



Turbulence

Tobias M. Schneider

Pierre Beck (TA)

Jean-Clement Ringenbach (TA)

Savya Deshmukh (TA)

28.02.2025

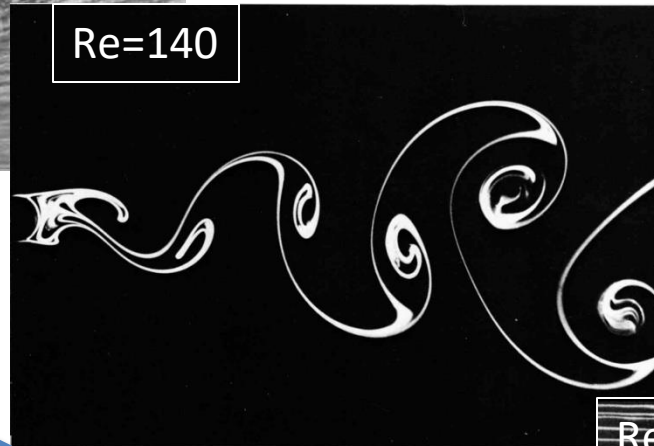
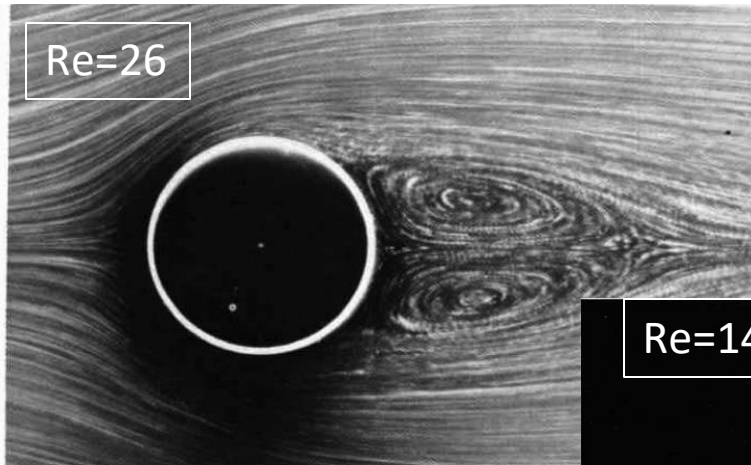
Vattenfall, Denmark

Plan for today

1. Symmetries of Navier-Stokes (Frisch Ch. 2.2)
2. Global conservation laws (Frisch Ch. 2.3)

New room 13-15: MA B1 11

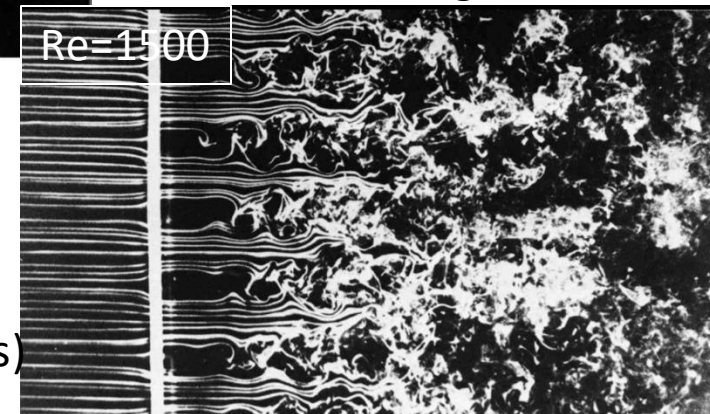
Turbulence and symmetries



Symmetry breaking

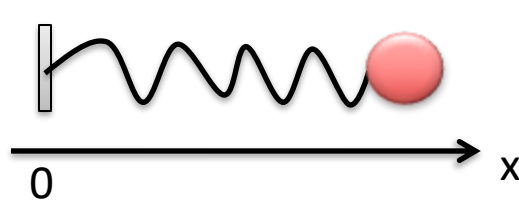
Reynolds number increases

Symmetries recovered
(in a **statistical** sense, far from boundaries)



Symmetries of dynamical equations

Example: overdamped particle in a quadratic potential (1D)

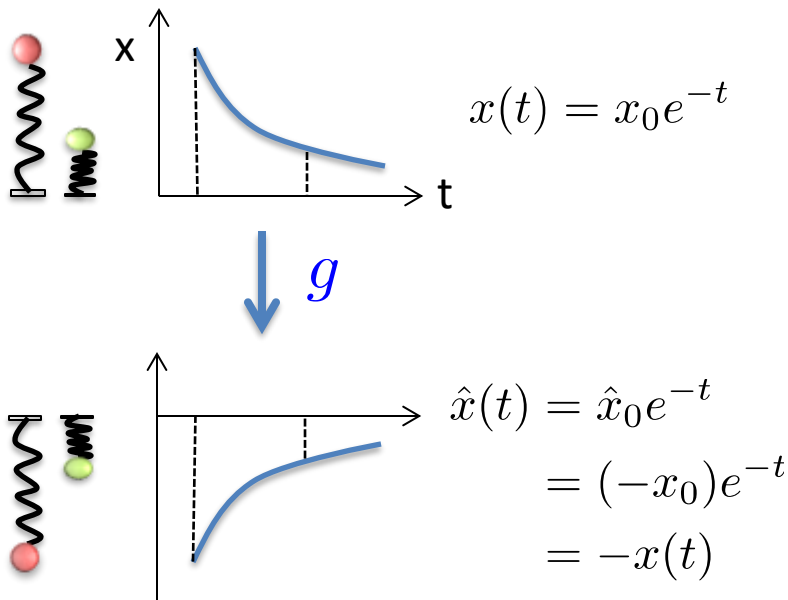


$$\dot{x} = -x; \quad x(t=0) = x_0$$

$$x(t) = x_0 e^{-t} = f^t(x_0)$$

Symmetry: $g : x \rightarrow -x$ (reflection)

Transforms solutions into solutions



Symmetry and time evolution commute

