Hydrodynamic Stability Theory

MAGIC014

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Some text books

Origins of hydrodynamic stability theory

Reynolds’ pipe experiment (1883):
What Reynolds saw
Lots of flows can become unstable...

E.g.

(Kelvin-Helmholtz instability)

- Waves appear and amplify.
- Hydrodynamic stability theory predicts the most unstable wavelengths and their growth rates; and whether the waves are steady, oscillatory, or travelling.
- Flows like the above can occur in the atmosphere and ocean.
Kelvin-Helmholtz in the atmosphere

- The role of Kelvin-Helmholtz instability in mixing is important in climate and weather models.
- Wind also generates ocean waves — important for shipping, oil rigs, coastal erosion etc.
Many applications of hydrodynamic stability theory...

- Instability of flow around wings increases drag.
- Same happens to flow around turbine blades in jet engines, power stations, wind turbines...
- Instability can also break up and help dissipate vortices behind aircraft — a major consideration at airports.
Flow over a delta wing

Instabilities are responsible for generating complex spatio-temporal flow structures.
Buoyancy driven instabilities...

Thermal convection appears in

- Natural ventilation — architecture.
- Magma — plate tectonics: earthquakes, volcanoes.
- Casting — super-alloys, materials science.
Patterns in thermal convection

2d rolls
- Circular rolls
- Spiral rolls
- Hexagons
- Squares
- ???