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Optimal estimates on free boundary propagation in thin-film flow

We present a method for the derivation of lower bounds on free boundary propagation for the thin-film equation, the most prominent example of a higher-order degenerate parabolic equation. In particular, we obtain sufficient conditions for instantaneous forward motion of the free boundary, upper bounds on waiting times, as well as lower bounds on asymptotic propagation rates. Our estimates coincide (up to a constant factor) with the previously known reverse bounds and are therefore optimal. To the best of our knowledge, these results constitute the first lower bounds on free boundary propagation for any higher-order degenerate parabolic equation. Our technique is based on certain new monotonicity formulas for solutions to the thin-film equation which involve weighted entropies with singular weight functions. It turns out that our method is not restricted to the thin-film equation, but also applicable to other higher-order parabolic equations.