Construction of LES model for high Mach number multiphase flow based on DNS analysis

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Abstract

In order to construct LES model for high Mach number multi-phase turbulent flow, direct numerical simulation (DNS) of high Mach number and low Reynolds number flow around a particle will be carried out and construction of its data base and examination of the flow phenomena will be conducted.

Reasons for using JSS2

In this project, direct numerical simulation (DNS) of high Mach number and low Reynolds number flow around a particle and construction of the data base will be carried out using a boundary-fitted coordinate system. Large scale numerical simulation is essential to construct the data base.

Achievements of the Year

The compressibility effect on vortex shedding and lift forces by rotation were investigated by performing DNS of the flow over a rotating sphere. In addition, the flow regime and other basic flow properties of a stationaly sphere in ransonic flows up to a Reynolds number of 1,000 were examined by DNS.

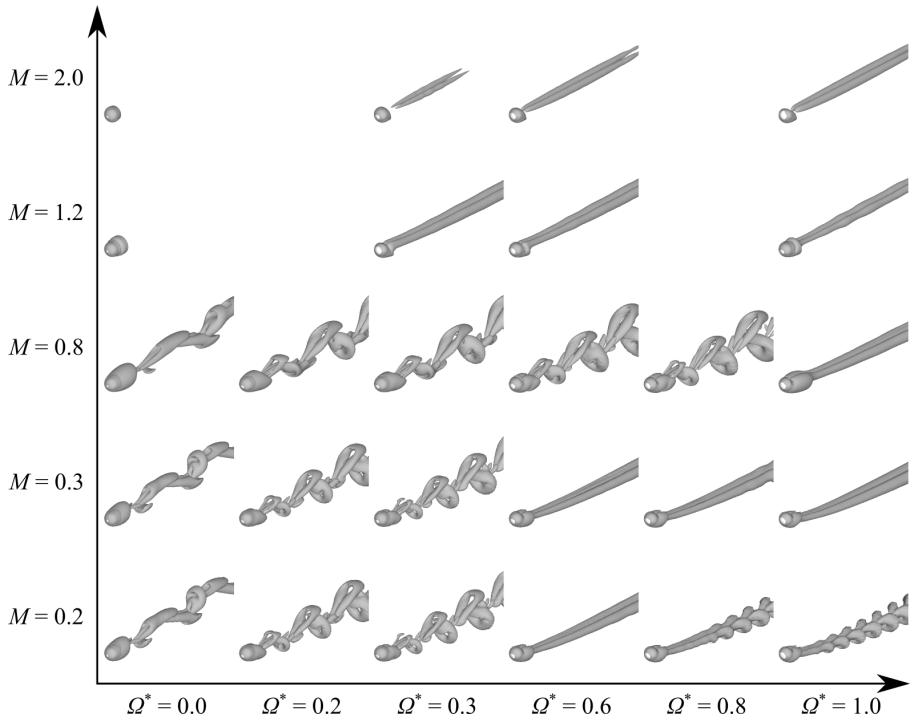

Fig. 1: Mach number and non-dimensional rotation rate effects on the wake sructure of rotating sphere

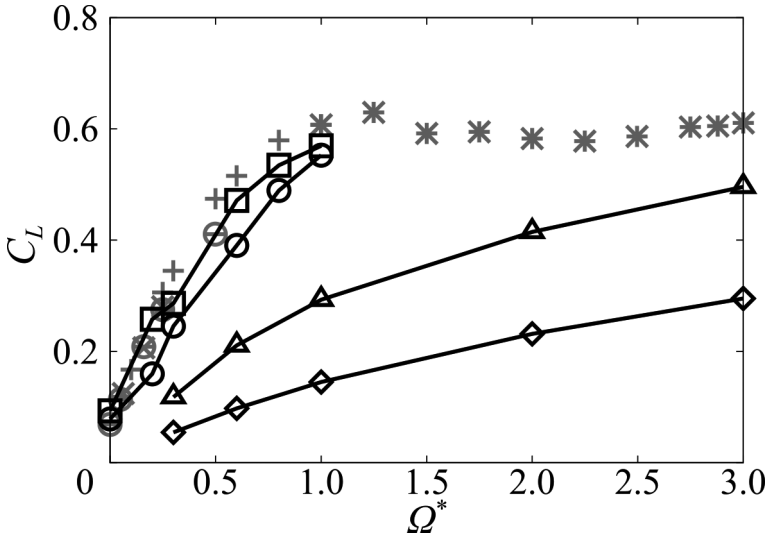

Fig. 2: Time-averaged lift coefficient of the rotating sphere

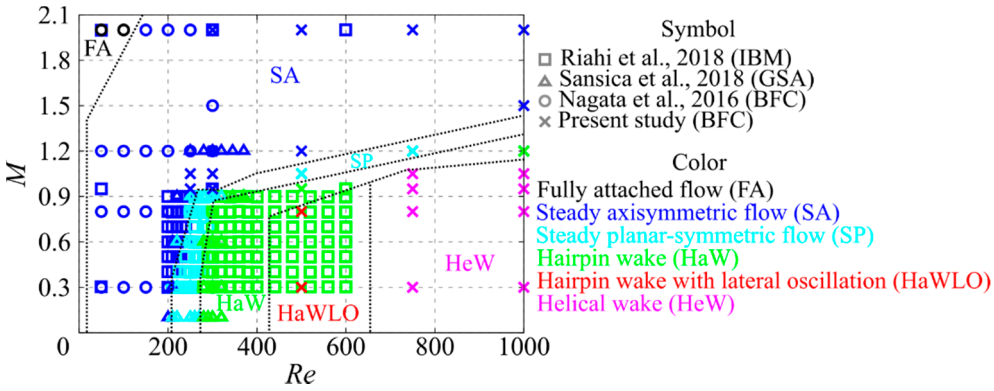

Fig. 3: The map of flow regime of stationaly sphere at the compressible low-Reynolds number flow

Publications

- Peer-reviewed papers

Nagata, T., Nonomura, T., Takahashi, S., Mizuno, Y., and Fukuda, K., "Direct Numerical Simulation of Flow past a Transversely Rotating Sphere up to a Reynolds Number of 300 in Compressible Flow," Journal of Fluid Mechanics, Vol. 857, December, 2018, pp. 878-906.

- Oral Presentations

Nagata, T., Nonomura, T., Yoshida, M., Takahashi, S., and Fukuda, K., "Analysis of aerodynamic coefficient and wake of a small particle in compressible flow at particle Reynolds number 50-1000 using DNS database," 32nd Symposium on Computational Fluid Dynamics, Tokyo, December, 2018.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	16 - 289
Elapsed Time per Case	100 Hour (s)

Resources Used

Fraction of Usage in Total Resources[*1] (%): 0.34

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	3,044,531.35	0.37
SORA-PP	0.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	37.59	0.04
/data	19,647.94	0.35
/ltmp	2,068.02	0.18

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	16.35	0.57

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage: Percentage of usage relative to each resource used in one year.