The background image shows an aerial view of a large wind farm. Numerous wind turbines are scattered across a field, with their blades creating a pattern of light and shadow against a bright, overcast sky.

Turbulence

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28.02.2025

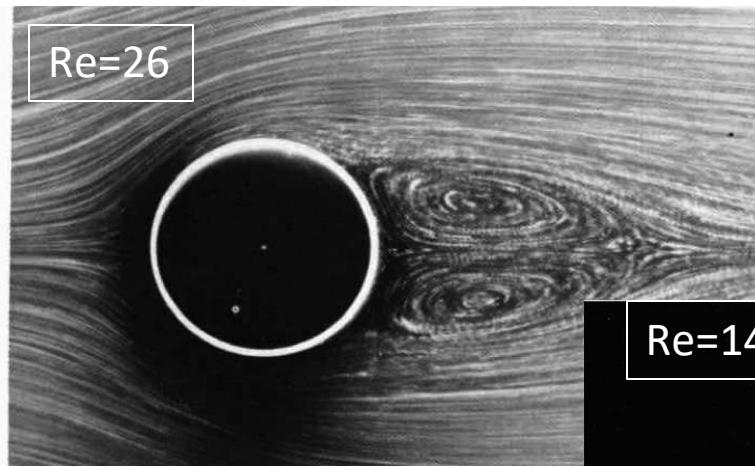
Vattenfall, Denmark

Plan for today

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

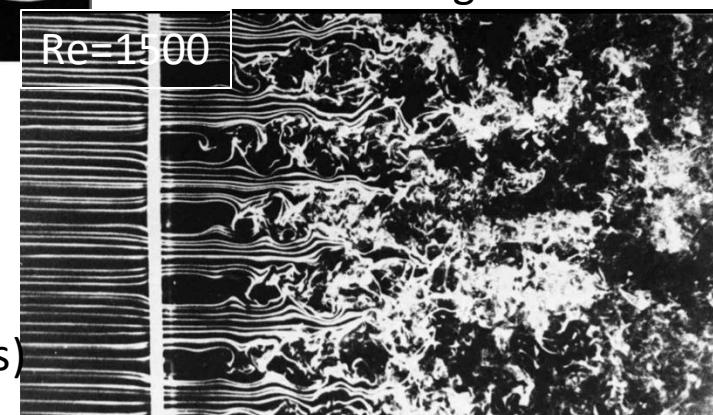
New room 13-15: MA B1 11

Turbulence and symmetries



Symmetry breaking

Reynolds number increases

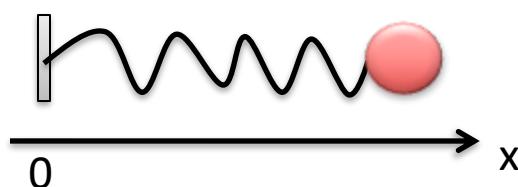


Symmetries recovered
(in a **statistical** sense, far from boundaries)

Fully developed turbulence

Symmetries of dynamical equations

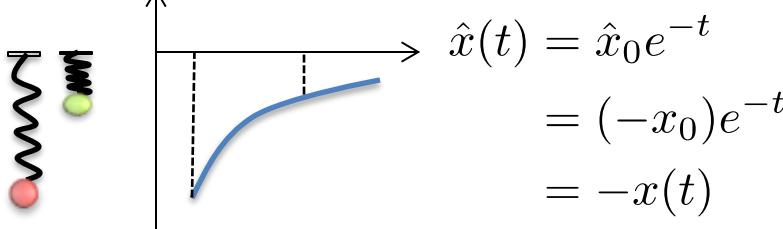
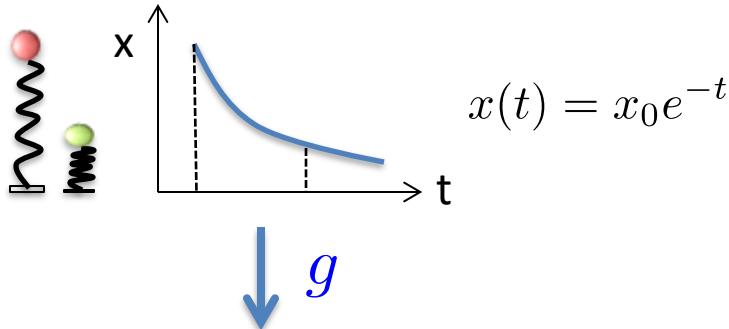
Example: overdamped particle in a quadratic potential (1D)



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

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

Transforms solutions into solutions



Symmetry and time evolution commute

