Abstract

We have recently studied both non-dissipative as well as dissipative atom-surface interactions. The physical situation is that an atom “sits” above a dielectric surface and its oscillating dipole can interact with the mirror dipole inside the medium. This leads, for close approach of atom and wall, to a van-der-Waals type interaction, which can be formulated without reference to so-called “retardation”. When the atom is further away from the surface, the travel time of the electromagnetic interaction (the speed of light) becomes so long that the phase of the wave function of the atom (in view of its “virtual transitions” to excited state) changes significantly before the exchange photon has a chance to return to the atom. In this regime, the 1/R^3 atom-surface interaction changes into a 1/R^4 Casimir-Polder interaction. A new result obtained recently concerns a symmetry breaking mechanism induced by the atom-surface interaction, which is due to the broken spatial symmetry due to the presence of the dielectric surface. It can lead to a mixing of atomic S and P state, with a long-range tail of a surprising functional form. All of these processes are non-dissipative; they do not lead to friction. However, Ohmic heating of the mirror charge in the material can lead to such a dissipative friction process, where an atom loses energy when flying by a dielectric surface at some distance, even though the wave function of the atom has negligible overlap with the medium. This process exists for both atoms as well as ions, where in the latter case it is even stronger. Physical foundations are pertinent formulas will be discussed.