Long-range Interactions of Excited Helium Atoms with Alkali and Alkaline Earth Atoms

J.-Y. Zhang[a], L.-Y. Tang[b], T.-Y. Shi[b], Z.-C. Yan[c,d] and U. Schwingenschlögl[a]

[a]*Division of Physical Science & Engineering, King Abdullah University of Science and Technology, Thuwal 23955-6900, Saudi Arabia*
[b]*State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, Wuhan 430071, People's Republic of China*
[c]*Center for Cold Atom Physics, Chinese Academy of Sciences, Wuhan 430071, People's Republic of China*
[d]*Department of Physics, University of New Brunswick, Fredericton, New Brunswick, Canada E3B 5A3*

Abstract. The long-range interaction plays an important role in determining the dynamics of cold or ultracold atoms. The long-range interaction coefficients C_5, C_6, C_7, C_8 and C_{10} for the first four excited states of helium atoms (i.e. He(2 ^{3}S), He(2 ^{1}S), He(2 ^{3}P) and He(2 ^{1}P)) with the ground and low-lying excited states of the alkali metal (Li, Na, K and Rb) and alkaline earth metal (Be, Mg, Ca and Sr) atoms are computed from the oscillator strength sum rules. The oscillator strengths of the helium and lithium atoms are calculated using Hylleraas basis functions. The oscillator strengths of the alkali metal (including Li) and alkaline earth metal atoms are calculated with a semiempirical method that treats the valence particles in an *ab initio* manner and uses a model potential to describe the core-valence interaction. For the long rang interaction between helium and lithium atoms, the coefficients calculated with Hylleraas basis functions agree with those obtained by the semiempirical method at the 0.1% level of accuracy. For the long-rang interaction between helium and other atoms, the uncertainties of the coefficients C_5, C_6 and C_7 are about 1~5% while the uncertainties of the coefficients C_8 and C_{10} are about 5~10%.