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Collisions of ultracold polar molecules in microwave traps

ALEXANDER AVDEENKOV, National Institute for Theoretical Physics, Stellenbosch Institute of Advanced Study, Stellenbosch, 7602, South Africa — The collisions between linear polar molecules, trapped in a microwave field with a circular polarization, are theoretically analyzed. Here we demonstrate that the microwave trap can provide a successful evaporative cooling for polar molecules not only in their absolute ground state. But the states in which molecules can be safely trapped depend on the frequency and the strength of the AC-field. For $^1\Sigma$ state molecules the collisional dynamics is mostly controlled by two ratios ν/B and $x = \mu_0 E/hB$ (ν is the microwave frequency, B is the molecular rotational constant, μ_0 is the dipole moment, and E is the electric field strength). We are mostly interested in the lowest energy strong-field-seeking state of the ground vibrational state, $|J = 0, M = 0>$ and we have found rather large inelastic cross sections for molecules even in this state. But we have found that the nature of this "inelasticity" should not cause the loss of molecules from the trap. We conclude that at same cases when the detuning is rather small, the elastic cross section is almost completely defined by the dipole-dipole interaction and it is mostly true for fermionic molecules.From the loading with molecules point of view we suggest that it is "safer" to load $|0, 0>$ molecules at $\nu/B < 2$, $|1, -1>$ at around $\nu/B = 3$, $|2, -2>$ at around $\nu/B = 5$ and so on and it would be better to have the parameter $x < 1$ which makes the regions of strong mixing smaller. We consider the collisional dynamics of $^2\Pi$ state (like OH) molecules and underline that now ratios ν/Δ and $x = \mu_0 E/\Delta$ (Δ is Λ- doubling splitting) play as controlling parameters.

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