Effect of gravity on premixed flame dynamics - Mathematical Approach -

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Combustion is the oldest technology for energy generations in human history. Although renewable energy is getting one of the mainstream of energy generations, combustion research still occupies an important position for balancing energy resources and improving energy efficiency. We believe that development of new technology through combustion process relies on deep understandings of contributions of each physical or chemical factor to flame dynamics, while the understanding is still limited due to the complexity of the whole process.

Keeping this in mind, we study the effect of gravity on dynamics of perturbed planar flames to understand flame morphology from the mathematical viewpoint. Our study is based on *the hydrodynamic model* developed in [1], which reduces the whole combustion process to the free-boundary problem of (imcompressible) Navier-Stokes equation whose free-boundary is expressed by the density discontinuity among combustible and burnt gases, equivalently the flame front. One of key issues to understand flame dynamics involving energy generation in combustion process is the *flame propagation speed* U for asymptotically stationary flame fronts depending on thermal expansion σ, a physico-chemical parameter called *Markstein number* $\mathcal{M}$ and gravity parameter G. We describe the relationship among them on *bifurcation diagrams*, which visualize information of solution structures in given systems depending on parameters. Through another mathematically simplified model (e.g. [2]), we clarify the intrinsic nature of bifurcations [3] and discuss the interpretation of present results.

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References

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