Abstract Submitted
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Temporal linear stability analysis of laminar flames on inclined fuel surfaces[1] RAQUEL HAKES, University of Maryland, WILFRIED COENEN, ANTONIO SANCHEZ, University of California, San Diego, MICHAEL GOLLNER, University of Maryland, FORMAN WILLIAMS, University of California, San Diego — Experiments have found substantial structural differences between buoyancy-driven flames developing on the upper and lower surfaces of inclined burning plates. These differences cannot be explained with existing analytical solutions of steady semi-infinite flames, which provide identical descriptions for the top and bottom configurations. We perform a temporal linear stability analysis to investigate the potential role of flame instabilities in the experimentally observed flow differences. The problem is formulated in the limit of infinitely fast reaction, considering the non-unity Lewis number of the fuel vapor. The analysis incorporates nonparallel effects of the base flow and considers separately spanwise traveling waves and Görtler-like streamwise vortices. The solution to the stability problem determines the downstream location at which the flow becomes unstable, characterized by a critical value of the local Grashof number, which varies with the plate inclination angle. The results for the underside flame indicate that instabilities emerge further downstream than they do for a topside, in agreement with experimental observations. Increased baroclinic vorticity production is reasoned to be responsible for the augmented instability tendency of topside flames.

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