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Depolarization of atoms induced by collisions

Depolarization of atoms is an angular momentum relaxation process which includes misalignment, disorientation and destruction of alignment. The alignment relaxation processes are for an axially symmetric ensemble of atoms excited evenly on Zeeman states |JM>; while disorientation is for the case of an asymmetric ensemble of atoms. Depolarization processes offer accurate information about the anisotropic interaction between atoms in the collision. Our quantum mechanical model for Neon*-Helium collisions offers theoretical depolarization rates for a wide temperature range. In particular reports, our K^{DA} misaligment rate coefficients *for* $Ne^*(2p_i\ [J=1])$ atoms induced by collisions with Helium ground state atoms and comparison with experiments done in atomic discharges at temperatures between 10 K and 3000 K is reported. Our full quantum close-coupling many-channel calculations use a model potential for describing the interaction between $Ne^*(2p_i\ [J=1])$ and Helium ground state atoms and include the Coriolis coupling due to the rotation of the internuclear axis. The analysis of isotropic collisions in a gaseous mixture at thermal equilibrium indicates that for temperatures above 77 K the anisotropy factor between the collisional channels determines the dependence of the depolarization rates. For temperatures below 77 K, our rates for the $Ne^*(2p_2\ [J=1])$ and $Ne^*(2p_{10}\ [J=1])$ atoms indicate a greater influence from the long-range Coulomb potentials. We can conclude that when the depolarization depends weakly on the long-range Coulomb polarization and van der Waals potentials, the cross sections for our intra- and inter-multiplet transitions tend to have a linear variation toward the zero collision energy limit. Our quantum calculations indicate that for the $Ne^*(2p_2)$ and $Ne^*(2p_{10})$ atoms at low collision energies, below 10 meV, the rotation of the atomic nuclei has a greater influence in the Hamiltonian of the Neon* - Helium system than the electrostatic interaction. This does not happen for the other atomic states, such as the $2p_5$ and $2p_7$ states, where the long-range part of the anisotropy in the electrostatic interaction has a much larger value. Our study helps to better understand the influence of collisions to the stability of atomic susceptibilities for quantum systems coupled with two or more lasers which are set up in an electromagnetically induced transparency regime and suggests the importance of inter- and intra-multiplet transitions to the thermal stability of quantum optical memories.

Biography

Cristian Bahrim has expertise in atomic collisions and interactions, spectroscopy and quantum optics. He has completed his PhD at the age of 30 years from the University of Paris, Orsay. He is a full professor at Lamar University and Assistant Director of the Office of Undergraduate Research. He is now President of the Texas section of the American Association of Physics Teachers.

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