

ME-445 AERODYNAMICS

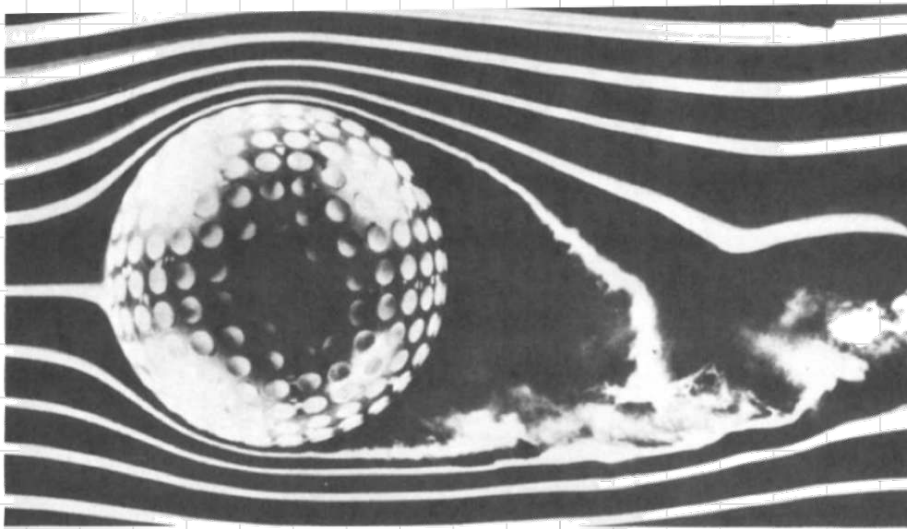
06 - Viscous flows



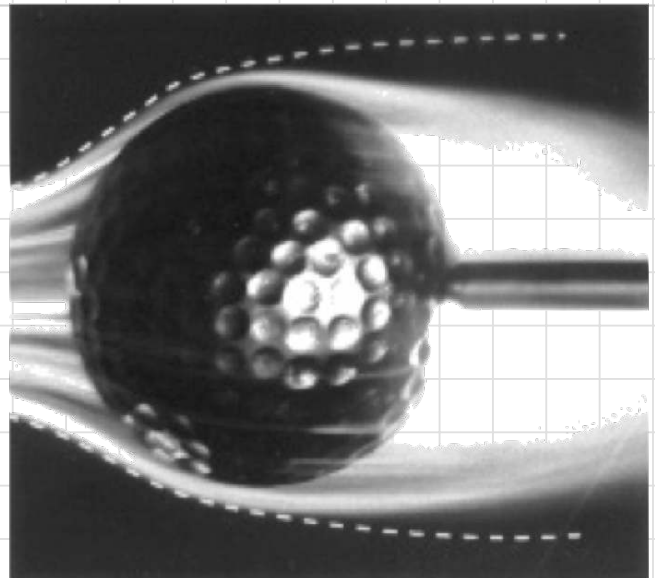
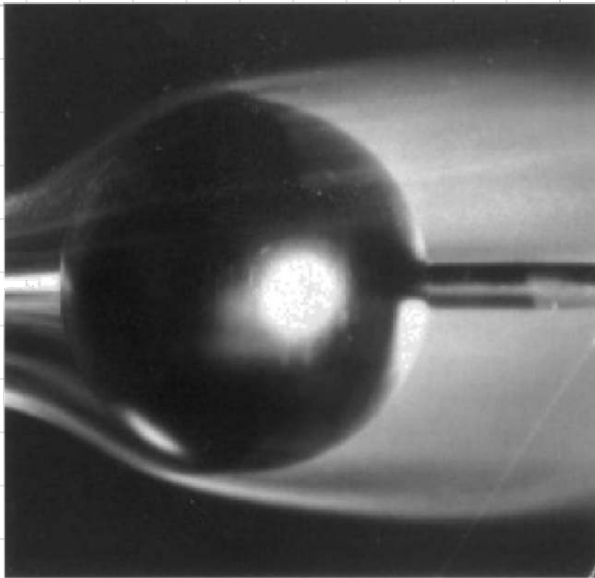
Sports balls



