

UvA-DARE (Digital Academic Repository)

Drops and jets of complex fluids

Javadi, A.

Publication date
2013

[Link to publication](#)

Citation for published version (APA):

Javadi, A. (2013). *Drops and jets of complex fluids*. [Thesis, externally prepared, Universiteit van Amsterdam].

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Bibliography

- [1] P. G. de Gennes, *Wetting: statics and dynamics*, Rev. Mod. Phys. **57**, 827 (1985).
- [2] T. Young, *An essay on the cohesion of fluids*, Phil. Trans. R. Soc. Lond. **95**, 6587 (1805).
- [3] P. G. de Gennes, *Soft Interfaces. The 1994 Dirac Memorial Lecture*, Cambridge university press, Collège de France, Paris, 1994.
- [4] F. Brochard-Wyart and P. G. de Gennes, Adv. Colloid interface Sci. **39**, 1 (1992).
- [5] J. Eggers and E. Villermaux, *Physics of liquid jets*, Reports on Progress in Physics **71** (2008), 279MO Times Cited:99 Cited References Count:601.
- [6] L. Rayleigh, Nature **44**, 294 (1891).
- [7] J. J. H. Terry, S. C. and J. B. Angell, *Gas-Chromatographic Air Analyzer Fabricated on a Silicon-Wafer*, Ieee Transactions on Electron Devices **26**, 1880 (1979), Jc568 Times Cited:401 Cited References Count:6.
- [8] B. A. Karniadakis, G. M. and N. Aluru, *Microflows and Nanoflows*, Springer Verlag. (2005).
- [9] H. Bruus, *Theoretical Microfluidics*, Oxford University Press. (2007).
- [10] P. Tabeling, *Introduction to Microfluidics.*, Oxford University Press. (2005).
- [11] C. V. W. B. K. M. M. W. F. Seemann, R. and S. Herminghaus, *Optimized droplet-based microfluidics scheme for sol-gel reactions*, Lab on a Chip **10**, 1700 (2010), 611NY Times Cited:3 Cited References Count:42.
- [12] I. Shestopalov, J. D. Tice, and R. F. Ismagilov, *Multi-step synthesis of nanoparticles performed on millisecond time scale in a microfluidic droplet-based system*, Lab on a Chip **4**, 316 (2004), 839VY Times Cited:164 Cited References Count:52.
- [13]

- [14] G. M. Whitesides, *The origins and the future of microfluidics*, Nature **442**, 368 (2006), 067CI Times Cited:942 Cited References Count:65.
- [15] S. A. D. Stone, H. A. and A. Ajdari, *Engineering flows in small devices: Microfluidics toward a lab-on-a-chip*, Annual Review of Fluid Mechanics **36**, 381 (2004), 775LT Times Cited:878 Cited References Count:150.
- [16] G. V. K. Gallardo, B. S., J. L. I. C. V. S. S. R. R. Eagerton, F. D., and N. L. Abbott, *ELectrochemical principles for active control of liquids on sub-millimeter scales*, Science **283**, 57 (1999), 155ZH Times Cited:247 Cited References Count:27.
- [17] M. A. Unger, H. P. Chou, T. Thorsen, A. Scherer, and S. R. Quake, *Mono-lithic microfabricated valves and pumps by multilayer soft lithography*, Science **288**, 113 (2000), 302VT Times Cited:1170 Cited References Count:35.
- [18] P. V. N. P. D. N. Chang, S. T. and O. D. Velev, *Remotely powered self-propelling particles and micropumps based on miniature diodes*, Nature Materials **6**, 235 (2007), 141HZ Times Cited:39 Cited References Count:45.
- [19] L. S. C. J. Chen, L. and E. K. Lee, *Continuous dynamic flow micropumps for microfluid manipulation*, Journal of Micromechanics and Microengineering **18** (2008), 259UH Times Cited:12 Cited References Count:136.
- [20] H. Wijshoff, *Structure- and fluid-dynamics in piezo inkjet printheads*, P.O. Box 101, 5900 MA Venlo, The Netherlands, 2008.
- [21] D. J. Beebe and E. Berthier, *Flow rate analysis of a surface tension driven passive micropump*, Lab on a Chip **7**, 1475 (2007), 224DY Times Cited:34 Cited References Count:16.
- [22] P. J. Y. K. K. C. K. H. B. E. B. D. J. Ju, J. and S. H. Lee, *Backward flow in a surface tension driven micropump*, Journal of Micromechanics and Microengineering **18** (2008), 329ST Times Cited:2 Cited References Count:13.
- [23] G. M. Walker and D. J. Beebe, *A passive pumping method for microfluidic devices.*, Lab on a Chip **2**, 131 (2002).
- [24] A. R. Wheeler, *Chemistry - Putting electrowetting to work*, Science **322**, 539 (2008), 363WV Times Cited:38 Cited References Count:17.
- [25] W. W. J. J. Prins, M. W. J. and J. W. Weekamp, *Fluid control in multichannel structures by electrocapillary pressure*, Science **291**, 277 (2001), 391JM Times Cited:184 Cited References Count:13.
- [26] L. Shui, E. J. C. T. Pennathur, S., and A. van den Berg, *Multiphase flow in lab on chip devices: A real tool for the future*, Lab on a Chip **8**, 1010 (2008), 320LT Times Cited:4 Cited References Count:84.

