DYNAMIC POLARIZABILITIES OF RARE EARTH ATOMS AND THEIR INTERACTIONS WITH HELIUM ATOMS

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Inelastic collisions of open shell atoms in states of non-zero orbital angular momentum L are controlled by the potential energies of the molecular states formed by the approaching atoms and specified by the projection quantum number M. The orientation-dependence of the interaction is determined by the differences in the potential energies. At ultralow temperatures the scattering arises from the interactions at large internuclear distances R which vary asymptotically as $C_6^{(L,M)}/R^6$if one of the atoms is in a state of zero orbital angular momentum. The van der Waals coefficients C_6 (L,M) can be expressed in terms of the dynamic scalar and tensor polarizabilities of the interacting atoms. We apply a version of time-dependent density functional theory developed by Chu and Chu to calculate the polarizabilities and we compare them at zero frequency with measurements. We then evaluate the interaction anisotropy. We find for most of the rare earths that the shielding of the inner d and f electrons by the outer shell 4s electrons reduces significantly the anisotropy indicating that the inelastic cross sections will be small so that rare earths are good candidates for cooling and trapping in a helium buffer gas as in experiments by Doyle et al.