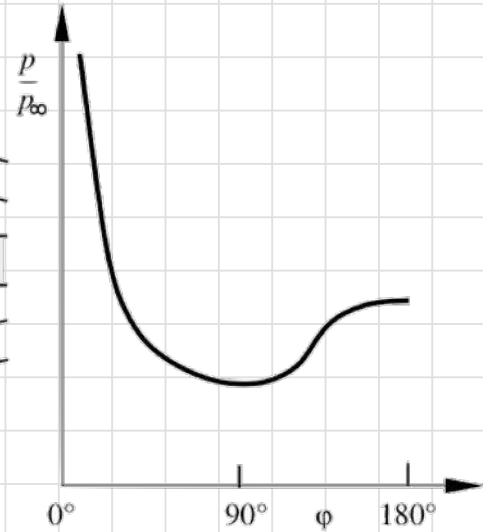
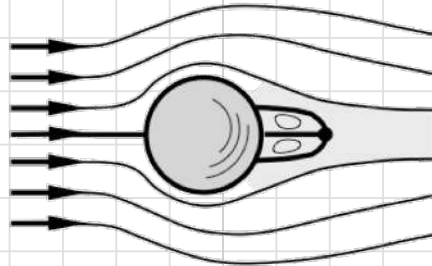
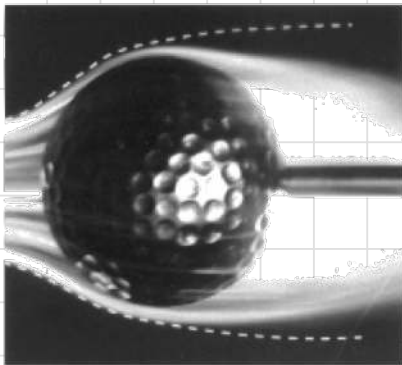
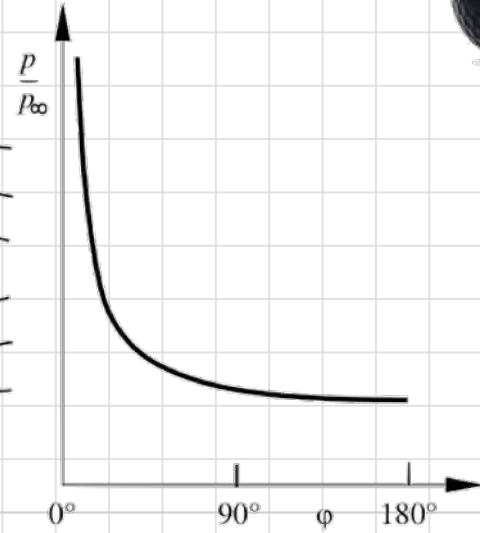
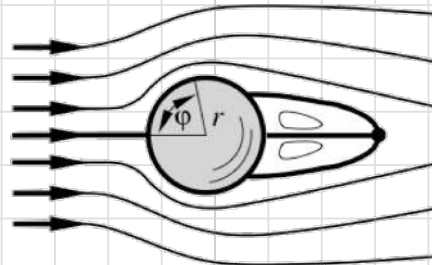
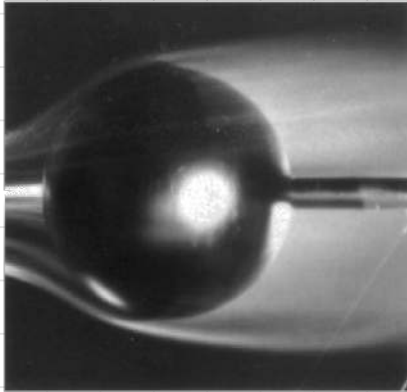
Golfball



