PRESS RELEASE

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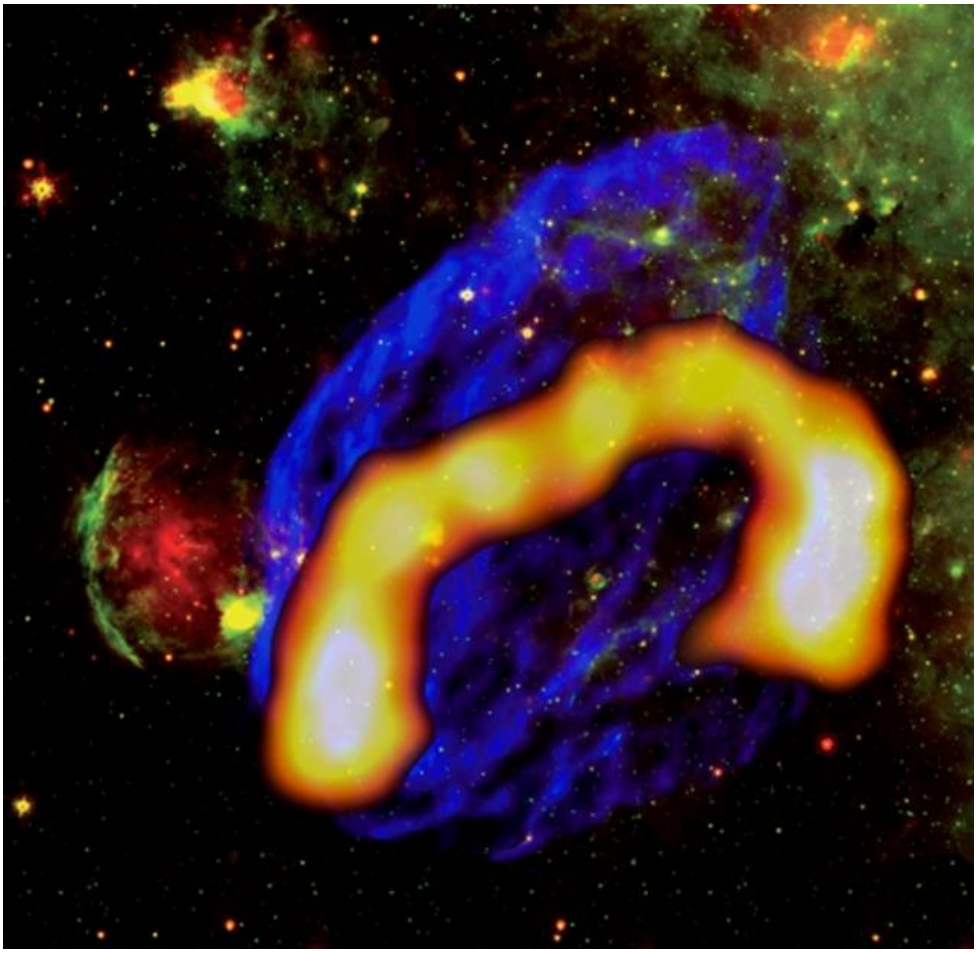
AGILE RESOLVES THE MYSTERY OF THE ORIGIN OF COSMIC RAYS



The Supernova Remnant W44, the relic of a stellar explosion that occurred about 20000 years ago, imaged in gamma-rays by AGILE (orange and white emission). Superimposed on the gamma-ray map is the radio emission detected by the *Very Large Array* (purple-shaded emission) and the infrared emission detected by the *Spitzer* satellite (green and red emission). Picture credits: AGILE team, Castelletti et al. (2007).

THE ITALIAN SATELLITE AGILE HAS DISCOVERED A PATTERN OF GAMMA-RAY EMISSION FROM THE SUPERNOVA REMNANT W44 THAT CAN BE UNAMBIGUOUSLY ATTRIBUTED TO ACCELERATED PROTONS SMASHING AGAINST SURROUNDING GAS. FOR MANY DECADES, A DIRECT IDENTIFICATION OF SITES IN OUR GALAXY WHERE PROTON ACCELERATION TAKES PLACE HAS BEEN ELUSIVE. THE AGILE DATA RESOLVES THE PROBLEM OF CLEARLY IDENTIFYING A SOURCE OF ENERGETIC COSMIC RAYS IN OUR GALAXY.