- [27] K. A. B. J. S. D. Mugele, F. and S. Herminghaus, *Electrowetting: a convenient way to switchable wettability patterns*, Journal of Physics-Condensed Matter **17**, S559 (2005), Sp. Iss. SI 911UM Times Cited:30 Cited References Count:50.
- [28] t. Yager, P., *Microfluidic diagnostic technologies for global public health.*, Nature **442**, 412 (2006).
- [29] X. D. Zhang, C. and Y. Li, *Micropumps, microvalves, and micromixers within PCR microfluidic chips: advances and trends*, Biotech. Adv. **25**, 483 (2007).
- [30] N. P. . M. U. Pilarek, M., *Biological cardio-micro-pumps for microbioreactors and analytical micro-systems.*, Sensors and Actuators B: Chemical **156**, 517 (2011).
- [31] E. J. I. J. M. J. . R. E. Bonn, D., *Wetting and spreading.*, Rev. Mod. Phys. **81**, 739 (2009).
- [32] G. Lippmann, *Relation entre les phenomenes electriques et capillaires*, Ann. Chim. Phys. **5**, 494 (1875).
- [33] G. Beni and S. Hackwood, Appl. Phys. Lett. **38**, 207 (1981).
- [34] B. Berge, *Électrocapillarité et mouillage de films isolants par leau.*, C. R. Acad. Sci. II **317**, 157 (93).
- [35] A. W. Adamson, *Physical Chemistry of Surfaces 5th edn*, New York: Wiley, Cambridge; New York, 1990.
- [36] A. G. Papathanasiou and A. G. Boudouvis, *A manifestation of the connection between dielectric breakdown strength and contact angle saturation in electrowetting*, Appl. Phys. Lett. **86** (2005).
- [37] M. Maleki, E. Reyssat, D. Quéré, and R. Golestanian, *On the landau-levich transition*, Langmuir **23**, 10116 (2007).
- [38] R. E. Rosensweig, *Ferrohydrodynamics*, Cambridge University Press, Cambridge; New York, 1985.
- [39] E. Resler and R. Rosensweig, *Magnetocaloric power*, AIAA Journal **2**, 1418 (1964).
- [40] R. L. Bailey, *Lesser Known Applications of Ferrofluids*, Journal of Magnetism and Magnetic Materials **39**, 178 (1983).
- [41] R. Moskowitz, *Dynamic Sealing with Magnetic Fluids*, Asle Transactions **18**, 135 (1975), W2576 Times Cited:17 Cited References Count:6.
- [42] D. B. Hathaway, *Use of Ferrofluid in Moving-Coil Loudspeakers*, Db-Sound Engineering Magazine **13**, 42 (1979), Gl419 Times Cited:9 Cited References Count:0.