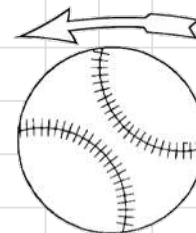
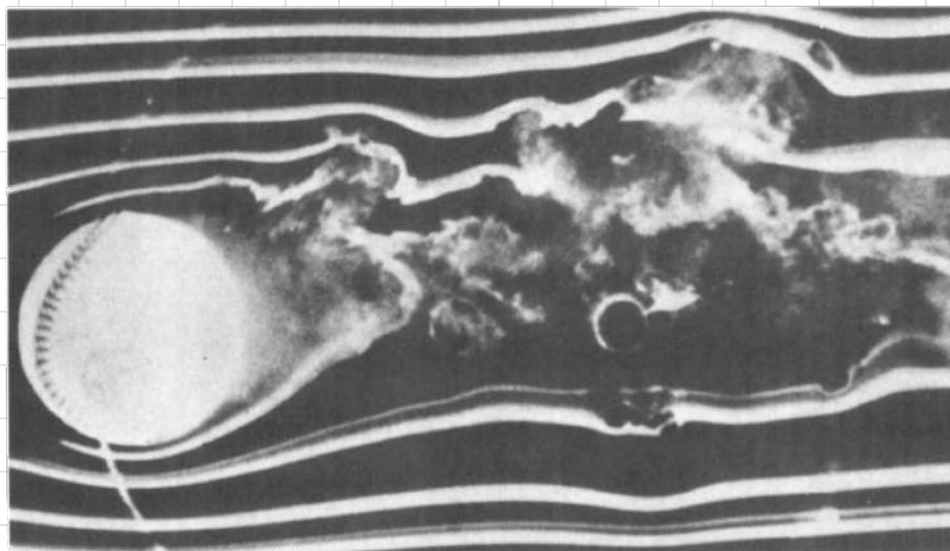
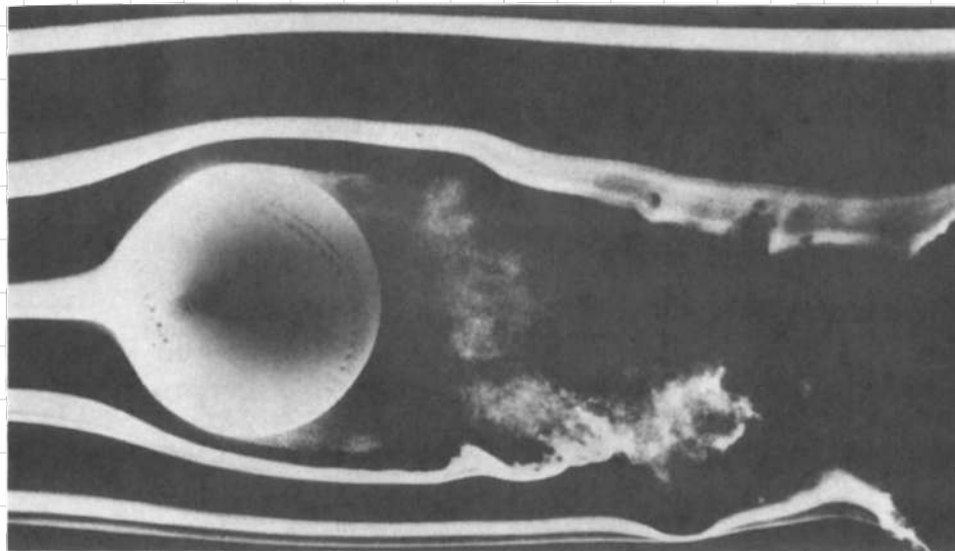
DIAMETER = 4.27 cm (American)
= 4.11 cm (British)
MASS = 0.046 kg
TYPICAL $Re = 2 \times 10^5$



