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General Relativistic Radiation Magnetohydrodynamic Simulations of Black Hole Accretion

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In this talk, I will review recent progress in adding radiation physics to global, general relativistic magnetohydrodynamic (GRMHD) simulations of black hole accretion, starting from a purely optically thin treatment, then transitioning to purely optically thick, and finally discussing the current prospects for treatments that can capture the full range of optical depths. The optically thin treatment is the easiest to implement, as the radiation simply enters the GRMHD equations as a cooling term, although the physics of the radiative processes themselves can be challenging to treat accurately. The optically thick treatment that I will discuss solves the radiation equations in a form very similar to the GRMHD equations, making its implementation relatively straightforward, although the method has significant limitations, motivating current efforts to advance it further. Throughout the talk I will show examples of how these various versions of radiation MHD have already been applied to the study of black hole accretion in different regimes.