



Mathematics > Analysis of PDEs

Fluid accumulation in thin-film flows driven by surface tension and gravity (I): Rigorous analysis of a drainage equation

C. M. Cuesta, J. J. L. Velazquez

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We derive a boundary layer equation describing accumulation regions within a thin-film approximation framework where gravity and surface tension balance. As part of the analysis of this problem we investigate in detail and rigorously the 'drainage' equation $(\phi'''+1)\phi^3=1$. In particular, we prove that all solutions that do not tend to 1 as the independent variable goes to infinity are oscillatory, and that they oscillate in a very specific way. This result and the method of proof will be used in the analysis of solutions of the afore mentioned boundary layer problem.

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