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Calculation Of Radiative Heating Flux Over A Meteoroid Entering The Earth Atmosphere

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ABSTRACT

A computational approach for high temperature nonequilibrium radiative heating prediction has been established in order to analyze the aerothermal environment over the meteor entering the earth atmosphere. Firstly, the high temperature air flowfield properties such as different species number density and temperature are simulated by solving the thermochemical nonequilibrium Navier-Stokes equations with finite volume method combined with LU-SGS (Lower Upper Symmetric Gauss-Seidel) iteration algorithm, for which a two-temperature thermal model and a 11-species chemical model including N_2, N_2^+, O_2, O_2^+, NO, NO^+, N, N^+, O,O^+, and e^- are applied. Secondly, to couple the radiation with flowfield, the loosely coupled strategy is employed. The radiative heat flux is computed by means of a three dimensional

ray-tracing method. The major radiative mechanisms of air are obtained using atomic spectral model and quasi-steady-state (QSS) model along with a smeared-rotational band (SRB) model for molecular bands.

The method is applied to spherical asteroids (1m -50m) entering earth atmosphere at speeds ranging from 5 to 25km/s and the radiation energy flux computations are performed over the wavelength range of 200-20000nm. It is shown that the finite rate thermochemical nonequilibrium processes approach asymptotically to the equilibrium state, with lower flight altitudes, larger asteroid sizes or higher velocities(seeing Fig.1 and Fig.2). This computational means is capable of predicting the radiative heat flux for part of trajectories for meteor entries where the air temperature is below 30000K.

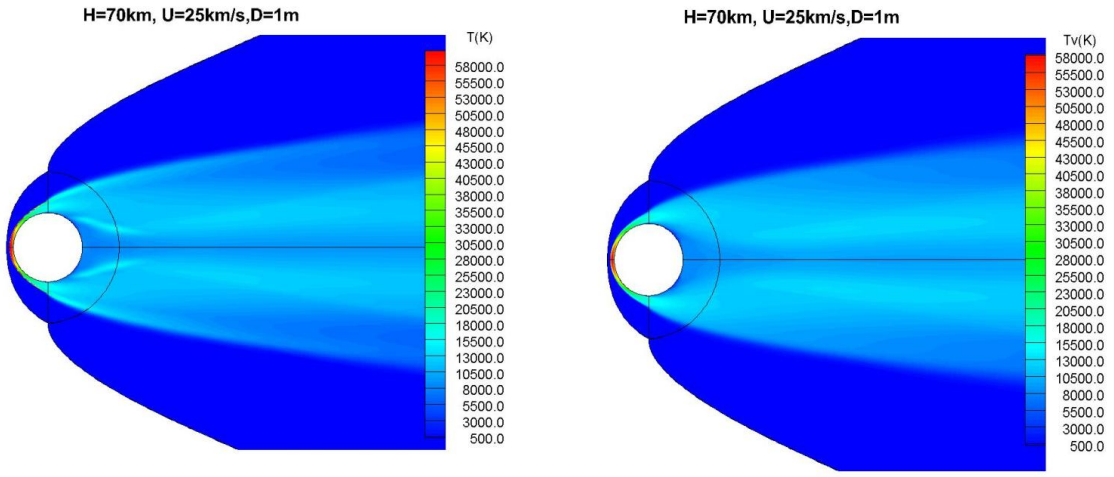

Fig.1 The translational and vibrational temperature distributions for altitude of 25km and velocity of 25km/s (d =1m)

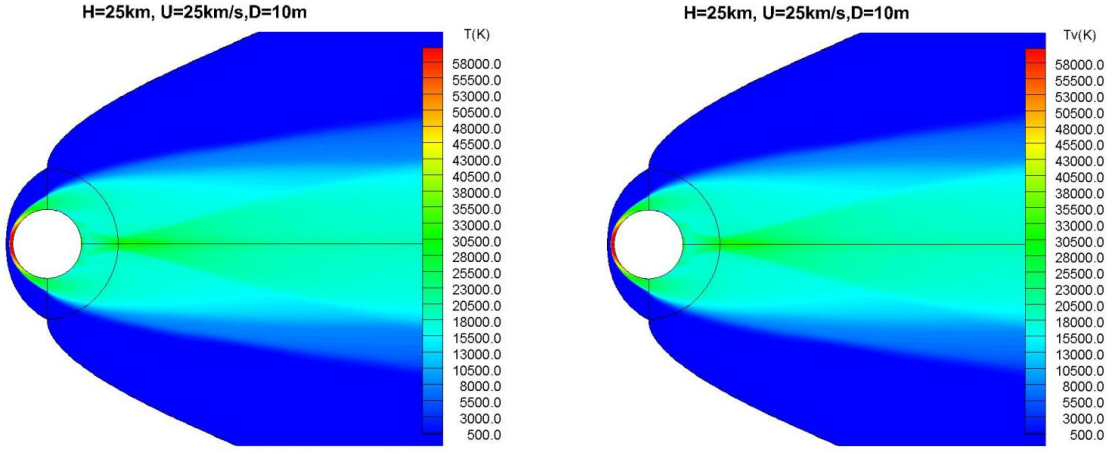

Fig.2 The translational and vibrational temperature distributions for altitude of 25km and velocity of 25km/s (d =10m)

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