Shear–thinning liquid films: Macroscopic and asymptotic behaviour by quasi self–similar solutions

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Abstract. We consider the spreading of a thin droplet of viscous liquid on a plane surface driven by capillarity in complete wetting regime. In case of constant viscosity, the no slip condition leads to a force singolarity at advancing contact lines. It is nowadays well known that the introduction of appropriate slip conditions removes this paradox and alters only logarithmically the macroscopic behaviour of solutions at intermediate time scales. Here we consider a different approach, which consists in keeping the no-slip condition and assuming instead a shear-thinning rheology. This relaxation leads, in lubrication approximation, to fourth order degenerate parabolic equations of quasilinear type. By analyzing a class of quasi self-similar solution to these equations in the limit of Newtonian rheology, we obtain a scaling law in time for macroscopic quantities (such as macroscopic profile, effective contact angle) which is only logarithmically affected by the shear thinning parameters. As opposed to positive slippage models, the scaling law is uniform for large times as far as the macroscopic support is well defined, and thus could describe also the asymptotic behaviour of a large class of solutions for fixed shear–thinning rheology.

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