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 and benefits of using JAXA Supercomputer System

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

In this study, the transonic flow over an isolated sphere up to a Reynolds number of 1,000 was investigated by the direct numerical simulation (DNS) of the three-dimensional compressible Navire-Stokes equations. The Mach number effects on the types of flow patterns, the flow geometry, and the drag coefficient were investigated. As a result, we confirmed that (1) the wake is significantly stabilized at the transonic regime; (2) the increment of the drag coefficient in the continuum regime due to the Mach number effect can be characterized with regardless of the Reynolds number even though low-Reynolds number conditions, (3) and the increment of the pressure and viscous drag coefficients are predictable by Prandtl-Glauert transform and the movement of the position of the separation point, respectively, up to a Mach number of approximately 0.8.

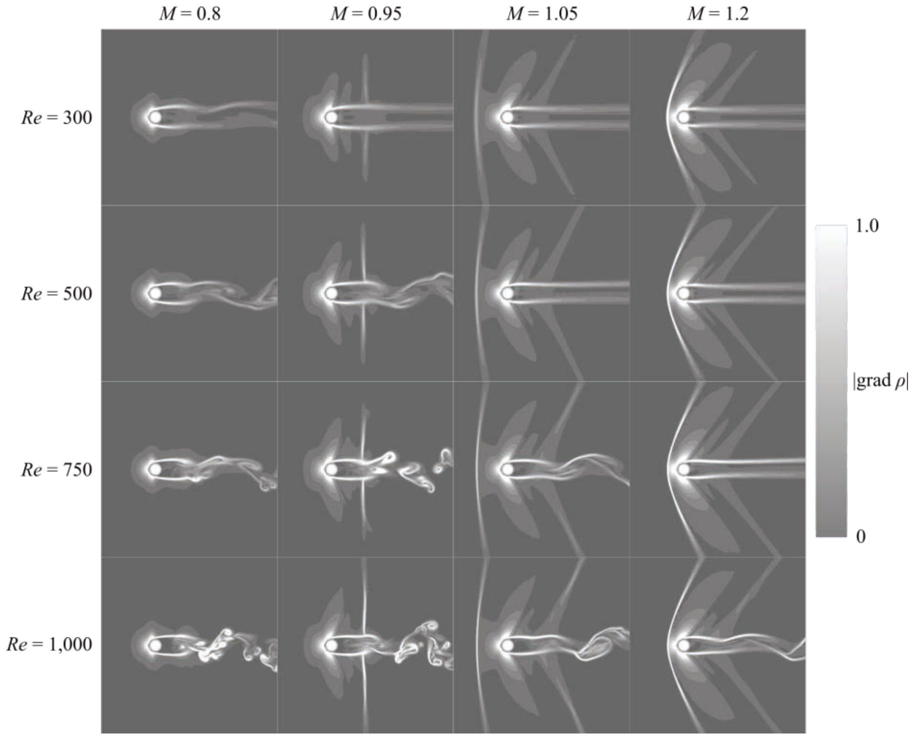

Fig. 1: Mach number and Reynolds number effects on the wake sructure of a stationaly isolated sphere (distribution of the absolute value of the density).

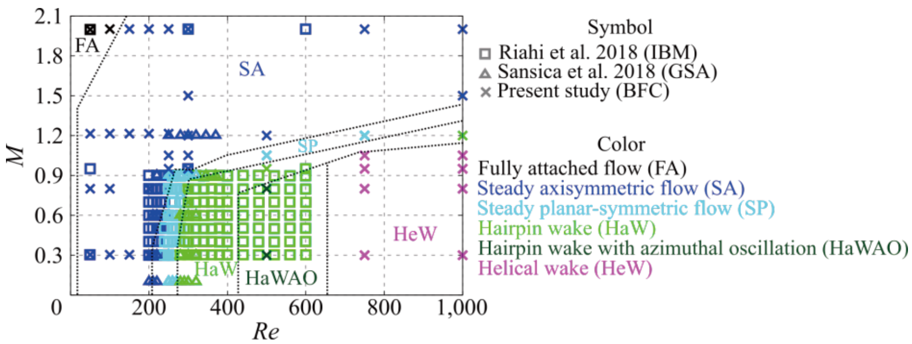

Fig. 2: Relationship between the separation point and the total drag coefficient

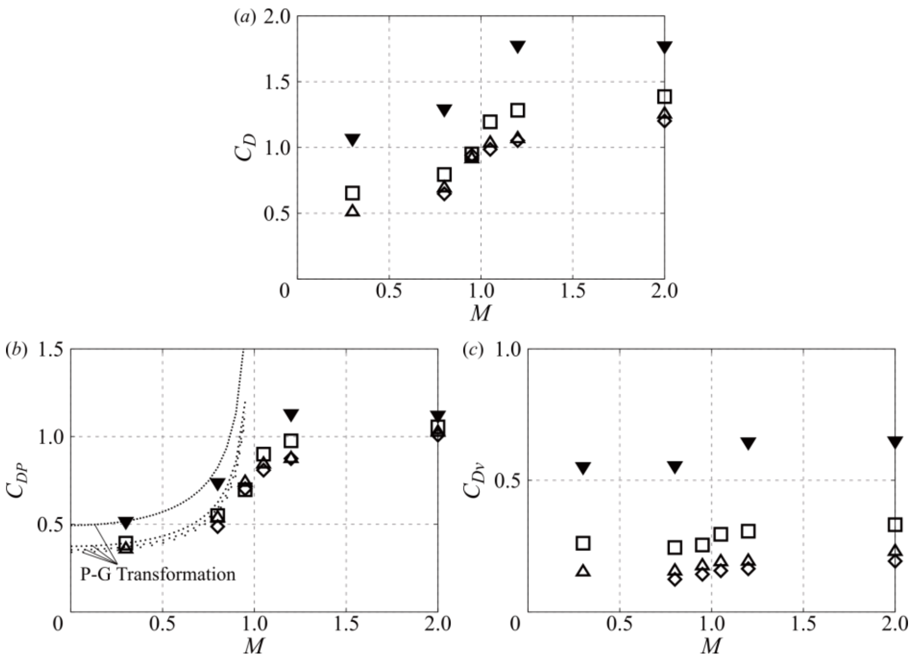

Fig. 3: The map of flow regime of stationaly sphere at the compressible low-Reynolds number flow.

Publications

- Oral Presentations

Nagata, T., Nonomura, T., Takahashi, S., and Fukuda, K., "onsideration of Mach and Reynolds numbers effect on flow field and drag coefficient of a particle in transonic flow at Reynolds number between 300 and 1000," Proceedings of the 51st Fluid Dynamics Conference / the 37th Aerospace Numerical Simulation Symposium, 1E08, Tokyo, July (2019)

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	16 - 289
Elapsed Time per Case	200 Hour(s)

- **Resources Used**

Fraction of Usage in Total Resources*1(%): 0.29

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
SORA-MA	2,523,635.64	0.31
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	42.35	0.04
/data	24,530.76	0.42
/ltmp	3,044.58	0.26

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	18.89	0.48

*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.