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General-relativistic model of hot accretion flows with global Compton cooling

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We present a model of optically thin, two-temperature, accretion flows using an exact Monte Carlo treatment of global Comptonization, with seed photons from synchrotron and bremsstrahlung emission, as well as with a fully general relativistic description of both the radiative and hydrodynamic processes. We consider accretion rates for which the luminosities of the flows are between ~0.001 and 0.01 of the Eddington luminosity. The black hole spin parameter strongly affects the flow structure within the innermost 10 gravitational radii. The resulting large difference between the Coulomb heating in models with a non-rotating and a rapidly rotating black hole is, however, outweighed by a strong contribution of compression work, much less dependent on spin. The consequent reduction of effects related to the value of the black spin is more significant at smaller accretion rates. For a non-rotating black hole, the compressive heating of electrons dominates over their Coulomb heating, and results in an approximately constant radiative efficiency of approximately 0.4 per cent in the considered range of luminosities. For a rapidly rotating black hole, the Coulomb heating dominates, the radiative efficiency is ~1 per cent and it slightly increases (but less significantly than estimated in some previous works) with increasing accretion rate. We find an agreement between our model, in which the synchrotron emission is the main source of seed photons, and observations of black-hole binaries in their hard states and AGNs at low luminosities. In particular, our model predicts a hardening of the X-ray spectrum with increasing luminosity, as indeed observed below ~0.01 of the Eddington luminosity in both black-hole binaries and AGNs. Also, our model approximately reproduces the luminosity and the slope of the X-ray emission in Cen A.

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