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The secret of splashing: interplay of air and roughness

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We studied splashing on both smooth and rough dry surfaces using high speed photography. For smooth substrates, a striking phenomenon is observed: splashing can be completely suppressed by decreasing the pressure of the surrounding gas. The threshold pressure where a splash first occurs is measured as a function of the impact velocity and found to depend on the molecular weight of the gas and the viscosity of the liquid. Both experimental scaling relations support a model in which the compressibility of the gas is responsible for creating the splash[1]. For the case of rough substrates, we systematically varied both the surface roughness and the pressure of the surrounding gas and found two distinct contributions to a splash. One is caused by air and has the same characteristics as the “coronal” splash observed on smooth substrates. A second, “prompt” splash, contribution is caused by surface roughness. We have also measured the size distribution of the droplets emitted from a splash. For a smooth surface, a broad distribution of droplet sizes is found at high gas pressures. As the gas pressure is lowered towards the splash/no-splash transition the distribution gets more and more peaked at a characteristic size. For a rough surface, the distribution is strongly correlated with the surface roughness. [1] L Xu, W W Zhang and S R Nagel, Phys. Rev. Lett. 94, 184505 (2005)