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From viscous to elastic sheets: Dynamics of smectic bubbles KIRSTEN HARTH, TORSTEN TRITTEL, Institute of Experimental Physics, Otto von Guericke University Magdeburg, DEVARAJ VAN DER MEER, Physics of Fluids Group, Univ. of Twente, The Netherlands, RALF STANNARIUS, Institute of Experimental Physics, Otto von Guericke University Magdeburg — Oscillations and rupture of bubbles composed of an inner fluid separated from an outer fluid by a membrane, represent an old but still immensely active field of research. Membrane properties apart from surface tension are often neglected for fluids (e.g. soap bubbles), whereas they govern the dynamics in systems with a rigid membrane (e.g. vesicles). Due to their layered phase structure, smectic liquid crystals can form stable, uniform and easy-to-handle fluid films of immense aspect ratios. Only recently, freely floating bubbles detached from a support could be prepared. We analyze their relaxation from strongly non-spherical shapes and the rupture using high-speed video recordings. Peculiar dynamics intermediate between simple viscous fluid films and an elastic response are observed: Fast oscillations, slowed relaxation and even the reversible formation of wrinkles and extrusions. Bubble rupture deviates qualitatively from previously observed behavior of simple Newtonian and other complex fluids. It becomes retarded by at least two orders of magnitude compared to the predictions of Taylor and Culick. A transition between fluid-like and elastic behavior is seen with increasing thickness. We give experimental results, an intuitive explanation and a novel hydrodynamic description.

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