ABSTRACT

Direct Numerical Simulation of Rotating Bodies in Stable-stratification using Moving Nonconforming Schwarz-Spectral Element Method

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Vortex shedding and the related added-mass effect's impact on drag and lift felt by rotating spherical and ellipsoidal bodies moving in flows at moderate Reynold's numbers has been recently quantified using a novel moving nonconforming Schwarz-spectral element method [1,4]. In the current study we extend this method to the problem of rotating bodies in stably-stratified flows. Existing research of stratified-flow interaction with bluff bodies have focused on non-moving or periodically oscillating bodies [2]. Though the importance of movement of bodies and the consequent added-mass, on generation of internal gravity waves is well known. In the current study, we quantify the effect of rotation in spherical and ellipsoidal bodies within stratified flows. For the study, we conduct DNS for a range of Reynolds numbers (100-300) and Richardson numbers (Ri), for constant rotation speed. Simulations were conducted using the Nek5000, and compared against the unstratified cases obtained by Mittal et al. [4].

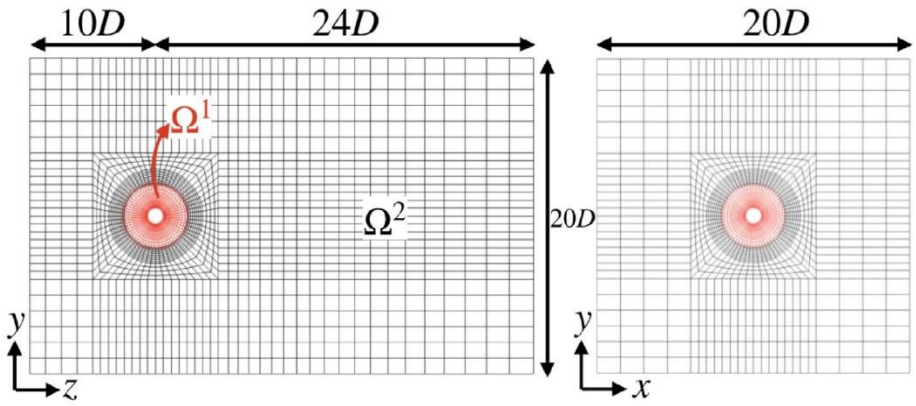

Figure 1: Domain decomposition of the rotating sphere case [4].

[1] Mittal, K., Dutta, S., & Fischer, P. (2019). Nonconforming Schwarz-spectral element methods for incompressible flow. Computers & Fluids, 191, 104237.
[2] Ortiz-Tarin, J. L., Chongsiripinyo, K. C., & Sarkar, S. (2019). Stratified flow past a prolate spheroid. Physical Review Fluids, 4(9), 094803.
[3] https://nek5000.mcs.anl.gov/
[4] Mittal, K., Dutta, S., & Fischer, P. (2020). Direct numerical simulation of rotating ellipsoidal particles using moving nonconforming Schwarz-spectral element method. Computers & Fluids, 205, 104556.