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Expanded Application of the Linear Response Method

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The Linear Response Method (LRM) uses tabulated data obtained with a small number of radiation fields to replace inline steady-state non-local thermodynamic equilibrium (NLTE) collisional-radiative calculations for (nearly-) arbitrary radiation fields. The tabulated data includes first-order derivatives with respect to the frequency-dependent radiation, i.e. linear response coefficients. Straightforward application of the LRM provides radiative properties and equation-of-state information as a function of plasma conditions and radiation field as required for radiation-hydrodynamics calculations. This approach has successfully been used in simulations of inertial confinement fusion hohlraums and other high energy density applications.

The response coefficients themselves contain information which can improve simulations in other ways. One approach provides a simple quantitative measure of how far a given set of conditions is from LTE. This allows a code to transition between LTE and NLTE data and numerical treatments at the most appropriate time. A more far-reaching improvement comes from integrating the response coefficients into radiation transport calculations, making them implicit and consistent with both the material temperature and the radiation field. We discuss these improvements and their implementations.

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