

How, where and when do cosmic rays reach ultrahigh energies?

Tuesday, 26 July 2022 09:00 (45 minutes)

Understanding how ultrahigh energy cosmic rays (UHECRs) reach energies in excess of $1e20$ eV stretches particle acceleration physics to its very limits. In this talk, I will discuss how such energies can be reached, using general arguments that can often be derived on the back of an envelope. I will review possible particle acceleration mechanisms, with special attention paid to shock acceleration. Informed by the arguments derived in the talk, and with insights from Galactic CR acceleration in supernova remnants, I will then discuss which classes of astrophysical sources might be UHECR sources, including my own (biased) perspective. Aided by hydrodynamic simulations, I will show that shocks in the backflows in radio galaxies are good accelerators of UHECRs, then present simulations in which the jet flickers and explore the impact on the jet morphology. I will explore a scenario in which a significant fraction of UHECRs originate from local radio galaxies like Centaurus A and Fornax A, arguing that they can explain the observed UHECR anisotropies. Finally, I will highlight the importance of variability in these potential UHECR sources, and explore the intriguing possibility that the UHECR arrival directions are partly a result of “UHECR echoes” or “reverberation” from magnetic structures in the local Universe.

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