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The origin of hydrodynamic instability from noise in the Keplerian accretion flow and its rivalry with the magento-rotational instability

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Abstract:
We attempt to address the old problem of accretion flow: the origin of turbulence and hence transport of angular momentum in accretion flows. We undertake the problem by introducing an extra force in Orr-Sommerfeld and Squire equations along with the Coriolis force mimicking the local region of the accretion disk. Subsequently, we solve the equations with the WKB approximation method. We investigate the dispersion relation for the Keplerian flow for all possible combinations of wave vectors. Due to the very presence of extra force, we show that the flow becomes unstable for a certain range of wave vectors. We also study the Argand diagrams of the perturbation eigenmodes. This helps us to compare the different timescales corresponding to the perturbations as well as accretion. We ultimately obtain with this formalism that fluid gets enough time to be unstable and hence plausibly turbulent, particularly in the local regime of the Keplerian accretion disks. Repetition of the analysis throughout the disk explains the transport of angular momentum and matter along outward and inward directions, respectively. Apart from this, we also study the same problem in the presence of magnetic field. It helps us study whether the magneto-rotational instability (MRI) and the hydrodynamic instability due to the presence of the extra force in the flow act constructively or destructively. We obtain that it depends on the parameters (Reynolds number, the strength of the extra force, wavevenctors, etc.) involved in the problem.

Reference:
Ghosh, S., Mukhopadhyay, B., 2021, Physical Review Fluids, 6, 013903
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