Theoretical Studies of Pressure Broadened
Alkali-Metal Atom Resonance Lines

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Broadened absorption lines of alkali-metal atoms are prominent in the optical spectra of brown dwarfs (cf. Burrows et al., 2001) and may be a source of opacity in extra-solar giant planet atmospheres (Seager and Sasselov, 2000; Brown, 2001). The pressure broadening of the resonance lines of Na and K by various perturbing gases is thought to be evident in M and L-dwarf optical spectra. Recently, absorption in the region of the Na resonance line has been detected in the transit of an extra-solar giant planet using the HST STIS spectrograph (Charbonneau et al., 2001).

The pressure broadening of a resonance line is commonly represented in stellar atmosphere models as a Lorentzian shape arising from the van der Waals interaction between the alkali-metal atom and a perturbing atom or molecule (cf. Schweitzer et al., 2001). An improved description results with the use of molecular potential energy surfaces describing the interaction between the alkali-metal atom and the perturber. Accurate calculations of the pressure-broadened line profiles are important in developing effective temperature and density diagnostics for brown dwarf and extra-solar giant planet atmospheres.

We report quantum-mechanical calculations of the absorption spectra of Na and K broadened by He and discuss the validity of various approximations for the pressure-broadened line shapes. The calculated spectra are compared to available experimental results and astrophysical applications are discussed.

References:

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