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Aerodynamic Heating/Ablation/Conduction Calculation Of Iron Asteroid Entering The Earth's Atmosphere At Hypervelocity

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ABSTRACT

Under severe aerodynamic heating, the material of iron asteroids may melt instead of breakup, causing only mass loss when the surface temperature reaches the melting point. In order to study the melting ablation situation of iron asteroids entering the earth's atmosphere at hypervelocity, a coupled technique of

aerodynamic heating/ablation and internal heat conduction with moving boundary was established. The technical difficulty is redistributing grid nodes with the prerequisite of keeping the topology, related information and node number unchanged. The deformed unstructured grid is applied in aerodynamic heating and three-dimensional finite element heat transfer calculation to realize the coupling solution of mesh deformation and temperature field. Its solution strategy is that the ablation shape and three-dimensional finite element heating transfer calculation use the same set of four nodes tetrahedron grid and the aerodynamic heating calculation uses its boundary nodes. The ablation shape calculation applies the spring sheet stretching technique of unstructured grid. The grid cell and node number information are keeping unchanged in solving the ablation shape, while only the node coordinates are changed. The coupled method is applied to an iron 50m asteroid entering the earth atmosphere at 19km/s and 10 degree reentry angle, and the surface material melts and ablates under intense aerodynamic heating. However, due to the short flight time in atmosphere, the internal temperature of the asteroid does not increase much. So when an iron asteroid enters earth's atmosphere, it will not explode and disintegrate in the air duo to the strong thermal stress generated inside. The result is that it will hit the earth with a hard fireball.