



Regimes of flame behavior during thermoacoustic instabilities in non-adiabatic slender channels

Gatón-Pérez P.^{1*}, Jiménez C.², Martínez-Ruiz D.¹ and Kurdyumov V.N.²

*Lead presenter: pedro.gaton.perez@upm.es

¹ ETSIAE, Universidad Politécnica de Madrid, Madrid 28040, Spain

² Energy Department, CIEMAT, Madrid 28040, Spain

Thermoacoustic instabilities of premixed flames propagating from the open to the closed end of a channel with adiabatic walls can be reproduced numerically [1], with oscillating frequencies that are well predicted by the 1D acoustic eigenvalues of a system with sound-propagating properties corresponding to those of the burnt and fresh gas regions separated by the flame [2]. In the present work, a set of 2D numerical simulations of flames in non-adiabatic channels is employed to explore and validate the theoretical extension for the modulation of these acoustic frequencies subject to conductive heat losses proposed in [3], where the flame is considered as a planar acoustically passive surface.

Furthermore, the numerical results serve to explore the modeling of two-dimensional acoustics variations and non-isothermal eigenfunctions that induce vorticity at the flame front, enhancing the surface production and corrugation of the reactive front. In turn, this study is instrumental to provide a causality study in the origin and transition of such instabilities, supplemented with experimental results for stoichiometric methane-air flames that remain adequate to model the behavior of nearly equidiffusional flames propagating in slender channels.

References

- [1] Carmen Jiménez, Daniel Fernández-Galisteo, and Vadim N. Kurdyumov. Flame-acoustics interaction for symmetric and non-symmetric flames propagating in a narrow duct from an open to a closed end. *Combustion and Flame*, 225:499–512, 2021.
- [2] Paul Clavin, Pierre Pelcé, and Longting He. One-dimensional vibratory instability of planar flames propagating in tubes. *Journal of Fluid Mechanics*, 216:299–322, 1990.
- [3] Enrique Flores-Montoya, Victor Muntean, Mario Sánchez-Sanz, and Daniel Martínez-Ruiz. Non-adiabatic modulation of premixed-flame thermoacoustic frequencies in slender tubes. *Journal of Fluid Mechanics*, 933:A50, 2022.