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Status of the search for cosmic-ray origins: a multimessenger view

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The quest for finding the origins of cosmic rays has been going on for many decades. Cosmic rays as charged particles react to cosmic magnetic fields and therefore travel in diffusive motion through the Universe. Their imprint on Earth therefore has little information on their original direction so that finding the sources of cosmic rays is a major challenge and the question of their origins one of the leading questions in physics and astrophysics. To solve this riddle, a multimessenger approach is used. Cosmic-ray interactions in the sources lead to the production of particle showers, from which gamma-rays and neutrinos are observable on Earth. As these travel on straight paths through the Universe, these messengers can be used to further unravel the cosmic-ray origins. One messenger alone is never enough - high-energy photons are also produced by electrons via bremsstrahlung or inverse Compton scattering. High-energy neutrinos are very difficult to detect. Nevertheless, the newest generation of detectors, concerning cosmic rays themselves, high-energy gamma-rays, and neutrinos, are so advanced now that it is possible to combine the different pieces of information to deduce first evidence of where cosmic rays come from.

In this talk, the current state of the art will be reviewed from this multimessenger perspective. In particular, it will be shown how theoretical results are combined with multimessenger data in order to pinpoint the sources of cosmic rays.

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