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A Resolved-Super-Transition-Arrays method for calculation of the spectral absorption coefficient in hot plasmas

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A new method, 'Resolved-Super-Transition-Arrays', for calculation of the spectral absorption coefficient in hot plasmas is presented. The formulae of the traditional Super-Transition-Arrays method [A. Bar Shalom, J. Oreg, W.H. Goldstein, D. Shvarts and A. Zigler, Phys. Rev. A 40, 3183 (1989)] are recovered from the formulae of the new method by an approximation based on a cumulant expansion truncated at the third term. In the new method an expression for the many-electron two-time dipole autocorrelation function of ions in hot dense plasmas in terms of Complex Pseudo Partition Functions is derived. The Fourier transform with respect to time together with the fluctuation-dissipation theorem yields an expression for the spectral absorption coefficient. In this expression a multitude of Gaussian Super-Transition-Arrays sharing the same set of one-electron solutions, required by the traditional method to resolve the detailed spectrum, is replaced by a single Complex Pseudo Partition Function which represents the exact analytical sum of the contributions of all relevant transition arrays. A new computer program is presented, capable of evaluating the absorption coefficient by both the new and the traditional Super-Transition-Arrays methods. A numerical example of gold at temperature 1keV and density 0.5 gr/cm^3, is presented, demonstrating the simplicity, efficiency and accuracy of the new method.

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