- [43] A. M. Morimoto, Y. and Y. Yotsumoto, *Dispersion State of Protein-Stabilized Magnetic Emulsions*, Chemical and Pharmaceutical Bulletin **30**, 3024 (1982), Pg458 Times Cited:16 Cited References Count:20.
- [44] R. S. Newbower, *A new technique for circulatory measurements employing magnetic fluid tracers.*, Proc. Biomedical Symp. (1972).
- [45] Y. K. Maruno, S. and M. Soga, *Plain Paper Recording Process Using Magnetic Fluids Magneto-Fluid-Graphy*, Journal of Magnetism and Magnetic Materials **39**, 187 (1983), Ry147 Times Cited:13 Cited References Count:1.
- [46] L. Kuhn and R. A. Myers, *Ink-Jet Printing*, Scientific American **240**, 162 (1979), Gm854 Times Cited:18 Cited References Count:4.
- [47] M. I. Shliomis, *Magnetic Liquids*, Uspekhi Fizicheskikh Nauk **112**, 427 (1974), S5821 Times Cited:106 Cited References Count:107.
- [48] C. Huh and L. E. Scriven, J. Colloid Interface Sci. **35**, 85 (1971).
- [49] R. Cox, J. Fluid Mech. **168**, 169 (1986).
- [50] D. A. A. B. Rio, E. and L. Limat, Phys. Rev. Lett. **94** (2005).
- [51] J. Plateau, *Statique expérimentale et théorique des liquides*, Gauthier-Villars et C^{ie}, Paris, 1873.
- [52] L. Rayleigh, Proc. R. Soc. Lond. **10**, 4 (1879).
- [53] N. S. Clarke, Mathematika **12** (1966).
- [54] S. Senchenko and T. Bohr, Phys. Rev. E **71** (2005).
- [55] C. Clanet and J. C. Lasheras, J. Fluid Mech. **383**, 307 (1999).
- [56] A. M. Sterling and C. A. Sleicher, J. Fluid Mech. **68**, 477 (1975).
- [57] S. P. Lin and R. D. Reitz, Ann. Rev. Fluid Mech. **30**, 85 (1998).
- [58] A. C. Merrington and E. G. Richardson, Proc. Phys. Soc. **59**, 1 (1947).
- [59] U. S. Sauter and H. W. Buggisch, *Stability of initially slow viscous jets driven by gravity*, J. Fluid Mech. **533**, 237 (2005).
- [60] P. A. Monkewitz, Eur. J. Mech. B/Fluids **9**, 395 (1990).
- [61] S. Le Dizès, Eur. J. Mech. B/Fluids **16**, 761 (1997).
- [62] L. da Vinci, *The Notebooks of Leonardo da Vinci ed and Transl. E MacCurdy*, (New York: George Brazillier) , p 756 (1508).
- [63] E. Mariotte, *Traité du Mouvement des Eaux et Des Autres Corps Fluides*, (Paris: E Michallet) (1686).