The AGILE team reports these findings in a paper to be published by Astrophysical Journal Letters. AGILE is a space mission sponsored by the Italian Space Agency (ASI), the Italian Institute of Astrophysics (INAF), and the National Institute of Nuclear Physics (INFN). The investigation on the Supernova Remnant W44 has been carried out in collaboration with Y. Fukui, S. Yoshiike, K. Torii of Nagoya University (Japan), and G. Castelletti and G. Dubner of the Instituto de Astronomìa y Fìsica del Espacio (Argentina).

Cosmic-rays (protons/ions and electrons) are particles of very large energy (sometimes much larger than those achievable on Earth) that constantly bombard the Earth from the deep cosmos. Their origin is a mystery that motivated decades of observations and theoretical investigations starting from the early studies by W. Baade, F. Zwicky in the 30's and by E. Fermi and V. Ginzburg in the 50's. Among the sources candidate for the cosmic-ray origin, the relics of stellar explosions in our Galaxy named "Supernova Remnants"(SNRs) are of special interest. The strong shock produced by the stellar explosion sweeps for many thousands of years the surrounding gas, and in doing so SNRs can accelerate particles to very high energies. However, despite many attempts and a wealth of indirect information involving radio, optical and X-ray observations, no direct evidence of proton acceleration has ever been obtained. The high-energy emission detected around SNRs can be produced much more easily by electrons, and the proton contribution can be masked by that of energetic electrons radiating more efficiently. However, there is a very clear "signature" for the existence of accelerated protons that hit surrounding gas: the emission of gamma-rays with quite special characteristics deriving from the production of particles ("neutral pions") uniquely produced by proton-proton interactions. Detecting this gamma-ray signature of neutral pions has been for decades the "Holy Grail" of many satellites catching gamma-rays from space.

Both the Italian space mission AGILE and the *Fermi* NASA observatory are currently active in studying cosmic gamma-ray sources. Since AGILE is especially sensitive at energies near 100 MegaElectronvolt, it is the ideal instrument to provide the unique signature for the existence of neutral pions. AGILE can therefore obtain the decisive information for resolving the problem of the cosmic-rays origin. Out of a sample of about 10 well-studied SNRs, the AGILE team is now publishing the most recent findings on the Supernova Remnant W44 located at about 6000 lightyears from the Earth. The AGILE data very clearly show a pattern of gamma-ray emission which follows the most prominent shocks produced by the W44 explosion that occurred about 20000 years ago. Particles (protons and electrons) can be accelerated at the propagating shock for thousands of years and can reach the highest energies of interest to explain the cosmic-rays. AGILE unambiguously detects the gamma-ray signature for the existence of protons. "We are very excited", says Andrea Giuliani who is the first author of the AGILE paper. "In the case of this very interesting source we could analyze in great detail the gamma-ray signal together with the radio emission. By comparing these two emissions, we have thoroughly tested the hypothesis that accelerated protons produce the observed gamma-ray emission against alternative explanations. We have been greatly helped by the "neutral pion signature", that is evident in the AGILE data". "The gamma-ray emission is concentrated where the gas is compressed by the shock in agreement with expectations from cosmic-ray acceleration models", says Martina Cardillo, a co-author of the paper.

AGILE Principal Investigator Marco Tavani (INAF) adds that "the AGILE special characteristics make possible the detection of gamma-rays just at the energies at which neutral pions radiate with an unambiguous signature. This result is obtained for the first time, and confirms the hypothesis that SNR shocks may accelerate protons in large numbers. Whether our observations can explain also other properties of cosmic-rays and their propagation in the Galaxy is a matter for future investigations."

"The AGILE gamma-ray imager", says Guido Barbiellini, INFN coordinator of the AGILE project, "reaches its optimal sensitivity at the photon energies characterizing the neutral pion decay. It looks as if it were planned just to obtain this important result on particle accelerators in our Galaxy."

"Despite its relatively small size", says Enrico Flamini, ASI Chief Scientist, "AGILE has achieved an optimal performance at a very competitive cost because of its innovative technology. AGILE has then kept its promise. The Italian high-energy astrophysics community is very competitive. This community also play an important role in Fermi, and ASI supports data analysis for both AGILE and Fermi at the ASI Science Data Center in Frascati."

More information on the AGILE Mission: http:/agile.iasf-roma.inaf.it, http://agile.asdc.asi.it.

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