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Dedication lecture

RADIATIVE TRANSFER IN PLANETARY ATMOSPHERIC ENTRY FLOWS: CHALLENGES FOR FUTURE MISSIONS

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ABSTRACT. The aim of this lecture is to outline the issues and challenges related to radiative transfer in hypersonic flows around space capsules entering Earth or other planetary atmospheres. Conversion of the kinetic energy of the space vehicle into internal energy of the gaseous medium, associated with the formation of a shock layer around the vehicle with partial dissociation and ionisation, leads lo intense heat flux to the thermal shield. As the entry velocity increases, radiative heat flux from the shock layer to the heat shield also increases and may become dominant compared to convective heat flux for earth re-entries of some planned planetary missions.

After a review of the scarce in-flight measurements available from previous space missions, present laboratory experiments, developed for the simulation of such flows and associated radiation, will be described.

The radiation mechanisms involved in these applications require numerous spectroscopic data that are not fully available. The guidelines followed at EM2C laboratory to build the *High Temperature Gas Radiation* (HTGR) spectroscopic database, and its partial experimental validation, will be presented. Need for further research in this direction will be discussed.

The talk will then focus on the simulation capabilities of coupled radiation and aero-thermal-chemical fields. It is well established that at high altitudes and low densities, the gaseous medium is under chemical and thermodynamic non-equilibrium conditions. Radiation simulation and coupling (with chemistry and internal atomic and molecular states) under these conditions is actually a challenging issue. As the altitude decreases, the medium tends to chemical and thermal equilibrium and radiation prediction becomes easier. Another challenging problem is the understanding of the interaction between radiation and the newly developed ablative materials for heat shields. The radiative flux is a component of the total flux leading to internal ablation and its transfer through the porous structure is not well understood. Similarly, the role of ablation gases that may attenuate radiation to the heat shield is an active topic of research.