- [64] P. S. Laplace, *Mécanique Céleste Supplément au X Libre*, (Paris: Courier) **2** (1805).
- [65] F. Savart, *Title*, Ann. Chim. **53**, 33798 (1833).
- [66] J. A. F. Plateau, Acad. Sci. Brux. Mem. **16**, 3 (1843).
- [67] J. Plateau, Acad. Sci. Brux. Mem. **23**, 5 (1849).
- [68] J. Plateau, Ann. Phys. Chem. **80**, 566 (1850).
- [69] L. Rayleigh, Phil. Mag. **34**, 14554 (1892).
- [70] L. D. Landau and E. M. Lifshitz, *Fluid Mechanics.*, (Oxford: Pergamon) .
- [71] J. Eggers, *Nonlinear dynamics and breakup of free-surface flows*, Reviews of Modern Physics **69**, 865 (1997), Xl665 Times Cited:591 Cited References Count:265.
- [72] R. J. Donnelly and W. Glaberso, *Experiments on Capillary Instability of a Liquid Jet*, Proceedings of the Royal Society of London Series a-Mathematical and Physical Sciences **290**, 547 (1966), 74999 Times Cited:121 Cited References Count:5.
- [73] E. F. Goedde and M. C. Yuen, *Experiments on Liquid Jet Instability*, Journal of Fluid Mechanics **40**, 495 (1970), F5606 Times Cited:161 Cited References Count:9.
- [74] J. Eggers and T. F. Dupont, *Drop Formation in a One-Dimensional Approximation of the Navier-Stokes Equation*, Journal of Fluid Mechanics **262**, 205 (1994).
- [75] E. J. B. D. H. M. Javadi, A. and N. M. Ribe, Phys. Rev. Lett. **110** (2013).
- [76] G. I. Barenblatt, *Scaling, Self-Similarity, and Intermediate Asymptotics*, Cambridge University Press, Cambridge, 1996.
- [77] E. Guyon, *Physical hydrodynamics*, Oxford University Press on Demand, 2001.
- [78] L. Rayleigh, *On the theory of long waves and bores*, Proceedings of the Royal Society of London Series a-Containing Papers of a Mathematical and Physical Character **90**, 324 (1914), V41xd Times Cited:30 Cited References Count:5.
- [79] E. J. Watson, *The Radial Spread of a Liquid Jet over a Horizontal Plane*, Journal of Fluid Mechanics **20**, 481 (1964), Wq867 Times Cited:213 Cited References Count:16.
- [80] J. W. M. Bush and J. M. Aristoff, *The influence of surface tension on the circular hydraulic jump*, Journal of Fluid Mechanics **489**, 229 (2003).

- [81] L. R. F. M. Craik, A. and P. Gibbon, *The circular hydraulic jump.*, J. Fluid Mech. .
- [82] I. Tani, *Water Jump in the Boundary Layer*, Journal of the Physical Society of Japan **4**, 212 (1949), Xw712 Times Cited:33 Cited References Count:2.
- [83] X. Liu and J. Lienhard, *The hydraulic jump in circular jet impingement and in other thin liquid films.*, Exps. Fluids .
- [84] J. G. Zhao and R. E. Khayat, *Spread of a non-Newtonian liquid jet over a horizontal plate*, Journal of Fluid Mechanics **613**, 411 (2008), 366LD Times Cited:2 Cited References Count:31.
- [85] S. W. E. Bird, R. B. and E. N. Lightfoot, *Transport Phenomena.*, John Wiley. .
- [86] A. Kreiba, *The rheological properties of aqueous polyacrylamide solutions*, Msc thesis (Canada - Concordia University) .
- [87] H. A. E. H. A. H. K. M. A. B. T. H. J. L. Ellegaard, C. and S. Watanabe, *Creating corners in kitchen sinks*, Nature **392**, 767 (1998), Zj679 Times Cited:36 Cited References Count:5.
- [88] A. J. M. Bush, J. W. M. and A. E. Hosoi, *An experimental investigation of the stability of the circular hydraulic jump*, Journal of Fluid Mechanics **558**, 33 (2006), 068MD Times Cited:17 Cited References Count:40.
- [89] R. N. M. Habibi, M. and D. Bonn, *Coiling of elastic ropes*, Physical Review Letters **99** (2007), 220EV Times Cited:4 Cited References Count:17.
- [90] L. D. Landau and E. M. Lifshitz, *Theory of Elasticity*, (Oxford: Pergamon) .
- [91] G. Barnes and R. Woodcock, *Liquid rope-coil effect.*, Am. J. Physics **26**, 205 (1958).
- [92] R. Barnes, G. & MacKenzie, *Height of fall versus frequency in liquid rope-coil effect.*, Am. J. Physics **27**, 112 (1959).
- [93] J. O. Cruickshank, *Viscous fluid buckling: a theoretical and experimental analysis with extensions to general fluid stability*, Ph.D. thesis, Iowa State University, Ames, Iowa, 1980.
- [94] J. O. Cruickshank and B. R. Munson, *Viscous-Fluid Buckling of Plane and Axisymmetric Jets.*, Journal of Fluid Mechanics **113**, 221 (1981), My851 Times Cited:59 Cited References Count:6.
- [95] H. E. Huppert, *The intrusion of fluid mechanics into geology.*, J. Fluid Mech. **173**, 557594 (1986).

