Advanced Topics in Fluid Dynamics

Assessment: 40\% from exam/project, 60\% from three assignments

Contact: Dr Geoff Vasil: geoffrey.m.vasil@gmail.com

Fluid instabilities form a major cornerstone of modern science and applied engineering. A enormous number of applications involve dynamics the moves away from a quasi-balanced state at an exponential rate when a parameter passes through a critical value. A "tipping point", so to speak. After the onset of an instability, a system will eventually settle into a new configuration or complex time-dependent state.

This course will introduce a classic set of fluid instabilities that drive a wide range of observable phenomena in astrophysics, the geosciences, and engineering. We will study the dynamics of: (i) Rayleigh-Benard thermal convection, (ii) centrifugally unstable Taylor-Couette flow, (iii) shear-driven Kelvin-Helmholtz vortices, (iv), and transition to turbulence. Time permitting, we will introduce more advanced topics based on class interest. Possible examples include, magnetohydrodynamics, gravitational collapse and star formation, kinetic-particle streaming instabilities, elastic-beam buckling, Faraday pattern-formation, and/or large-scale baroclinic (weather-generating) instability in the atmosphere and ocean.

The recommended books for this course are:

S. Chandrasekhar, "Hydrodynamic and Hydromagnetic Stability" (Dover Books)

P. G. Drazin \& W. H. Reid, "Hydrodynamic Stability" (Cambridge University Press)