



## Modeling of the stardust reentry flows with ionization in DSMC

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*Research output: Chapter in Book/Report/Conference proceeding > Conference contribution*



### Abstract

Ionized hypersonic flows for the Stardust blunt body at 80 km altitude were simulated using the direct simulation Monte Carlo (DSMC) method, at a speed of 12.8 km/s, the fastest man-made object to enter the Earth's atmosphere. The modeling of ionization processes and energy exchange between translational and internal modes in DSMC is discussed. Eleven species including 5 ions and electron and chemical reactions are considered in the flowfield. It was found that the charge neutrality assumption held in the bow-shock region and using this assumption, ionization processes were modeled. The electron-vibration energy exchange model is important for the prediction of electron and vibrational temperature profiles, and this process was modeled by Lee's relaxation time for the first time in DSMC. DSMC results were compared with CFD(DPLR) results, with the main result that DSMC predicted lower energy exchange rates between translational and internal modes than CFD. The lower energy exchange rates resulted in lower dissociation rates and a lower degree of ionization in DSMC. Furthermore, radiation was calculated using the NEQAIR code from the CFD(DPLR) and DSMC flowfields along the stagnation line for NO, N<sub>2</sub><sup>+</sup>, N, and O. The development of the DSMC models significantly affected the N radiation and O radiation in ultraviolet range.

ORIGINAL LANGUAGE	English (US)
TITLE OF HOST PUBLICATION	Collection of Technical Papers - 45th AIAA Aerospace Sciences Meeting
PAGES	7392-7414
NUMBER OF PAGES	23
STATE	Published - Jul 2 2007
EXTERNALLY PUBLISHED	Yes
EVENT	45th AIAA Aerospace Sciences Meeting 2007 - Reno, NV, United States Duration: Jan 8 2007 → Jan 11 2007

### Publication series

NAME	Collection of Technical Papers - 45th AIAA Aerospace Sciences Meeting
VOLUME	11
Other	
OTHER	45th AIAA Aerospace Sciences Meeting 2007
COUNTRY	United States
CITY	Reno, NV
PERIOD	1/8/07 → 1/11/07

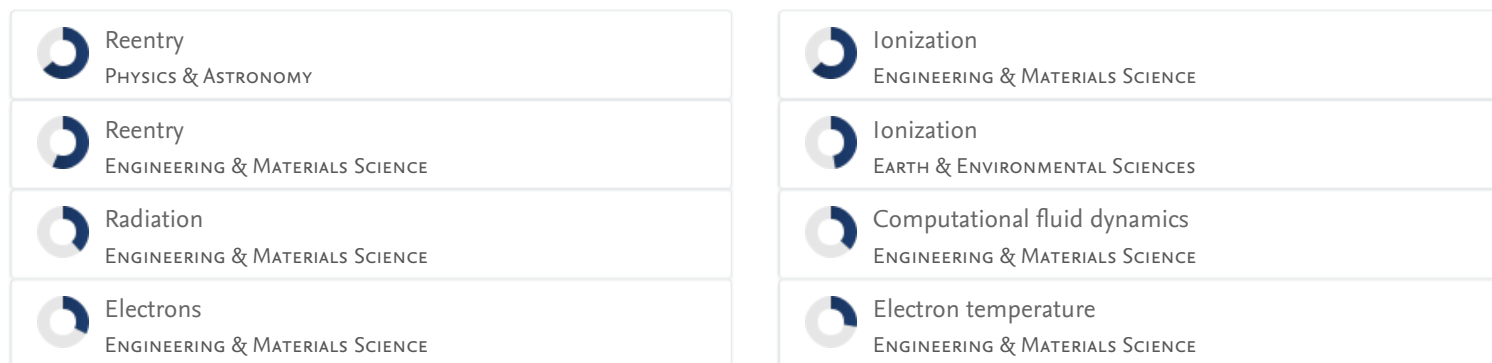
### ASJC Scopus subject areas

Space and Planetary  
Science

Aerospace  
Engineering

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Ozawa, T., Zhong, J., Levin, D. A., Boger, D., & Wright, M. (2007). Modeling of the stardust reentry flows with ionization in DSMC. In *Collection of Technical Papers - 45th AIAA Aerospace Sciences Meeting* (pp. 7392-7414). (Collection of Technical Papers - 45th AIAA Aerospace Sciences Meeting; Vol. 11).



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