# A Large-Area Survey of Ultrahigh-Energy Cosmic Rays

**New measurements from an observatory in Argentina suggest that all the most energetic cosmic rays arise from the same types of extragalactic accelerators.**

By **Marric Stephens**

Cosmic rays strike Earth from all angles and with energies that span many orders of magnitude. The precise distribution and spectrum of these particles—protons and heavier nuclei—offer clues to the particles' makeup and origins. In the past decade, surveys of ultrahigh-energy cosmic rays conducted by the Pierre Auger Observatory in Argentina revealed a new spectral feature known as the instep. Located between the previously identified "ankle" and "toe," the instep hinted that most of the cosmic-ray flux above about 10 exa-electron-volts originates in nuclei heavier than hydrogen (see **Viewpoint: The Anatomy of Ultrahigh-Energy Cosmic Rays**). The Pierre Auger Observatory Collaboration has now augmented those results with a campaign that takes in a larger area of the sky [**1**].

As before, the new data were obtained using the facility's array of water-filled tanks spread over an area of about 3000 $km^2$. Each of the tanks is lined with sensors that pick up Cherenkov radiation from the fast-moving muons created when a cosmic-ray particle strikes the upper atmosphere. Reconstructing the properties of an incoming cosmic ray from these detections entails accounting for Earth's magnetic field. Because this adjustment becomes harder as the zenith angle approaches 90° (arrival just above the horizon), previous measurements included only events with zenith angles less than 60°. The new data include events up to 80°, meaning approximately 75% of the entire sky has now been observed. The instep showed up in every direction. This spatial uniformity suggests that the feature results from cosmic-ray accelerators that are numerous, extragalactic, and governed by similar physical mechanisms.

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## REFERENCES

1. A. Abdul Halim *et al.* (Pierre Auger Collaboration), "Energy spectrum of ultrahigh-energy cosmic rays across declinations –90° to +44.8° as measured at the Pierre Auger Observatory," **Phys. Rev. Lett. 135, 241002 (2025).**