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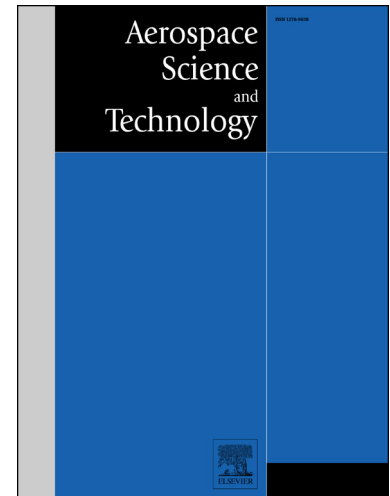
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# Assessment of Vibration-Dissociation Coupling Models for Hypersonic Nonequilibrium Simulations

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## Abstract

The fidelity of three widely-used two-temperature vibration-dissociation coupling models, including the Park model (1988), the Macheret–Fridman model (1994), and the coupled vibration-dissociation-vibration (CVDV) model (1963), is numerically investigated via a comparison with state-specific results and existing shock tube data for oxygen flows. Under the hypothetical condition where a Boltzmann distribution corresponding to a vibrational temperature is assumed, it is found that the CVDV model with a proper parameter is capable of providing the most accurate results, whereas the Park and Macheret–Fridman models present similar prediction accuracy for which the nonequilibrium dissociation rate coefficients could be as much as three orders of magnitude lower than state-specific values. However, for actual postshock flows with intensive vibrational excitation and dissociation processes, the CVDV model still shows significant discrepancies relative to state-specific results and experimental data, presenting a much lower vibrational temperature and a higher degree of dissociation. The essential cause for the disagreement lies in the existence of non-Boltzmann

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