The Fastest Smooth Taylor Bubble

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The complicated nature of singularities associated with topological transition in the plane Taylor-bubble problem is briefly discussed in the context of estimating the speed of the fastest smooth Taylor-bubble in the absence of surface tension. Previous numerical studies were able to show the presence of a stagnation point at the tip of the bubbles for dimensionless speed $F < 0.357$ but were incomplete in characterizing the topology of these bubbles at the tip for values of $F > 0.29$ due to difficulties in obtaining numerical solutions with well-rounded profiles at the apex. These difficulties raise the question whether the bubbles rising at a speed $F \in (0.29, 0.357)$ are smooth, pointed or spurious. This issue has led us to carefully scrutinize certain asymptotic behavior of the Fourier spectrums of the numerical solutions for a wide range of values of F and to extend these results in an appropriate limiting sense. Our findings indicate that these plane bubbles with $F < 0.35784$ (accurate up to four decimal places) have well-rounded profiles at the apex. The purpose of this paper is to describe our approach and its use in arriving at the above conclusion.

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