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Gravity-driven liquid flow over a flexible beam HYOUNGSOO KIM, Princeton University, PETER HOWELL, University of Oxford, MARINELA POPOVA, University of Toronto, HOWARD STONE, Princeton University — We study theoretically and experimentally the time dependence of a liquid spreading along a flexible beam. The flow is modeled using lubrication theory and the substrate is modeled as an (Euler-Bernoulli) elastic beam. We classify the model problem into two cases depending on the maximum beam deflection angle ϕ_{max} from the horizontal, i.e. a small deflection ($\phi_{max} < 30^\circ$) and large deflection ($30^\circ < \phi_{max} < 90^\circ$). For a small deflection case, we obtain asymptotic solutions for the liquid propagation speed for the early time and terminal time periods, which for the front position $\sigma(t)$ show power-law behaviors $\sigma(t) \sim t^{4/5}$ and $\sigma(t) \sim t^4$, respectively. The theoretical model also predicts the deflection angle of the beam at the propagating liquid front. We validate the results with experiments, which show good agreement with theory. Furthermore, for large beam deflections, we obtain experimental results demonstrating power-law behaviors, $\sigma(t) \sim t$ and $\phi(t) \sim t^2$ for the early time period.

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