Atomic processes in dense plasmas through the average-atom approach

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In this talk, we will address the calculation of cross-sections for some atomic processes, in the context of dense, coupled, plasmas.

Due to their relative simplicity of implementation, compared to more detailed models (detailed level accounting, detailed configuration accounting, etc.), average-atom models are a privileged framework for the quantum and statistical modeling of dense plasmas. They notably allow one to account for electron screening and ion surrounding using a quantum description both for bound and free electrons. This is useful in order to describe plasmas in which part of the ion orbitals are shifted towards the continuum or even pressure-ionized.

First, we will recall the specific issues of atomic modeling of dense plasmas and present a brief history of average-atom models. Then, we will describe the methods that use average-atom models in order to calculate thermodynamic properties and cross-sections of atomic processes in dense plasmas. We will see which relevant results they can provide, some of their limitations, and briefly discuss some problems that remain open, such as the modeling of fluctuations, or the accounting for channel mixing and collective phenomena in the photoabsorption.