9-17-2012

Regular and Irregular Splashing of Drops on Geometric Targets

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Juarez, G., Gastopoulos, T., Zhang, Y., Siegel, M. L., & Arratia, P. (2012). Regular and irregular splashing of drops on geometric targets. *Physics of Fluids, 24*(9), 091105. doi: 10.1063/1.4747159

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Abstract
The effect of target cross-sectional geometry on drop splashing is investigated using surfaces with length scales comparable to the drop diameter. The target cross-sectional geometries are regular polygon shapes that vary from a triangle ($n = 3$) to a decagon ($n = 10$), where n is the number vertices. The impacting cross-sectional surface area of all targets is constrained to equal the cross-sectional area of the impacting drop which is 6.38 mm^2.

Disciplines
Mechanical Engineering

Comments
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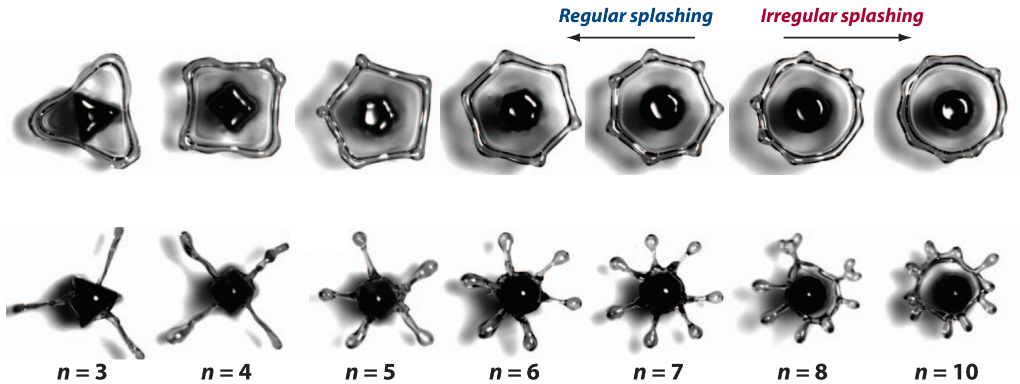

FIG. 1. Example snapshots, as seen from above, of the formation and subsequent breakup of liquid lamella into filaments. As the target cross section is varied from a triangle ($n = 3$) up to a decagon ($n = 10$), where n is the number of vertices, a transition from regular ($3 \leq n < 8$) to irregular ($n \geq 8$) splashing occurs. (Top row) At maximum expansion, for $3 \leq n < 8$, geometrically shaped lamella that are azimuthally rotated by π/n with respect to the target orientation are observed. For $n \geq 8$, the lamella shapes are independent of target cross section. (Bottom row) The breakup of lamella into filaments is controlled for $3 \leq n < 8$, as the number and location of filaments is equal to n and are spaced apart by π/n, respectively. Lamella breakup for $n \geq 8$, however, is irregular and independent of target cross section.

Regular and irregular splashing of drops on geometric targets

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(Received 3 August 2012; published online 17 September 2012)
[http://dx.doi.org/10.1063/1.4747159]

The effect of target cross-sectional geometry on drop splashing is investigated using surfaces with length scales comparable to the drop diameter. The target cross-sectional geometries are regular polygon shapes that vary from a triangle ($n = 3$) to a decagon ($n = 10$), where n is the number vertices. The impacting cross-sectional surface area of all targets is constrained to equal the cross-sectional area of the impacting drop which is 6.38 mm^2.

In our experiments, liquid drops with a diameter D of 2.85 mm fall from a height of 15 cm before colliding with the target surfaces. Drops impact the targets with a measured velocity U of 1.56 m/s. The liquid drops are a mixture of de-ionized water and glycerol and have a viscosity μ of 10 cP and a surface tension γ of 35.3 dyn/cm. The resulting Reynolds number ($\mathrm{Re} = \rho DU/\mu$) is 550 and the Weber number ($\mathrm{We} = \rho DU^2/\gamma$) is 250. Images from above the targets are recorded using high-speed photography at 40 000 frames per second.

Figure 1 shows example snapshots from the top view of drops colliding with different geometric targets. As the target cross-sectional geometry is varied, we observe a transition from regular ($3 \leq n < 8$) to irregular ($n \geq 8$) splashing. The top row of Fig. 1 shows liquid lamella moments after impact as the outer rim reaches its maximum value during radial expansion. For $3 \leq n < 8$,

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the observed lamella shapes are identical to the geometric target but are azimuthally rotated by π/n with respect to the target vertices. This is due to the azimuthal variation of viscous dissipation along the target surface. For $n \geq 8$, the lamella do not resemble geometric shapes and are independent of target cross section. The bottom row of Fig. 1 shows the subsequent breakup of liquid lamella into secondary filaments. For $3 \leq n < 8$, the geometrically shaped lamella undergo a regular breakup into n filaments that are azimuthally spaced apart by π/n. For $n \geq 8$, however, the lamella undergo an irregular breakup as the number and location of filaments is governed by the most unstable Plateau-Rayleigh mode rather than the target geometry.[1]

This work was supported by the National Science Foundation through the award CBET-0932449.

[1] G. Juarez *et al.*, "Splash control of drop impacts with geometric targets," Phys. Rev. E **85**, 026319 (2012).