ABSTRACT
Nonequilibrium describes a physical process that is not able to reach a well-defined equilibrium state within a time scale relevant to a system. Such processes occur in the gas and plasma flows of a number of systems in aerospace engineering. For gas flow around a hypersonic vehicle, nonequilibrium energy transfer and chemistry of the molecules directly affect the heat transfer to the vehicle. For spacecraft electric propulsion systems, nonequilibrium in the plasma affects the thrust produced and the operational lifetime of the thrusters. In this seminar, recent progress is presented in high fidelity computational modeling that spans length scales from atoms to the full system level. For analysis of nonequilibrium hypersonic flow, molecular dynamics is employed to model individual molecular collisions. The molecular information is integrated to construct a database of rate coefficients that enable the detailed simulation of nonequilibrium energy transfer and chemical reactions in macroscopic hypersonic gas flow. For analysis of an electric propulsion device, molecular dynamics is again used to analyze individual sputtering events caused by the impact of a high-energy ion on a surface. The atomic-level information is used to construct databases that are employed in nonequilibrium modeling of a plasma thruster in order to assess macroscopic erosion.

BIO
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