Golfball

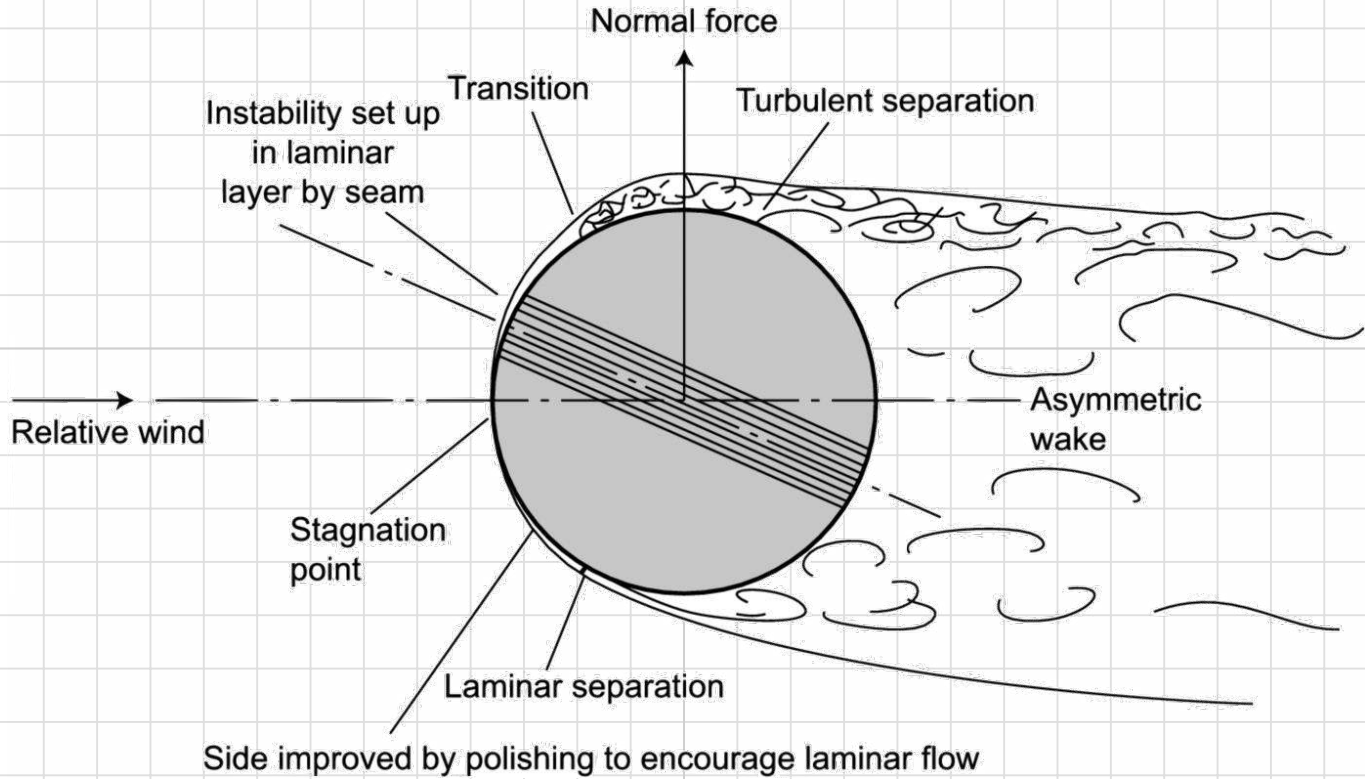


Baseball

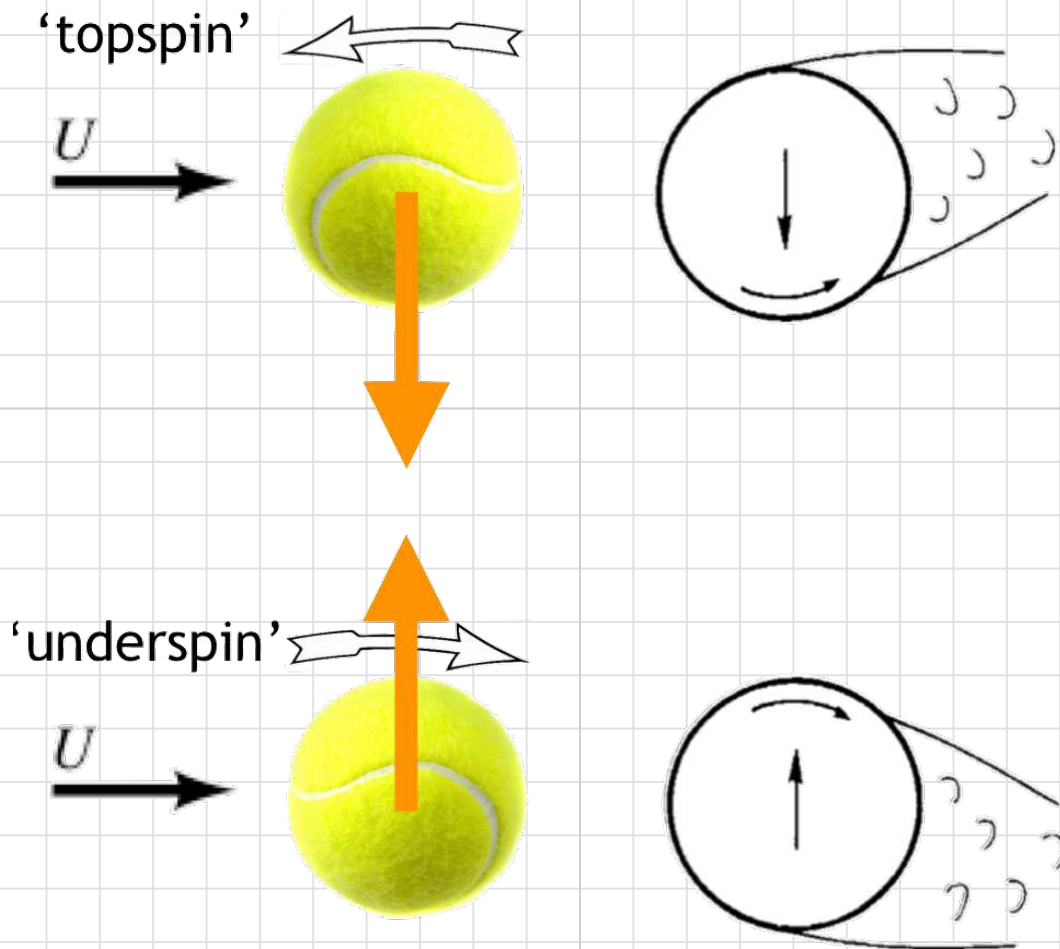


DIAMETER = 7.23 cm
MASS = 0.156 kg
TYPICAL $Re = 1.5 \times 10^5$

Cricket



