Research Plan

10th, January, 2023

「Formula of propagation velocity of curved flame fronts in low-Mach-number model」

The study mentioned above treats a planar flame front. In order to consider more realistic case, we derive the formula of propagation velocity of curved flame fronts in low-Mach-number model. To this end, we pursue the multiscale analysis of a flame front by introducing a preheat zone on the unburned side of the front[P.Pelce,P.Clavin(1982),P.Clavin,F.A. Williams(1982),M.Matalon,B.J.Matkowsky(1982)]. Thanks to this analysis, it is possible to consider the influence of pressure and viscous dissipation terms as well as that of convection and diffusion terms in the heat-conduction equation. As the boundary conditions inside the preheat zone, we employ those obtained by extend results obtained in the study of reaction and compression zones to the weakly non-linear case. It is expected to obtain the formula of flame propagation velocity incorporating the effect of viscosity and non-adiabaticity of temperature accompanied with the traditional curvature, or stretch, effect [G.H.Markstein(1951),W.Eckhaus(1961),M.Matalon,C.Cui,J.K.Bechtold(2003)]. Besides, we reveal the suppression effect of vorticity production on the hydrodynamic instability, or the Darrieus-Landau instability.

「Weakly non-linear equation for a flame front in low-Mach-number model」

We reveal the particular scale factor which characterizes both hydrodynamic and thermal-diffusive instabilities of a flame front. Then, applying the method of singular perturbations, under the obtained scale factor, to the governing equations in low-Mach-number model, we derive the weakly non-linear equation describing the dynamics of density-discontinuous front in the compressible fluid.

「Group action influenced by positive or negative information based on hydrodynamic model」

We investigate how the group behavior is influenced by the positive or negative information. Based on the hydrodynamic model, we incorporate the effect of information emitted by some point, whose scale must be considered adequately, into the equation of momentum. The information wave is considered to conduct in a similar to the behavior of heat. The velocity field of group is affected by the strength and frequency of information wave. By coupling the hydrodynamic model with the real data, the coefficients of conductivity and diffusivity would be estimated properly so that the model fits the real-time behavior of the group in the particular place.