# Ignition by a Concentrated Heat Source Near a Cold Wall Using a Chain-Branching Kinetics Model

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This work investigates ignition by a point heat source in hydrogen-air mixtures using the two-step chain-branching model proposed in [ 1 ] and [ 2 ]. The study begins with a one-dimensional spherically symmetric formulation corresponding to ignition from an isolated source point in infinite space, and considers instantaneous energy deposition and also the case when the release of energy occurs in a finite time $\Delta t$. The model captures the coupled interplay of heat and species transport with reactive dynamics, enabling the determination of critical ignition thresholds and the influence of key dimensionless parameters such as the Lewis number $(Le_F, Le_Z)$ and the heat release factor $(q)$ on ignition sustainability or extinction.

In order to study ignition when the source is located near a cold wall, the model is extended to a two-dimensional axisymmetric configuration using polar coordinates. The latter configuration is essentially ignition from a thermal dipole [ 3 ]. The goal is to evaluate whether the ignition criteria and flame behavior established in the 1D case remain valid or are altered in more realistic multidimensional scenarios with heat losses, thus offering a more complete understanding of early flame development under confined or anisotropic conditions.

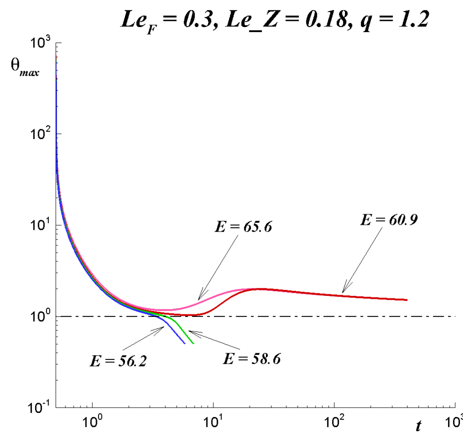


Figure 1: The maximum dimensionless temperature of the 1D problem, $\theta_{\max}$, as a function of time for successful and unsuccessful ignitions with varying the energy $E$ and $\Delta t = 0.5$ for $q = 1.2$.

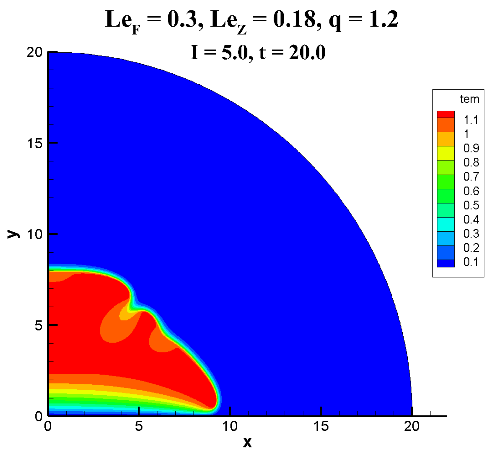


Figure 2: The spatial temperature distribution of the 2D problem for $t = 20.0$ and dipole intensity, $I = 5.0$ during ignition near a cold wall with $\Delta t = 0.1$.

## References

[1] Ya. B. Zeldovich and G. I. Barenblatt. Combustion and Flame, vol. 3, pp. 61–74, 1959.

[2] J. W. Dold, R. W. Thatcher, A. Omon-Arancibia, and J. Redman. Proceedings of the Combustion Institute, vol. 29, pp. 1519–1526, 2002.

[3] V. N. Kurdyumov, C. Jiménez, M. Sánchez-Sanz. Combustion and Flame, vol. 234, 111643, 2021.