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Fast winds in active galactic nuclei as sources of ultra-high-energy cosmic rays

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We discuss the possible production of ultra-high-energy cosmic rays (UHECRs) in fast winds of active galactic nuclei (AGN). Recent X-ray observations of AGN are revealing the widespread presence of powerful outflows of baryonic material reaching mildly relativistic velocities, in the form of variable, blue-shifted absorption lines of ionized heavy elements.
Being discerned in both radio-quiet and radio-loud AGN, they are distinct from radio jets and likely subtend much broader opening angles, and have been plausibly interpreted as winds driven by the accretion disk. In such winds, strong shocks can plausibly form at different locations, either external shocks due to interaction with the ambient medium or internal shocks due to inhomogeneities within the flow, wherein hadrons can be potentially accelerated up to UHE. This scenario has some clear advantages compared to the better studied picture of UHECR production in AGN jets: i) the sources can be much more numerous and nearer than radio-loud AGN and hence in better accord with the observed isotropy; ii) the elemental composition of the winds is not only clearly baryonic but also guaranteed to contain heavy nuclei including iron, and hence can more readily account for a mixed composition as indicated by recent measurements. We discuss further implications of this scenario, including expectations for multi-messenger signatures.

Primary author: Dr INOUE, Susumu (RIKEN)

Co-author: Dr LIU, Ruo-Yu (Max Planck Institute for Nuclear Physics)

Presenter: Dr INOUE, Susumu (RIKEN)

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