

Title: Universality Class of Black Hole Accretion Across the Mass Scale

Authors: Ashish Joshi & Arka Chatterjee

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Abstract: Black holes span nearly eight orders of magnitude in mass, ranging from stellar to supermassive black holes. A long-standing conjecture in accretion theory holds that the physics governing accretion flows is scale-invariant. For a given mass accretion rate, the properties of the flow should depend only on the accretion rate rather than the mass of the black hole. We test this hypothesis by compiling and analyzing four observational signatures, such as Quasi Periodic Oscillations (QPO), X-ray photon index, coronal radius, and the ratio of outflow-to-inflow accretion rate -across a multi-population sample of black holes combining X-ray binaries (BHXRBS), active galactic nuclei (AGN), ultra luminous X-ray sources (ULXs), and tidal disruption events (TDEs). While reproducing the expected inverse scaling of high frequency QPOs (HFQPOs) with black hole mass, we introduce the accretion rate as a third axis. Our study reveals that all observed HFQPOs are confined to a specific accretion rate regime. Furthermore, we identify a global negative correlation between the coronal radius and the accretion rate. Finally, we produce the photon index versus luminosity relationship with additional data points from the high-accretion regime. We are exploring the global inflow to outflow trend for the same population along with the timing and spectral aspects.