Paper ID: 15877
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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 3 (3C)

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RADIATIVE GASDYNAMICS OF MARTIAN ENTRY PROBES

Abstract

A brief description is presented for a computing platform NERAT-ASTEROID, intended for numerical investigation of the radiative aerothermodynamics of Martian entry probes. Available experimental and calculated data for spacecrafts Pathfinder, Mars Science Laboratory (MSL), and Exomars, as well as for their reduced models intended for ground experimental researches, are reviewed and analysed with the use NERAT-ASTEROID codes. General goal of the paper is the prediction of conductive and diffusion heat fluxes to surface of large scale space vehicles intended for investigation of Mars and other planets. The aerophysical models of entering space vehicles are complicated by the fact of the barest necessity to take into account turbulent mixing of chemically nonequilibrium gases, and nonequilibrium radiation heat transfer. Attempts to predict radiative heating along the whole generatrix of space vehicle surface pose a number of additional problems of radiation heat transfer in shock layer and wake regions. General ways for verification and validation all of such models and codes are the comparison with available experimental and flight data. Unfortunately, the list of the data is not very large until the present. Therefore comparative investigations of aero-thermodynamic data obtained with the use of different computational models and codes are also of much current interest. Two- and three dimensional multi-physics radiative-gasdynamic models are realized in the NERAT-ASTEROID computer platform, which is used for aero-thermodynamic and radiative heating prediction of descent space vehicles of Martian and Earth space vehicles. Gasdynamic codes NERAT-2D and 3D included unto the computing platform use the time-relaxation method on structured multi-blocks curvilinear calculation grids. On the each time step the following groups of governing equations are integrated successively: the RANS and continuity equations, the equations of mass conservation of chemical species, the equation of energy conservation together with equations for vibrational energy conservation, the electron energy conservation, and the radiation heat transfer equation. Some computing models, intended for determination of integrated (averaged) radiative characteristics are considered. These are: multi-group models of spectrum, the ray-tracing method for radiative heating prediction of space vehicle surface, half-moment method. To create different multi-group spectral models of gases of complex chemical composition a computing code ASTEROID is used, which is also presented in the paper.