THIRD SOUND PROPERTIES (MKS UNITS)

The third sound speed at a film thickness $h$ is essentially $\sqrt{g h}$ where the van der Vaals force (per unit mass) at the film surface is used for $g$. At absolute zero, there is also a modification due to an inactive portion of the film, a combination of a "solid layer" at the substrate and wavefunction healing lengths at both surfaces.

physical constants... Boltzmann and particle mass

$$k := 1.3805 \times 10^{-23} \quad m_4 := 6.646 \times 10^{-27}$$

film parameters... $h_1 := 3.578 \times 10^{-10}$ 1 layer

$$\rho := \frac{m_4}{h_1^3} \quad \text{density}$$

$$T_v := 39 \quad \beta := 41.7 \quad \text{van der Waals strength and retardation}$$

$$D := 1.46 \cdot h_1 \quad \text{inactive thickness}$$

Putting all this together into $c_3^2 = \frac{\rho_s}{\rho} \frac{d}{dh} U(h)$ gives...

$$T=0 \text{ third sound speed} \quad c_3(h) := \sqrt{\frac{1 - \frac{D}{h}}{\frac{3 \cdot k \cdot T_v}{m_4} \left(\frac{h_1}{h}\right)^3 \left(\beta + \frac{4 \cdot h}{3 \cdot h_1}\right) \left(\beta + \frac{h}{h_1}\right)^2}}$$

Here's a plot of speed (m/s) vs height (layers)

$$d := 2, 2.2 \ldots 20$$