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ON THE UNSTEADY VORTEX SHEDDING BEHIND A CYLINDER

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KEY WORDS

Direct Simulation Monte Carlo (DSMC), Vortex shedding, Simplified Bernoulli Trials on transient adaptive subcells (SBT-TAS), Nearest Neighbor (NN).

ABSTRACT

In this work, the accuracy of a newly suggested collision scheme in the DSMC method, Simplified Bernoulli Trials [1] over transient adaptive subcells, SBT-TAS, for prediction of vortex shedding of a rarefied flow past a cylinder is calculated. Results of SBT-TAS are compared with the SBT on uniform grid, and conventional/sophisticated collision models, e.g. no time counter (NTC) and the nearest neighbor (NN) with respect to their accuracy on predicting vortex formation and shedding frequency behind a two-dimensional cylinder in subsonic flow (Mach 0.6) regime [2]. The Knudsen number based on free-stream conditions was 0.00833, the flow and cylinder surface temperature was kept at 300 K and flow Reynolds number was 80. In this condition, the SBT and NTC collisions schemes on the same grid and with the same number of particles per cell (PPC) predicts the vortex behind the cylinder quite weak and the structure of vortices are quite smeared out. On the other hand, the SBT-TAS and NN collisions schemes predicted the strength of the vortices and their oscillation with the same level of accuracy, see Fig. 1. Our results demonstrated that SBT-TAS provided the most accurate solution for vortex structures if subcells are adapted to particle per subcell PPSC=3. Decreasing the PPC further resulted in a decrease in the SOF, which is the ratio of the mean free path to lambda.

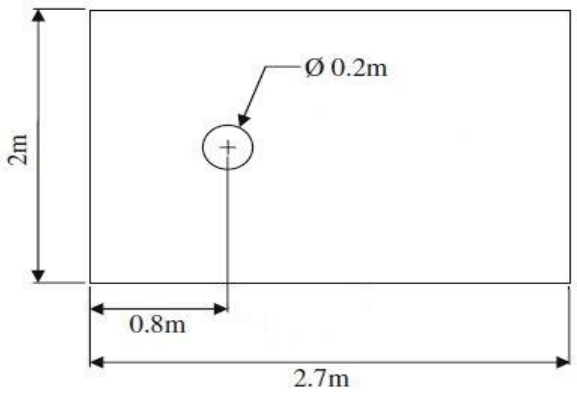

Fig. 1. Geometry of cylinder considered for simulation of unsteady vortex

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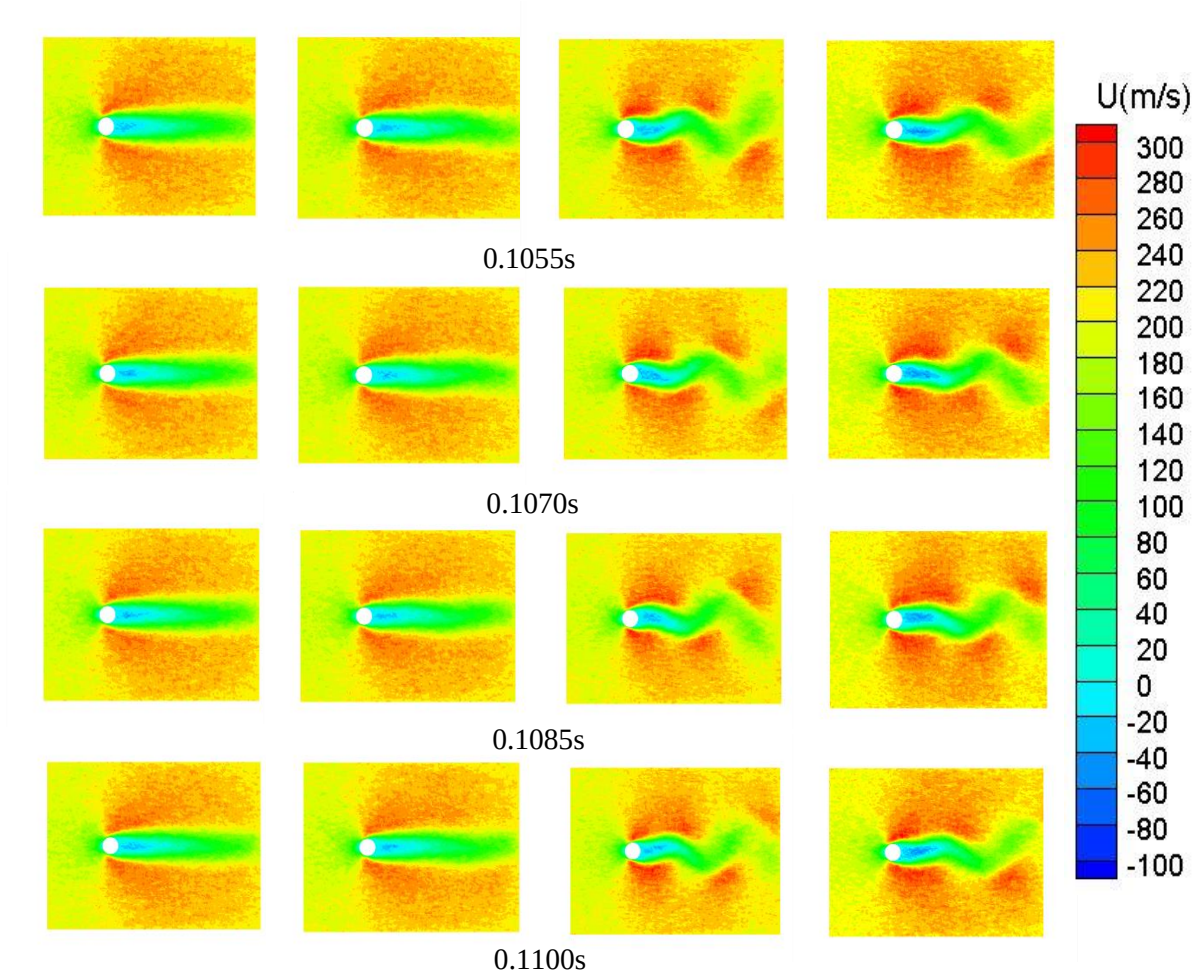

Figure 2: Contours of stream-wise velocity (m/s) at different times for the vortex shedding behind a cylinder with 4×10^6 total initial number of particles and division size equal to 200×150 cell for NTC, SBT, NN and SBT-TAS (PPSC=3) collision schemes respectively from left to right.

Table 1: Comparison of the SOF (MCS/λ) value between all DSMC collision schemes.

scheme	Divisions size	Total initial number of particles	Initial PPC	SOF (MCS/λ)	PPSC adaptation in TAS
NN	200×150	4×10^6	32	0.43	-
SBT-TAS				**0.24**	1
SBT-TAS				0.47	2
SBT-TAS				0.66	3
NTC				2.08	-
SBT				2.08	-

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