Frequency Domain Control by the Autler-Townes Effect

Marjatta Lyyra and E. H. Ahmed

Physics Department, Temple University, Philadelphia, PA 19122-6082

In recent years Quantum Optics has been expanded from atomic to molecular systems despite much weaker oscillator strengths and complex relaxation pathways that have presented serious challenges in the past. The richness of molecular excitation pathways and the variety of molecular interactions has made it possible to develop novel applications in this field. We have demonstrated how the Autler-Townes effect can be used to control molecular angular momentum alignment and how the Autler-Townes split line shape, combined with accurate control-laser electric field amplitude measurement, can be used to map the absolute magnitude of the molecular internuclear distance dependent electronic transition dipole moment function. In addition, the electric field amplitude in the control laser Rabi frequency can be used as a “tuning” mechanism for the mixing coefficients of energy levels that are weakly perturbed by the spin-orbit interaction, i.e. to control the valence electron spin polarization and the spin multiplicity of molecular quantum states.

Figure 1. Dependence of the singlet-triplet mixing and the magnitude of the AT splitting on the control laser power. The leftmost peak in each spectrum corresponds to fluorescence from a level with primarily triplet character \( (^3\Sigma_g^- \text{ state}) \) while the peak(s) on the right correspond to fluorescence from the AT split pair of levels of primarily singlet character \( (^1\Pi_g \text{ state}) \) of Li\(_2\). Figure reproduced from Ref. 4.


