RADIATIVE TRANSFER IN GASES UNDER THERMAL AND CHEMICAL NONEQUILIBRIUM CONDITIONS: APPLICATION TO EARTH ATMOSPHERIC RE-ENTRY

Jean-Michel Lamet[*], Yacine Babou, Philippe Rivière, Marie-Yvonne Perrin, Anouar Soufiani
Laboratoire EM2C du CNRS (UPR 288) et de l'ECP
École Centrale Paris, 92295 Châtenay-Malabry Cedex, France
[*] also with ONERA, DMAE/C2A, Toulouse, France

ABSTRACT.   It is well known that the Kirchhoff's law, connecting emission to absorption through the Planck's function, is no more valid when the medium is not at local thermal and chemical equilibrium. The aim of the present paper is to analyze the effects of this nonequilibrium on radiative transfer, and in particular, for atmospheric air re-entry applications. A general formulation is proposed in the framework of multi-temperature description of the thermodynamic state of the gas mixture. Application of this model to simulate an earth re-entry experiment first leads to a reasonable agreement and then outlines important effects of chemical nonequilibrium, especially through bound-free transitions.