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The natural breakup length of a steady capillary jet[1] SASA BAJT, HENRY CHAPMAN, MAX WIEDORN, JURAJ KNOSKA, YANG DU, Center for Free-Electron Laser Science, Deutsches Elektronen Synchrotron (DESY), Notkestrasse 85, 22607 Hamburg, Germany., MICHAEL HEYMAN, Dept. Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany., BRAULIO GANAN-RIESCO, Ingeniatrics Tecnologias S.L., 41900 Camas, Sevilla, Spain, JOSE M. LOPEZ-HERRERA, MIGUEL A. HERRADA, FRANCISCO CRUZ-MAZO, ALFONSO M. GANAN-CALVO, Universidad de Sevilla, ETSI, 41092 Sevilla, Spain — The averaged natural breakup length of capillary jets ejected in inactive environments are determined by the liquid properties, its velocity and its diameter. Despite its theoretical and applied interest, a general procedure to predict that length has not been proposed yet. Here we describe and quantify the energy route that sets it. We find that the underlying mechanism that determines that length is the short-term transient growth rate of perturbations excited by the jet breakup itself. We propose a perturbation analysis of the time averaged energy conservation equation in the absence of body forces. The balance of total energy rates due to the perturbations is reduced, by dimensional analysis, to a closed algebraic expression with two universal constants. These constants are calculated by optimal fitting of a large set of experiments from diverse sources, experimental and numerical, which confirm the universal scaling law found.

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