Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Shape of long gas bubbles propagating in square capillaries
MIRCO MAGNINI, Univ of Nottingham, OMAR K MATAR, Imperial College London — We present the results of a systematic analysis of the shape of the thin lubrication film surrounding a long gas bubble transported by a liquid flow in a square capillary. Direct numerical simulations are performed for a range of capillary and Reynolds numbers Ca=0.002-0.5 and Re=1-2000, and very long bubbles, up to 20 times the channel hydraulic diameter. In agreement with previous studies, when Ca¿0.05 the bubble exhibits an axisymmetric shape, whereas for Ca¡0.05 the bubble flattens at the centre of the channel wall and thick liquid lobes are left at the corners. When Ca¡0.01, the thin film at the centre of the wall assumes a saddle-like shape, which leads to the formation of two constrictions at the sides of the liquid film profile. The resulting cross-stream capillary pressure gradients drain liquid out of the thin-film, whose thickness decreases indefinitely as a power-law of the distance from the bubble nose. We report detailed values of the centreline and minimum film thickness along the bubble, bubble speed, and cross-sectional gas area fraction, at varying Ca and Re. Inertial effects retard the formation of the saddle-shaped film at the channel centre, which may never form if the bubble is not sufficiently long. However, the film thins at a faster rate as Re increases

Mirco Magnini
Univ of Nottingham

Date submitted: 21 Jul 2020 Electronic form version 1.4