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The Oscillation and Rupture of a Water-filled Balloon HUGH LUND, STUART DALZIEL, DAMTP, University of Cambridge — Experimental observations of the impact of a water-filled balloon on a rigid surface have shown that capillary-like waves form on the membrane, with the tension in the membrane as the restoring force. If the membrane ruptures during the impact, two forms of instability occur on the air/water interface. First, the rapid retraction of the membrane creates a small-scale shear instability. Second, larger scale growth of the interfacial amplitude occurs, as the restoring force for the capillary-like waves is lost while the kinetic energy within the water remains. A water-filled balloon that is held and forcibly oscillated then ruptured with a sharp object displays the same three phenomena: capillary-like waves, shear instability and larger-scale interfacial growth. In air, the large-scale growth of the interfacial amplitude becomes asymmetric, leading to the formation of so-called bubbles of the air phase and spikes of the water phase. For such a balloon held underwater, the interfacial growth is symmetric. In this paper, we present examples of the phenomena described above. Further, we explain why the late-time growth of the interfacial amplitude is a manifestation of the Richtmyer-Meshkov instability. Unlike the classical instability, growth may occur when there is no density difference across the interface. At late-time, measurements of the displacement of the maximum amplitude of the interface suggest a power law of the form t^{θ}, where t is time and θ is around 2/3.

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