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The Spreading of Superfluid Drops[1] MATTHEW WALLACE, DAVID MALLIN, MICHAEL MILGIE, University of California, Irvine , KENNETH LANGLEY, ANDRES AGUIRRE-PABLO, SIGUDUR THORODDSEN, King Abdullah University of Science and Techology, PETER TABOREK, University of California, Irvine — We have used video microscopy and interferometry to investigate the spreading of normal and superfluid helium drops impacting on a sapphire substrate in a saturated atmosphere of its own vapor. We find that in spite of having zero viscosity, the short-term spreading of superfluid drops (time t less than 30 ms) is nearly identical to normal helium; in both cases, the drop spreads to a characteristic diameter of 5 mm and assumes a pancake-like shape. Both normal and superfluid drops shrink with time; the normal fluid drops last up to 15 minutes, but the superfluid drops last only 2-15 seconds. Superfluid drops shrink via superflow through a fluid film at the contact line, flowing at the Feynman critical velocity. Remarkably, the drops undergo a two-phase geometry-dependent retraction. During the first phase, the drop is toroidally-shaped and the radius shrinks linearly in time; in the second phase the drop assumes the shape of a spherical cap and shrinks with the square root of time. Superfluid outflow causes the drop edges to become ragged and frayed, and causes droplets of fluid that appear to form spontaneously outside the expanding drop (exodroplets.) We provide detailed maps of drop topography and contact angle.

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