Fully-First-Principles Quantum Calculations of Helium-Broadened Metal Resonance Lines

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Abstract

Alkali and alkaline earth atomic resonance lines, broadened by collisions between the metal atoms and ambient H_2 and He, make substantial contributions to the atmospheric opacity of several brown dwarfs and other low mass astronomical objects. Analysis of these collisionally-broadened absorption features can in principle provide information about the composition and physical conditions of the atmospheres of these objects. This has stimulated both a variety of studies of the absorption features' line shapes and several attempts to use model line shapes to fit the observed dwarf spectra.

Here we present fully first-principles quantum calculations of the He-broadened Na I resonance line, calculations based on high-quality quantum chemical studies of the Na–He potential energy and transition dipole moment curves. We also investigate the sensitivity of the collisionally-broadened Na I line shape to the underlying potential and transition moment functions. This makes it possible to assess the reliability of commonly-used simplifications, such as the assumption that the transition moment is independent of the Na–He distance. If time permits, we will also present some preliminary work on the He-broadened K I and Ca I resonance lines.

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