Accretion, the process by which matter collects into a central object, is ubiquitous and often dynamically important for astrophysical objects on the scale of compact object disks ($\sim 10^{10}$ cm) up to that of galactic clusters ($\sim 10^{24}$ cm). In order for matter to accrete, it must lose angular momentum. The central issue in accretion theory is to explain the mechanism by which angular momentum is lost at rates sufficient to accord with observation, orders of magnitude beyond what may be accounted through collisional viscosity. For a wide class of astrophysical objects, characterized by collisional mean free paths far smaller than the system scale, the magnetorotational instability (MRI), first discovered in a restricted global form by Velikhov (1959); Chandrasekhar (1960), produces MHD turbulence and a level of angular momentum transport sufficient to account for observed rates of disk accretion (Balbus & Hawley 1991). However, in underluminous accretion flows in massive and supermassive central galactic black holes, the best studied example of which is Sagittarius A* at the center of our Milky Way, the MRI is not the sole means of turbulent transport. These flows are characterized by the radiatively inefficient accretion of a hot, dilute (mildly collisional to highly collisionless), and optically thin plasma. In these plasmas, even an extremely weak magnetic field can lead, in addition to the MRI, to anisotropic heat fluxes and viscous stresses directed along field lines, resulting in new classes of instabilities. Furthermore, in these radiatively inefficient flows, the energy generated through gravitational infall must be transported through local thermal fluxes rather than locally dissipated as in highly collisional systems.

We propose a model to explain how hot, dilute accretion onto compact objects may then occur. We use both fluid and kinetic theory to examine the effects of other instabilities, the magnetothermal instability (Balbus 2001) and magnetoviscous instability (Balbus 2004; Islam & Balbus 2005), that may operate within these flows. A more elaborate kinetic theory must be applied for those dilute systems in which the collisional mean free path is larger than the system scale or larger than the wavelengths of the fastest growing instabilities. Our work demonstrates that these new modes may create sufficient angular momentum and thermal energy transport to account for the expected rates of accretion.

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