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Relativistic MHD Jets and Their Interactions with the Intra-cluster Medium: Plasma Physics at its Extreme HUI LI, MASANORI NAKAMURA, SHENGTAI LI, LANL, HAO XU, LANL/UCSD — We present the formulation of magnetically dominated relativistic MHD flows as a model for extra-galactic jets produced by accretion onto supermassive black holes. Three-dimensional relativistic MHD simulations will be presented on how the energy outflow partitions among different physical components and on how the collimation occurs. We will also examine the stability of such systems. Similar to many of the laboratory plasma systems, current driven instabilities are crucial to jet dynamics, though relativistic velocities and expanding boundaries can significantly change the stability properties. In addition, the interaction between such flows with their environment, e.g., the intra-cluster medium, will be studied. 3-D instabilties that lead to flux conversion seem to be necessary for both the jet stability and the radio lobe formation. Simulations are compared with observations of X-ray cavities in clusters and the possibility of lobes being magnetically dominated on global scales will be discussed. We incorporate such models as AGNs in large scale cosmological cluster formation simulations to study the AGN feedbacks on structure formation. The morphology and properties of jet-lobe systems in realistic cluster simulations will be presented.

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