

Midterm

This is a take-home exam. You may consult among yourselves but you should have written and programmed everything you turn in yourself.

- 1. Viscosity in the capillary instability of a thread** Reproduce Figure 129 in Chandrasekhar. The relevant analysis is in § 111, in particular (158). You should briefly reproduce the working that leads to this equation.
- 2. The critical Rayleigh numbers for rigid-free and rigid-rigid boundary conditions** Plot the marginal stability curves in the (R, κ) plane. One approach is in § 15 of Chandrasekhar.
- 3. A numerical Rayleigh–Bénard problem** Solve (i)—(iii) of D 6.3, but with arbitrary boundary conditions. (iv) Compute the marginal stability curve for Hupnol by solving the vertical equation numerically and find the critical Rayleigh number. Do this for rigid-rigid, rigid-free and free-free boundary conditions.
- 4. Compressible Rayleigh–Bénard convection** Derive the governing equations for convection in a compressible isentropic perfect gas. Assume that viscosity and diffusivity are constant. How many non-dimensional parameters are there? Try and obtain an estimate for the critical Rayleigh number. This is an open-ended question. I have not done a literature search and there may be good articles on this.