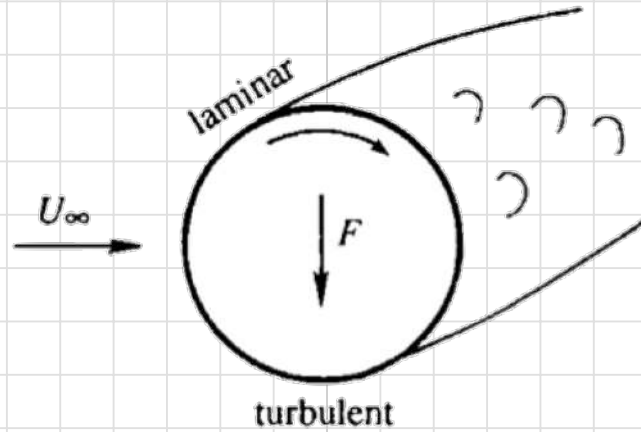
Tennis



Tennis

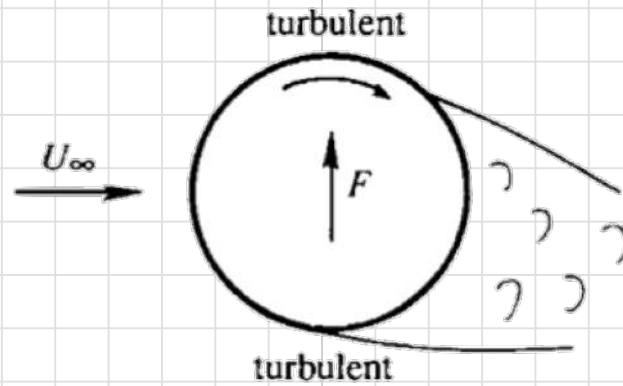


Inverse Magnus effect



turbulent

$$Re < Re_{cr}$$



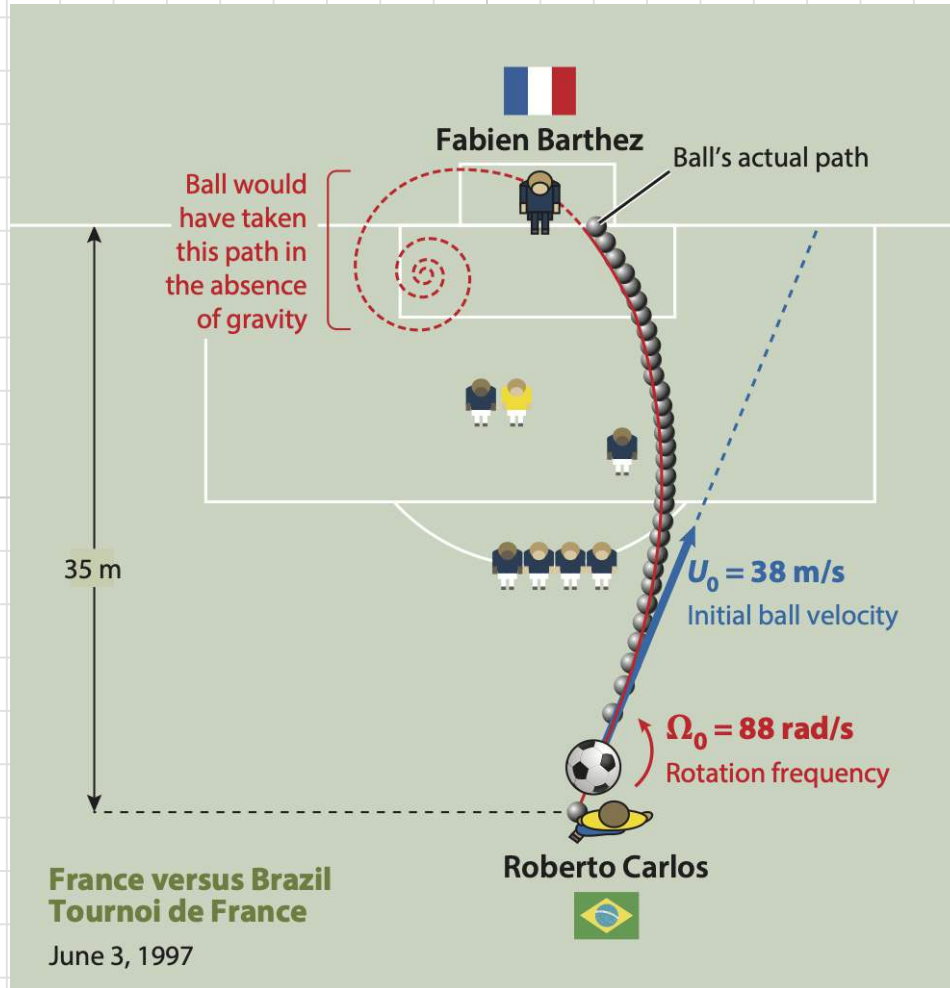
turbulent

