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Surface wave amplification of a falling liquid film by a perforation

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Falling liquid films are utilized in many technological systems to intensify mass and heat transfers. These systems usually involve thin liquid films flowing over complex surfaces with topographical features such as corrugations and perforations. The present study focuses on a falling liquid film flowing over a single circular perforation and the possibility of liquid surface wave amplification by the perforation for enhanced heat and mass transfer across the liquid-vapor interface. For the purpose, a vertical flat sheet with the perforation is solely supplied with liquid on its front. The behavior of the waves traveling on the surface of the falling film is examined when the film free surface is periodically forced at the inlet. We observe that for specific frequencies, the waves are more amplified when crossing the perforation. This amplification is related to the excitation and the resonance of sinuous waves traveling on the liquid curtain that closes the perforation. Further, the frequency spacing between resonance peaks scales as the inverse of the perforation diameter. Last, the resonance frequencies shift to higher values when the perforation diameter is increased.

Auteurs: Dr SATHYANATH, Rahul (Postdoctoral researcher, LGPM, CentraleSupélec); Dr DUVAL, Hervé (Professor, LGPM, CentraleSupélec, Université Paris-Saclay)

Co-auteurs: Dr RAMAMONJY, Aina (PRONOE, Station F, 5 Parv. Alan Turing, Paris); M. CASALINHO, Joel (LGPM, CentraleSupélec, Université Paris-Saclay)

Orateur: Dr SATHYANATH, Rahul (Postdoctoral researcher, LGPM, CentraleSupélec)

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