APR13-2013-001006

Abstract for an Invited Paper
for the APR13 Meeting of
the American Physical Society

Quasars in miniature: new insights into particle acceleration from X-ray binaries

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A variety of astronomical objects routinely accelerate particles to high energy, with the maximum possible energy per particle typically limited by the size of the system and magnetic field strength. For that reason, much attention has focused on the massive jets of relativistic plasma ejected from supermassive black holes in Active Galactic Nuclei (AGN), which are at least theoretically capable of producing particles (cosmic rays) up to a whopping 10^{20} eV. However neither how these jets are formed or function, nor how exactly they accelerate particles, is well understood. While we do not expect the mechanisms for particle acceleration in stellar remnant black holes within X-ray binaries (XRBs) to be particularly different than in other sources, XRBs do offer some unique insights. Primarily, jets very similar to those in AGN come and go on timescales of weeks to months, while often monitored simultaneously across the entire electromagnetic spectrum. Through such observations we have been able to probe the processes by which jets not only build up dynamically, but also at what point the jets begin to accelerate particles, providing hints about the necessary conditions and efficiencies. Because the physics of accretion-driven processes such as jets seems to scale predictably with black hole mass, we can also potentially apply what we are learning in these smaller systems to the same phenomena AGN, giving us a new handle on several longstanding questions. I will review our current understanding of particle acceleration in XRBs, as well as the increasing body of evidence suggesting that XRBs indeed seem to represent scaled-down (and thus handily faster evolving) versions of the much more powerful AGN. I will also touch on how accelerated particles from XRBs may contribute significantly to the low-energy Galactic cosmic ray distribution, with local impact on gas chemistry and star formation.