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Onset of air-induced splash at low impact speeds for low-viscosity liquids WENDY W. ZHANG, LEI XU, PRIYANKA JINDAL, SIDNEY R. NAGEL, University of Chicago — Recent experiments [Xu et al. PRL **94**, 184505 (2005)] revealed that the presence of air is essential for the splash formed after a low-viscosity liquid drop hits a dry, smooth solid. As the impact speed U_0 is increased from 2 m/s to 8 m/s, the threshold gas pressure, $P_T(U_0)$, below which the splash is suppressed, exhibits 2 distinct trends. Above a critical impact speed U_*, P_T decreases as $1/\sqrt{U_0}$. Below U_*, however, P_T decreases much more rapidly with U_0. Here we show that a simple idea can account for both the different trend and the form of $P_T(U_0)$ below U_*. The idea is that, within the leading-edge of the thin liquid sheet ejected after impact, the flow dynamics is initially dominated by viscous effects. For a drop of radius a, surface tension σ, dynamic viscosity μ_L, density ρ_L falling in ambient gas with sound speed C_g, this idea gives the scaling law $U_* \sim (U_\rho^2 U_\mu)^{1/3}$, where $U_\rho \sim \sqrt{\sigma/\rho_L a}$ is the capillary wave speed and $U_\mu \sim \sigma/\mu$ is the viscous decay speed for surface deformation. It also yields $P_T(U_0) \sim \sigma^2/(\mu_L a C_g U_0^2)$ for $U_0 \leq U_*$. The dependencies on μ_L, C_g and a are all consistent with available measurements. In addition, our results suggest that, at fixed U_0, a different physical mechanism becomes relevant for splash formation when the liquid viscosity is increased above a cross-over value. The predicted cross-over value agrees with the measured value for 4 m/s impact [Xu, PRE **75**, 056316 (2007)].

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