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Black holes on all scales: similarities and differences

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I will review what we know about astrophysical black holes, from the stellar mass back holes formed from the death of massive stars, to the supermassive black holes in galaxy centres. Where material falls onto a black hole of any size, the enourmous gravitational energy released transforms these darkest objects in the Universe into the brightest. The luminous accretion flow lights up the regions of intensely curved spacetime, and its spectrum and variabilty carry the imprint of strong gravity as well as the geometry and dynamics of the emitting material. I will show how the stellar mass black holes form a homogeneous set, and how their large changes in mass accretion rate on easily observable timescales mean that they form a a template for how the spectrum and variability of the accretion flow, and its associated jet, change with mass accretion rate. They ubiquitously show a dramatic switch in both spectral, variability and jet properties as the mass accretion rate changes, probably associated with a change from a hot, geometrically thick flow to a cool, geometrically thin disc. Since the geometry and dynamics of the disc are well understood, these spectra give a clean test of Einstin's gravity in the strong field limit, with clear evidence for the existance of a last stable circular orbit. The hot flows are less well understood, but it is possible that the characteristic timescale for variabilty seen in these data is from Lens-Thirring (vertical) precession of the flow around the black hole. Scaling these models of a changing accretion flow up to the supermassive black holes can give an explanation for the multiple different types of unobscured AGN. However, as well as similarities, there are also some differences in the properties of the spectra, variability and particularly in the jet. A small subset of the most massive black holes have highly relativistic jets, with relativisitically emitting out to GeV or TeV energies. I show that the statistics of these jets may be pointing to their origin from the highest spin black holes formed in major merger events.