turbulent

$$Re > Re_{cr}$$

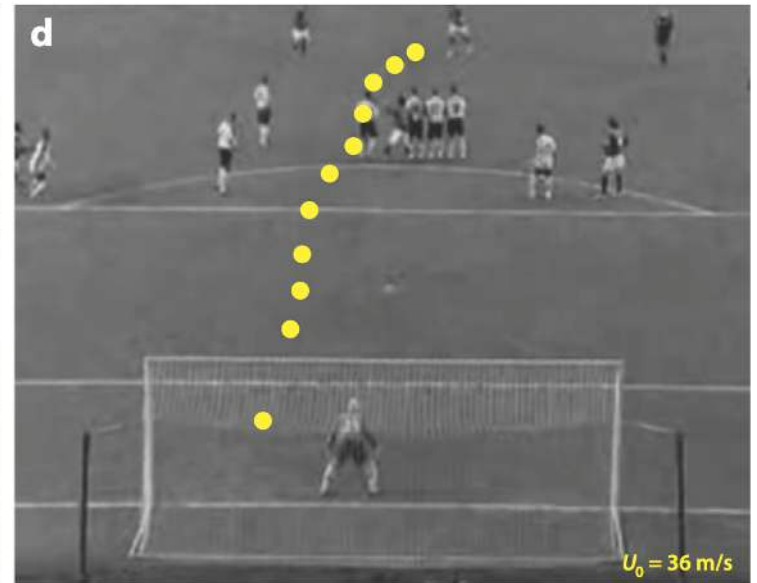
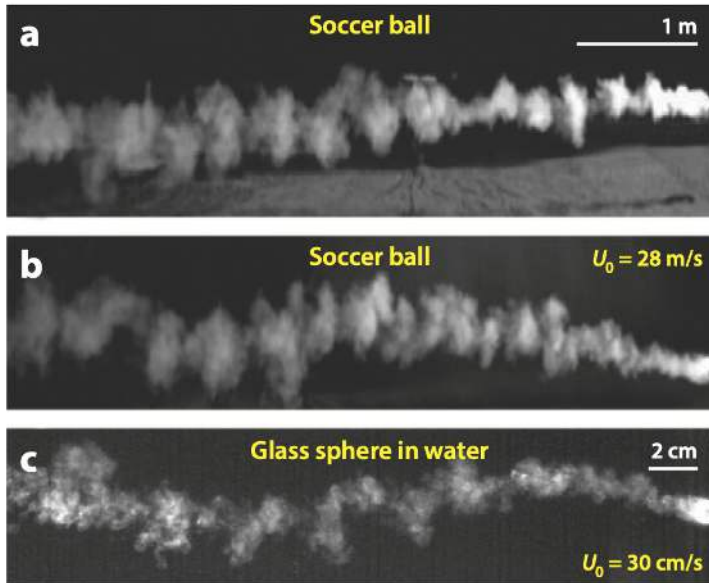
Soccer

Magnus effect



Soccer

Knuckle ball



Volleyball



a



b



c



d



e



f