Exercises in scaling:

1 Consider a ping-pong ball of negligible density and radius R sitting at the interface between a liquid (density ρ) and air free-surface. There is a coefficient of surface tension, γ [N m^{-1}] between the liquid and air. What is the frequency of the ping-pong ball oscillation?

2 **Euler's disk:** Place a coin on edge and spin it. After some time it is spinning with a very small angle α relative to the surface and you can observe the rotation frequency (or vibration frequency) Ω increase as the angle decreases until contact occurs. The motion depends on the mass m of the disk, gravity g, the disk radius a and the inclination angle α. (a) In the absence of any frictional effects (damping), Ω is related to α. Find the form of the relationship using dimensional arguments. (b) The motion eventually stops because of damping. Assume that the origin of the damping is from the viscosity μ of air. Using dimensional arguments determine the typical damping time τ.

3 An atomic bomb releases energy E in an explosion that generates a blast radius $R(t)$. Assume that the density of air doesn't change. (a) find the relationship between the radius and time. (b) from the images found in figure 1, compare the prediction with the recorded blast wave and compute the blast energy for a constant of proportionality equal to one.

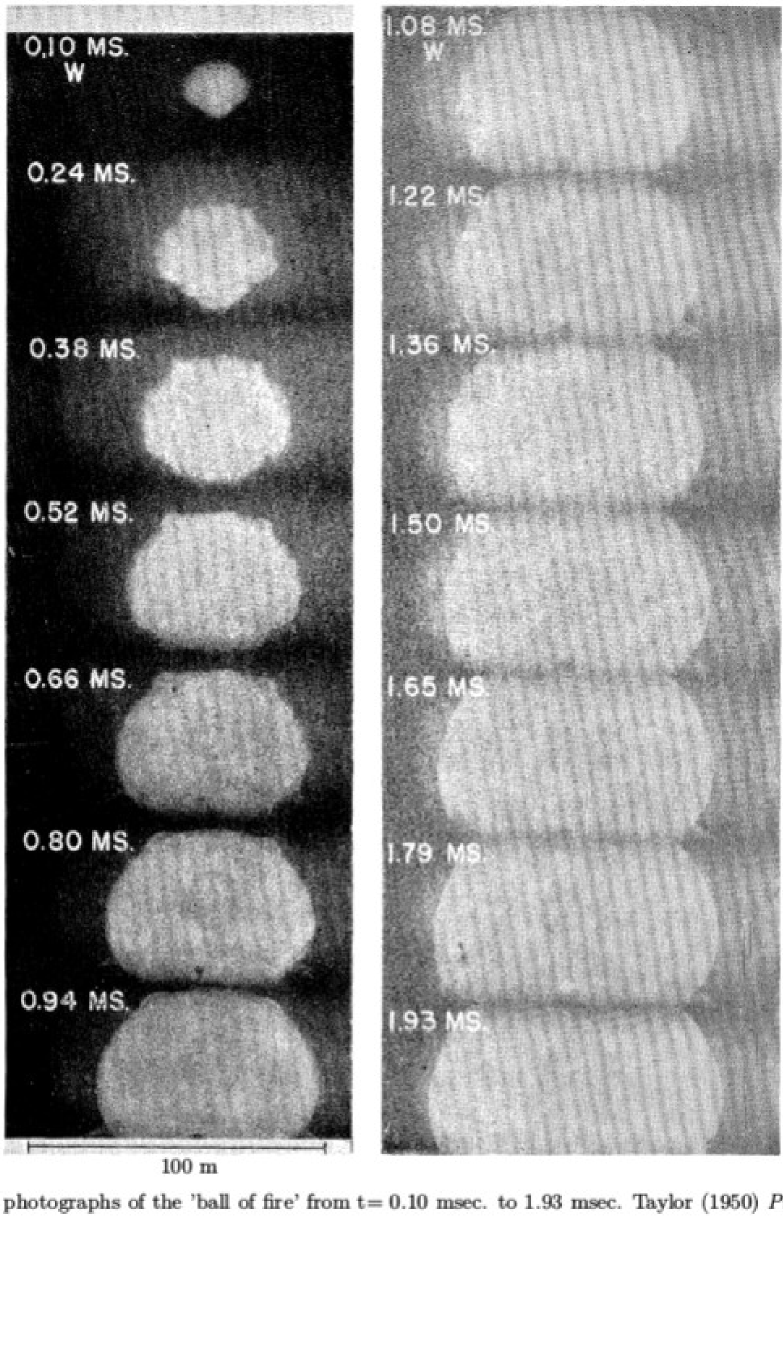

FIG. 1: Succession of photographs of the 'ball of fire' from t= 0.10 msec. to 1.93 msec. Taylor (1950) *Proc. R. Soc. London, Ser. A*: