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Author: Dr. Haiwei Yang
Harbin Engineering University, China, ningyumelemon@gmail.com

Mr. Yang Tianyang
Moscow Aviation Institute (National Research University, MAI), Russian Federation,
orange.tianyang@gmail.com
Prof. Ge Wang
Harbin Engineering University, China, wangge@hrbeu.edu.cn
Dr. Ben Guan
Harbin Engineering University, China, guanben@hrbeu.edu.cn

# SIMULATION OF RAREFIED HYPERSONIC FLOWS BY USING THE DIRECT SIMULATION MONTE CARLO METHOD

**Abstract**

When studying the problems of aerothermodynamics for hypersonic flight vehicles under high-speed flight conditions, physical processes such as internal energy excitation and chemical reaction of gas molecules in rarefied hypersonic flows should be considered. This process usually occurs in a non-equilibrium state. Since the Navier-Stokes equation is no longer efficient for simulating the rarefied hypersonic flows in the transition zone and the free molecular region ,the direct simulation Monte Carlo method can be applied in this condition. In this paper, the direct simulation Monte Carlo method is used to simulate the flow field around a blunt body and wedge hypersonic flight vehicle passing through the rarefied gas. The quantum kinetic method is used to simulate the chemical reaction in the rarefied gas flow field. Moreover, the variable soft sphere collision model and the Stockmayer potential function are used to simulate the collision pairs of particles and to determine the attractive and repulsive force of the pairs in the rarefied hypersonic flows. The influence of vibration-dissociation coupling model on the results of the numerical simulation has been studied in this paper as well. Through the calculation, the distribution of the translational temperature, rotational temperature, vibrational temperature, gases' component concentration in the stagnation line, characteristic parameters such as heat flux and pressure coefficient, friction coefficient on the surface which are fully determining the thermophysical states of such flow field for a hypersonic flight vehicle are obtained. The results of this study could provide guidance for the aerodynamic design of thermal protection system (TPS).