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A Projected Ghost Fluid Method for a mimetic approach for extreme contrast interfaces in multiphase flows

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Inspired by the Mimetic Finite Difference Method (MFD) [1], and the pioneering works of Verstappen and Veldman [2], an analysis of the Ghost Fluid Method (GFM) is performed. In particular, the research question whether or not is is possible to preserve flow properties in a sharp method for multiphase flow is intended to be answered.

In the context of a multimaterial domain, the Ghost Fluid Method (GFM)[3] for the Laplacian operator is reformulated from an algebraic perspective, where operators are represented by matrices. From this perspective, a whole new level of analysis can be attained. Namely, conceiving mass, heat and momentum transfer applications, the conservation of global properties will be discussed in detail, with particular emphasis on extreme contrast interfaces, such as those arising in liquid-vapor mixtures.

Despite being a sharp method, the GFM can indeed preserve the duality between divergence a gradient even when the field presents a value jump. This results in the ability to capture the exchange between kinetic and surface potential energy, among others. Its accuracy, however, is limited by the interface reconstruction scheme used.

Regarding flow discontinuities, the GFM is shown to result in an off-kernel linear system of equations for the Poisson problem. In order to fix this issue, the Projected Ghost Fluid Method (PGFM) takes a global approach to the discretization strategy in order to correct the regular GFM and thus guarantee a consistent discretization.

In addition to being mathematically neat and result in a compatible linear system of equations, the PGFM shows an extraordinary robustness in dealing with extreme contrast interfaces. A comparison study will be presented for several coefficient ratios.

REFERENCES

[1] Konstantin Lipnikov, Gianmarco Manzini, and Mikhail Shashkov. Mimetic finite difference method. *Journal of Computational Physics*, 257(PB):1163–1227, 2014.

[2] R. W C P Verstappen and A. E P Veldman. Symmetry-preserving discretization of turbulent flow. *Journal of Computational Physics*, 187(1):343–368, 2003.

[3] Xu-Dong Liu, Ronald P. Fedkiw, and Myungjoo Kang. A Boundary Condition Capturing Method for Poisson's Equation on Irregular Domains. *Journal of Computational Physics*, 160(1):151–178, 2000.