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Oscillating shocks in the transonic, viscous, variable Γ accretion flows around black holes

We investigate the time evolution of the transonic-viscous accretion flow around a non-rotating black hole. The input parameters used for the simulation are obtained from semi-analytical solutions. This code is based on the TVD routine and correctly handles the angular momentum transport due to viscosity. The thermodynamic properties of the flow are described by an equation of state with a variable adiabatic index. We regenerate the inviscid and viscous steady-state solutions including shocks, using the simulation code and compare them with the semi analytical solutions. Then we investigate accretion in the limit of viscosity where the solution becomes time-dependent. Particularly interesting is how shocks behave in the presence of viscosity. As the viscosity parameter (α) crosses a critical value, the previously steady shock becomes time-dependent, eventually leading to oscillations. The value of this critical viscosity depends on the injection angular momentum (λ_{ou}) and the specific energy (ϵ). We estimated the posteriori bremsstrahlung and synchrotron cooling and the net radiative output also oscillates with the frequency of the shock. We also study the variation of frequency, amplitude, and mean position of oscillation with α. Considering a black hole with a mass of $10M_{\odot}$, we observed that the power spectrum exhibits a prominent peak at the fundamental frequency of a few to about tens of Hz, accompanied by multiple harmonics. This characteristic is frequently observed in numerous accreting black hole candidates.

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