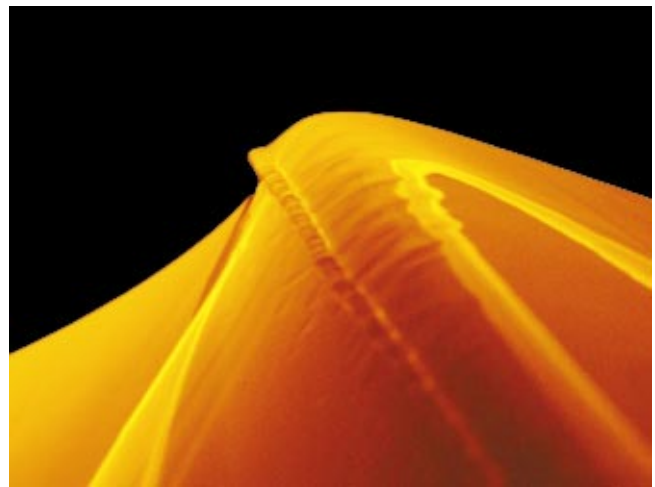
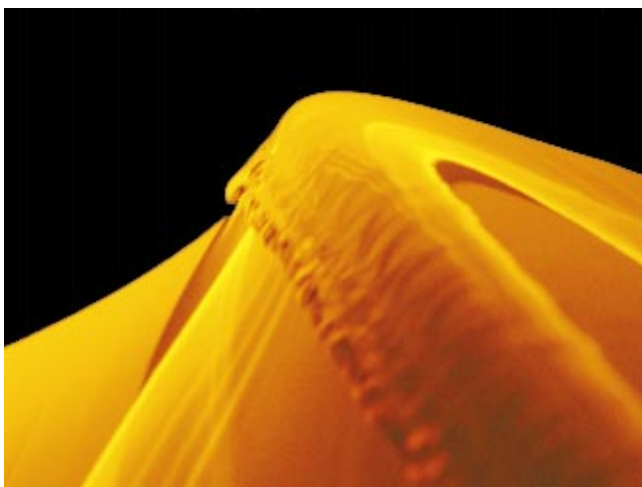


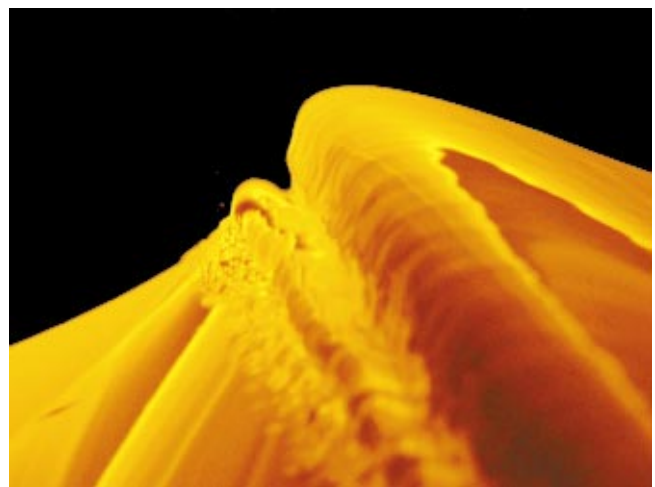
(a)



(b)



(c)



(d)

### The Generation of Microjets in Spilling Breakers in the Presence of Surfactants

Submitted by

X. Liu and J. H. Duncan, University of Maryland

In clean water, weak and/or short-wavelength spilling breakers are dominated by surface tension and the entire breaking process occurs without overturning of the free surface. Given the importance of surface tension in these breakers, it is not surprising that their behavior can change dramatically in the presence of surfactants. In the weak breaking event shown here, the water was mixed with sodium dodecyl sulfate (a soluble surfactant). As the wave approaches breaking, a bulge forms on the forward (left) face of the crest, see photograph (a). In photograph (b), a jet appears just above the leading edge of the bulge and in the subsequent photographs [(c) and (d)] this jet falls forward and collides with the front face of the wave. As can be seen in Fig. 1, the trajectory of the jet tip is parabolic.

These photographs were taken with a laser-induced fluorescence technique (dye: Rhodamine 6G; laser: Nd:YAG).

The horizontal field of view of the images is about 12 cm while the wavelength of the breaker is about 1 m.

The photographs and figure are reprinted from X. Liu and J. H. Duncan, *Nature (London)* **421**, 520–523 (2003). This work was supported by the National Science Foundation under Grant No. OCE0221335.

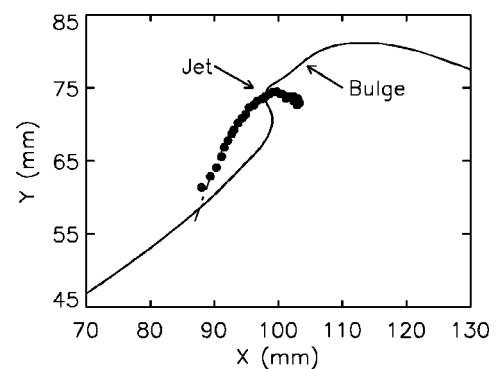


FIG. 1. The crest profile (solid line) of the wave as the jet begins to form and the position of the tip of the jet (filled circles) for subsequent times. The jet tip trajectory is parabolic with a vertical acceleration of  $0.66g$ .