- [96] J. S. Griffiths, R. W. & Turner, *Folding of viscous plumes impinging on a density or viscosity interface.*, Geophys. J. **95**, 397419 (1988).
- [97] R. W. S. Mahadevan, L. and A. D. T. Samuel, Nature **392**, 140 (1998).
- [98] G. I. Taylor, *Instability of jets, threads, and sheets of viscous fluid*, Proc. Intl. Congr. Appl. Mech. Springer .
- [99] J. O. Cruickshank, *Low-Reynolds-Number Instabilities in Stagnating Jet Flows*, Journal of Fluid Mechanics **193**, 111 (1988), P9028 Times Cited:34 Cited References Count:11.
- [100] J. D. Buckmaster, *New Large Damköhler Number Theory of Fuel Droplet Burning*, Combustion and Flame **24**, 79 (1975), V7275 Times Cited:8 Cited References Count:4.
- [101] R. W. S. Mahadevan, L. and A. D. T. Samuel, *Correction: Fluid ‘rope trick’ investigated*, Nature **403**, 502 (2000).
- [102] N. M. Ribe, Proc. R. Soc. Lond. **460**, 3223 (2004).
- [103] H. H. E. H. M. A. H. M. Ribe, N. M. and D. Bonn, *Multiple coexisting states of liquid rope coiling*, Journal of Fluid Mechanics **555**, 275 (2006).
- [104] L. D. Landau and E. M. Lifshitz, *Theory of Elasticity*, Pergamon Press, Oxford, 1959.
- [105] E. Sultan and A. Boudaoud, Phys. Rev. Lett. **96** (2006).
- [106] B. D. L. and A. Kudrolli, Phys. Rev. Lett. **94** (2005).
- [107] G. M. A. F. Donato, C. C. and R. E. de Souza, Phys. Rev. E **67** (2003).
- [108] A. Goriely and M. Tabor, Nonlinear Dyn. **21**, 101 (2000).
- [109] J. Coyne, IEE J. Oceanic Eng. **15**, 72 (1990).
- [110] A. Goriely and M. Tabor, Phys. Rev. Lett. **80**, 1564 (1998).
- [111] K. C. R. Balaeff, A. and L. Mahadevan, Proc. R. Soc. Lond. A **362**, 1355 (2004).
- [112] M. Habibi, *Coiling Instability in Liquid and Solid Ropes*, Ph.D. thesis, Université Paris 6- Pierre et Marie Curie, Paris, 2007.
- [113] L. Mahadevan and J. B. Keller, SIAM J. App. Math. **55**, 1609 (1995).
- [114] R. S. M. M. A. J. Moller, P. C. F. and D. Bonn, Phys. Rev. E **77** (2009).
- [115] D. Bonn and M. M. Denn, Science **324** (2009).

- [116] A. R. C. Bird, R. B. and O. Hassager, *Dynamics of polymeric liquids*, John Wiley & Sons, 1987.
- [117] H. M. G. R. R. N. M. Maleki, M. and D. Bonn, *Liquid rope coiling on a solid surface*, Physical Review Letters **93** (2004).
- [118] H. M. Ribe, N. M. and D. Bonn, *Stability of liquid rope coiling*, Physics of Fluids **18** (2006), 080HB Times Cited:17 Cited References Count:23.
- [119] M. M. G. R. R. N. M. Habibi, M. and D. Bonn, *Dynamics of liquid rope coiling*, Physical Review E **74** (2006), Part 2 121OC Times Cited:6 Cited References Count:17.