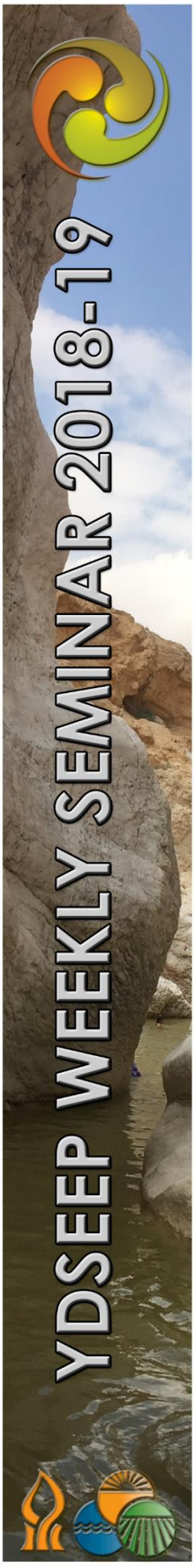

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Ratchet flows in forced liquid films

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Abstract:

A possibility of saturating Rayleigh-Taylor instability in a thin liquid film on the underside of a substrate in the gravity field by harmonic vibration of the substrate was recently investigated [E. Sterman-Cohen, M. Bestehorn, and A. Oron, Phys. Fluids 29, 052105 (2017); Erratum, Phys. Fluids 29, 109901 (2017)]. In the present work, we investigate the feasibility of creating a directional flow of the fluid in a film in the Rayleigh-Taylor configuration and controlling its flow rate by applying a two-frequency tangential forcing to the substrate. It is shown that in this situation, a ratchet flow develops, and the dependence of its flow rate on the vibration frequency, amplitude, its periodicity, and asymmetry level is investigated for water and silicone-oil films. A cause for the emergence of symmetry-breaking and an ensuing flow in a preferred direction is discussed. Some aspects of a ratchet flow in a liquid film placed on top of the substrate are discussed as well. A comparison with the case of a neglected fluid inertia is made, and the differences are elucidated.

A different mode for the emergence of ratchet flow in a liquid film under two-frequency excitation is found, this time it is typical for left-right symmetric excitations. A crucial importance of interaction between capillarity, gravity and forcing is discussed. It is found that in the long-time limit, the averaged flow rate along the system tends to a constant value under asymmetric forcing whereas under symmetric excitation, the flow rate remains pulsating.

Date & Location:

Tuesday, May 21st, 2019, 11:00
Lecture room, Physics Building (ground floor)