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Long timescale numerical simulations of large, super-critical accretion discs [online]

Tuesday, 6 May 2025 16:45 (15 minutes)

In this talk, I will report on some of the largest (in terms of simulation domain size) and longest (in terms of duration) 3D general relativistic radiation magnetohydrodynamic simulations of super-critical accretion onto black holes. The simulations are all set for a rapidly rotating ($a_* = 0.9$), stellar-mass ($M_{\rm BH} = 6.62 M_\odot$) black hole. The simulations vary in their target mass accretion rates (assumed measured at large radius). The results show that all of the simulations settle close to a net accretion rate of $\dot{m}_{\rm net} = \dot{m}_{\rm in} - \dot{m}_{\rm out} \approx 1$ (over the radii where our simulations have reached equilibrium), where $\dot{m} = \dot{M}/\dot{M}_{\rm Edd}$, despite the fact that the inward mass flux (measured at large radii) $\dot{m}_{\rm in}$ can exceed 1,000 in some cases. This is possible because the outflowing mass flux $\dot{m}_{\rm out}$ adjusts itself to very nearly cancel out $\dot{m}_{\rm in}$, so that at all radii $\dot{M}_{\rm net} \approx \dot{M}_{\rm Edd}$. In other words, these simulated discs obey the Eddington limit. The results are compared with the predictions of the slim disc (advection-dominated) and critical disc (wind/outflow-dominated) models and are found to agree quite well with the critical disc model both qualitatively and quantitatively.

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