact objects with gravity so strong that nothing "not even light" can escape them. Scientists believe the cores of most galaxies, including ours, contain supermassive black holes, which can contain the weight equivalent of billions of our suns crammed into a tiny space. They gobble nearby material, which in the process heats up and spew out particles and light before vanishing. Particularly bright galaxy cores are known as active galactic nuclei. Cosmic rays, discovered in 1912 by the Austrian Victor Hess, aren't really rays at all. They are subatomic particles, including nuclei of certain atoms that enter the atmosphere from space at nearly light speed. Low-energy cosmic rays come from ordinary stars. Medium-energy rays are thought to come from exploding stars. But the source of the most powerful ones "around 100 million times more energetic than any that laboratories on Earth can produce" has been unexplained. The highest-energy cosmic ray detected was measured in 1991 by the University of Utah's Fly's Eye Observatory, according to scientists involved in the new study. Its energy was logged at 300 billion electron volts. It thus would have felt like a fast-pitched baseball had it hit someone on the head, though it wouldn't have, as the atmosphere absorbs most cosmic rays. They are detected by ground instruments based on showers of secondary particles that they give off on impact. In the new study, scientists at the Auger Observatory "the world's largest for cosmic rays" found that of the 27 most energetic ones detected, 20 came from the direction of active galactic nuclei. There's only a one percent chance that such a correlation could have happened randomly, Mostafa said. Most likely, he added, if the rays had been coming randomly from all directions, only five or six would have seemed to come from such objects. Super-energetic cosmic rays also have to come from galaxies relatively close by, within 326 million light-years, Mostafa said. A light-year is the distance light travels in a year; but even that many light-years "is our local neighborhood in cosmic terms," he added.

Courtesy University of Utah World Science staff

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