“Ultra-High-Energy Cosmic Rays: Current Picture and Future Outlook”

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Engineering 100

Abstract

The study of Ultra-High-Energy Cosmic Rays (UHECR) has undergone dramatic evolution over the last two decades, driven primarily by the unprecedented capabilities of the Pierre Auger Observatory and the Telescope Array Project. Historically hindered by low statistics and substantial uncertainties, the UHECR field once grappled with basic questions about flux cutoffs, composition, and source identification. Today, however, we have established that the flux significantly cuts off above 50 EeV, detailed composition measurements reveal a complex, energy-dependent blend of atomic nuclei, and significant anisotropies have been identified, narrowing the list of potential astrophysical sources. With a cumulative exposure now exceeding 150,000km^2 sr yr at energies above 50 EeV, the observational data now provide robust insights into fundamental observables. However, this increased statistical power is also uncovering new phenomena such as unexpected muon excesses, a puzzingly narrow rigidity range, indications of mass-dependent anisotropies, and correlations between spectral features and composition evolution. These observations may again profoundly shift our understanding of particle physics at the highest energies. This talk will give an overview of the current UHECR picture, highlight new promising analysis techniques, and outline what can be expected in the next phases of Auger and TA. Finally, the talk will give a brief look at proposed next-generation ground- and space-based UHECR observatories.

Biography

Eric Mayotte is an Assistant Professor of Physics at the Colorado School of Mines whose research focuses on ultra-high-energy cosmic rays and neutrinos, optical detection techniques, mass-composition analyses, and the development of instrumentation for astroparticle physics. He received his PhD in 2016 and completed postdoctoral work at the Bergische Universität Wuppertal and later at Mines. He is a long-standing member of the Pierre Auger Collaboration, where he serves as the Mass Task Leader and participates in the Auger–Telescope Array Composition and Auger@TA working groups. He has just been named U.S. co-PI for Auger Operations. He is also active in the JEM-EUSO Collaboration as the Mines principal investigator for the POEMMA Balloon with Radio (PBR) NASA mission, with responsibilities that include optomechanical design, integration, field testing, and launch preparation. In addition, he is a founding member of the Colorado Underground Research Institute and a member of the Global Cosmic Ray Observatory (GCOS) collaboration. He was a lead convener of the 2024 Snowmass white paper on ultra-high-energy cosmic rays.