Very High Energy Gamma Rays

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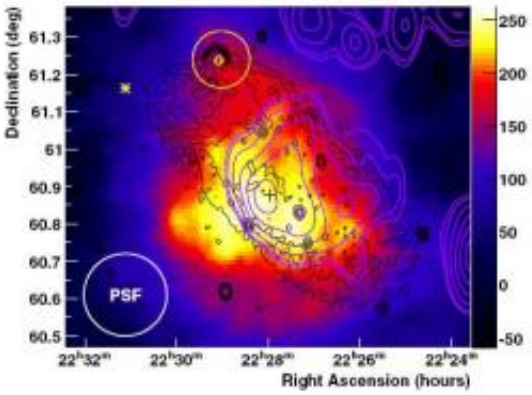

Very high energy gamma rays as measured by VERITAS. The color scale indicates the number of gamma-rays seen, with white being the most. Contours show the emission from molecular gas. The open yellow cross shows the location of a neutron star (the ashes of a supernova). Credit: Acciari et. al.

(PhysOrg.com) -- Gamma-rays are the most energetic known form of electromagnetic radiation, with each gamma ray being at least one hundred thousand times more energetic than an optical light photon. The most potent gamma rays, the so-called VHE (very high energy) gamma rays, pack energies a billion times this, or even more. Astronomers think that VHE gamma rays are produced in the environment of the winds or jets of the compact, ultra-dense remnant ashes of massive stars left behind from supernova explosions.

There are two kinds of compact objects produced in supernovae: black holes and neutron stars (stars made up predominantly of neutrons). The

winds, jets, or magnetic fields from the environments of these objects are known to be able to accelerate electrons to very close to the speed of light, and when light scatters off such energetic particles it becomes energized as well, sometimes turning into VHE gamma rays. An alternative scenario suggests that colliding protons could be the source of the VHE gamma rays.

VERITAS (the Very Energetic Radiation Imaging Telescope Array System) is designed to study gamma rays. It consists of four 12-m telescopes located at the Fred L. Whipple Observatory at Mt. Hopkins, Arizona. A team of eight CfA astronomers and a large international group of their colleagues used VERITAS to detect VHE gamma rays from a supernova remnant located in our galaxy about 40,000 light-years from earth. The array was able to obtain an image of the VHE emission; its high-confidence detection was notable for showing that these powerful gamma rays come from an extended region.

The scientists were surprised to find that the emission is centered on a nearby molecular cloud (as measured from the cloud's millimeter wave emission), and noticeably offset from the location of the neutron star itself. One implication is that these VHE gamma rays might not be produced by energetic electrons accelerated by the compact object, but by protons interacting with the molecular cloud. The new paper provides a deeper look at the physical processes underway in the environment of these extreme cosmic objects.

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