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The shape of a recoiling liquid filament[1] FRANCESCO PAOLO CONT, School of Engineering and Materials Science, Queen Mary University of London, JUAN F. MARIN, Departamento de Fisica, Universidad de Santiago de Chile, ARNAUD ANTKOWIAK, Institut Jean Le Rond dAlembert, Sorbonne Universits, Paris, France, J. RAFAEL CASTREJON PITA, School of Engineering and Materials Science, Queen Mary University of London, LEONARDO GORDILLO, Departamento de Fisica, Universidad de Santiago de Chile — We study the capillary retraction of a Newtonian semi-infinite liquid filament through analytical methods. We derive a long time asymptotic-state expansion for the filament profile using a one-dimensional free-surface slender cylindrical flow model based on the three-dimensional axisymmetric Navier-Stokes equations. The analysis identifies three distinct length and time scale regions in the retraction domain: a steady filament section, a growing spherical blob, and an intermediate matching zone. We show that liquid filaments naturally develop travelling capillary waves along their surface and a neck behind the blob. We analytically prove that the wavelength of the capillary waves is approximately 3.63 times the filament's radius at the inviscid limit. Additionally, the waves asymptotic wavelength, decay length, and the minimum neck size are analysed in terms of the Ohnesorge number. Finally, our findings are compared with previous results from the literature and numerical simulations in Basilisk obtaining a good agreement. This analysis provides a full picture of the recoiling process going beyond the classic result of the velocity of retraction found by Taylor and Culick.

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