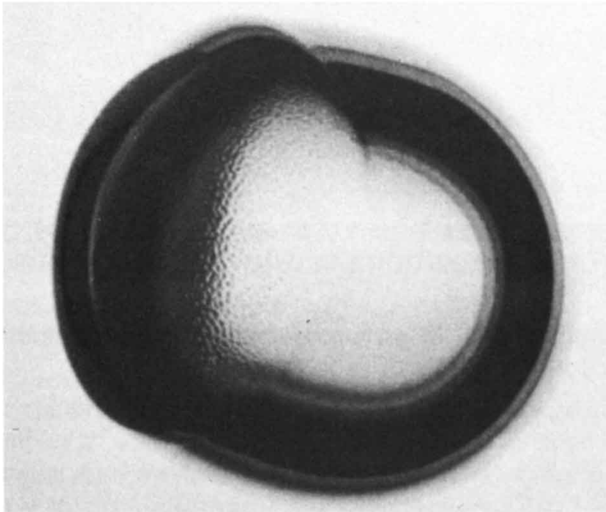

Figure 1

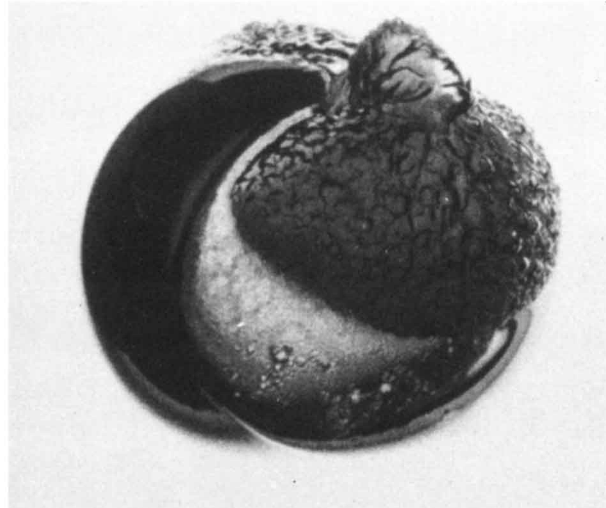

Figure 2

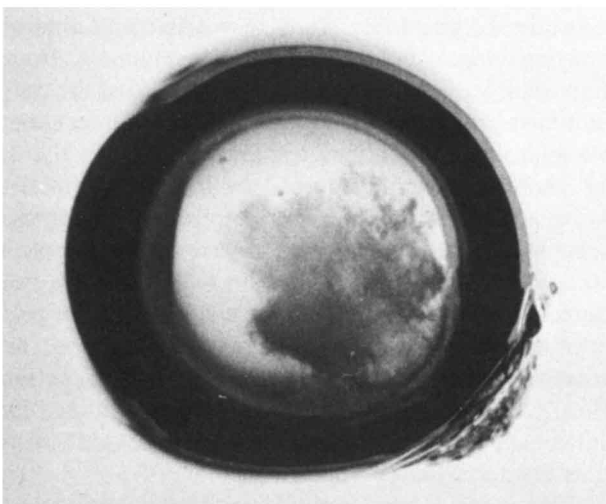

Figure 3

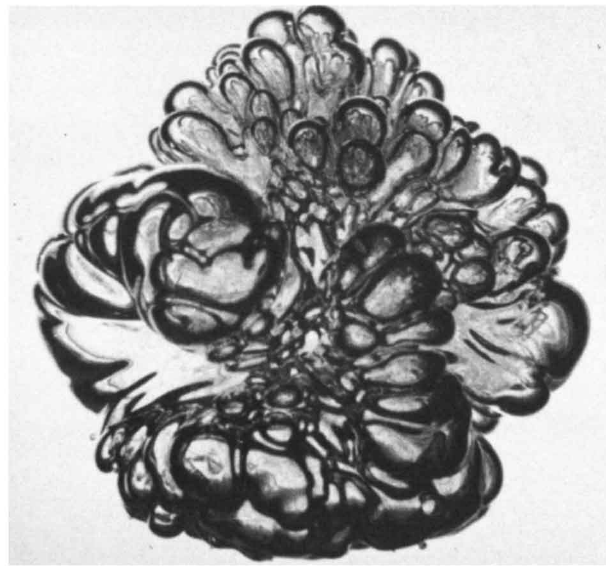

Figure 4

EXPLOSIVE BOILING OF A DROPLET AT THE SUPERHEAT LIMIT

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The photographs demonstrate the explosive boiling of droplets of ether immersed in glycerol. The temperature is 150 °C and the ambient pressure is 3 bar. At these conditions, homogeneous nucleation occurs spontaneously at the limit of superheat and a smooth vapor bubble grows relatively slowly and stably within each drop. The ether droplet shown in Fig. 1 was photographed after it had been evaporating stably for over 7 msec. Only a small amount of liquid remains in the shape of a thin cap that is visible in the upper left portion of the photograph. The thick black band surrounding the vapor region is caused by optical refraction. The bubble has an average diameter of 4 mm.

Incipient instability waves (with a length scale of 100 μm) have developed on the evaporating surface of the drop in Fig. 1 and give it a distinctive "orange-peel" appearance. Figure 2 shows a partially vaporized ether droplet photographed 115 μsec *after* naturally occurring temperature fluctuations had initiated violent boiling near the edge of the remnant liquid region. The clamshell-shaped unstable region rapidly spreads out radially, consuming the remaining liquid.

Figure 3 contains a profile view of an ether bubble (taken 120 μsec after the onset of unstable boiling) showing a miniature eruption within the bubble. During unstable boiling, very fine liquid droplets are torn from the evaporating interface and entrained in the flow leaving the interface. The average velocity of this transient two-phase jet is about 50 m/sec, and the corresponding mass flux is several orders of magnitude greater than that characteristic of ordinary boiling. Note the bulging of the bubble surface into the host fluid caused by the reaction to the thrust of the jet. This photograph dramatically demonstrates why vapor explosions are so violent.

After vaporization is completed, excess overpressure within the bubble causes it to expand rapidly and subsequently collapse and oscillate. The bubble in Fig. 4 was photographed during the first rebound following the initial collapse of the bubble. The breakup of the spherical bubble is a result of the Rayleigh–Taylor instability which is driven by the large accelerations of the bubble surface.