Accretion Flows and Millisecond Pulsars, from Light Cylinder to Magnetic Funnel

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I will present results from the first relativistic MHD simulations of accretion onto magnetized neutron stars, performed in general relativity in the Kerr spacetime geometry. Four regimes are recovered, in order of increasing stellar magnetic field strength (equivalently, decreasing mass accretion rate): (a) crushing of the stellar magnetosphere and direct accretion; (b) magnetically channeled accretion onto the stellar poles; (c) the propeller state, where material enters through the light cylinder but is prevented from accreting by the centrifugal barrier; (d) almost perfect exclusion of the accretion flow from the light cylinder by the pulsar's electromagnetic wind. A Poynting-flux-dominated relativistic jet, powered by stellar rotation, is produced when the intruding plasma succeeds in opening the pulsar's previously closed magnetic field lines. I will demonstrate the effect of changing the relative orientation of the stellar dipole and the large-scale magnetic field in the accreting plasma, and discuss our results in the context of the transitional millisecond pulsars and the neutron-star-powered ultra-luminous X-ray sources.

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