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## A STABLE SHARP INTERFACE LOW-MACH SCHEME FOR TWO-PHASE DILATABLE FLOWS

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Two-phase non-miscible flows with phase transition are often encountered in a wide range of industrial processes such as cooling and heat exchangers, an accurate and stable numerical solver is then necessary to predict the behavior of fluids. Flows of interest contain one liquid phase and one gas phase separated by an interface. The interface is of shock wave type discontinuity without mixture and remains sharp. The retained method to predict the interface motion is the Level-Set method [1].

Although in the liquid phase the Mach number is generally very low, each phase of the two-phase flow is described by a compressible solver called all regime Lagrange-Projection like numerical scheme. The main object is to deal with dilatable flows mainly in the gas phase and the key idea is to decouple the acoustic and transport phenomenon and then alter the numerical flux in the acoustic approximation to obtain a uniform truncation error in terms of Mach number [2]. According to the acoustic subsystem, an approximate Riemann solution that accounts for the capillary effects and phase transition is considered. The surface tension is treated as a pressure jump condition at interface with a well-balanced scheme, while the mass transfer is treated as the normal velocity jump across the interface. Based on net energy transfer across the interface, we can derive the mass transfer rate and determine the velocity jump [3]. To avoid mixing cell and remain interface sharp, the Ghost Fluid strategy [4] is applied for the coupling at interface.

When the fluid motion velocity is small compared to the sound speed, the low-Mach correction is necessary to keep the accuracy of a Godunov type Riemann solver. The ratio of pressure perturbation magnitude between two different phases could be extremely high, as the fluid property could vary a lot across the sharp interface. Classical low-Mach schemes [5][6] suffer from some problems of destabilization with the presence of high density and sound speed ratio across the interface. In this work, we propose a new stable low-Mach correction that takes density ratio into account and gives a stable prediction with suitable CFL condition. Numerical results on classical test-cases will be given at the conference and show the capability and efficiency of the proposed new approach.

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### REFERENCES

- [1] Osher, S. and Sethian, J. A. (1988). *Journal of computational physics*, 79(1):12–49.
- [2] Chalons, C., et al (2016). *Communications in Computational Physics*, 20(1):188–233.
- [3] Kharangate, C. R., and Mudawar, I. (2017). *INT J HEAT MASS TRAN*, 108, 1164-1196.
- [4] Fedkiw, R. P., et al (1999). *Journal of computational physics*, 152(2), 457-492.
- [5] Peluchon, S., et al (2017). *Journal of Computational Physics*, 339, 328-355.
- [6] Chalons, C., et al (2017). *Journal of Computational Physics*, 335, 885-904.