Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Levitation of a non–volatile drop by an evaporating pool: the inverse Leidenfrost effect S.J.S. MORRIS, UC Berkeley, MENG SHI, KAUST — Assuming axisymmetry, zero gravity, and uniform surface tension γ and vapour properties (viscosity η, conductivity k and density ρ), we determine the maximum value of the force F with which a heated sphere (radius b) can be pressed against the pool surface without rupturing it. The Laplace–Young and Reynolds equations form a coupled system of ODEs determining, in particular, film thickness h_0/b at the sphere bottom as a function of $F/(2\pi\gamma b)$ with $\varepsilon = \frac{\eta k \Delta T}{\gamma b \rho H_{lv}}$, as a parameter (latent heat H_{lv}). Numerical solutions for fixed small ε show that as $F/(2\pi\gamma b)$ is increased from zero, h_0/b first decreases to a minimum. With further increase in F, h_0 increases until a turning point is reached. There, the slope $\mathrm{d}h_0/\mathrm{d}F \to \infty$, and the response curve doubles back on itself to form an upper branch. Near the turning point, the interface shows an apparent contact line with apparent contact angle π (on the liquid side). The turning point corresponds to the contact line moving from the lower hemisphere to the upper; during this process, $F/(2\pi\gamma b)$ reaches its maximum (unity). This result is consistent with work by Adda–Bedia et al.(2016).

Stephen Morris
UC Berkeley

Date submitted: 01 Aug 2019