Abstract for 54th Sanibel Symposium, Saint Simons Island, GA 16-21 Feb., 2014

Retarded *N*-Body Dispersion Potential: Molecular QED Formulation

J. Aldegunde[1] and A. Salam[2]
1 Department of Physical Chemistry, University of Salamanca, 37008 Salamanca, Spain
2 Department of Chemistry, Wake Forest University, Winston-Salem, NC 27109, USA

A well-known success of the theory of non-relativistic quantum electrodynamics (QED) [1,2] is the calculation of the dispersion potential between two particles separated by a distance R, by Casimir and Polder [3]. They showed that accounting for the finite speed of propagation of electromagnetic signals weakened the energy shift by a factor of R^{-1} relative to the R^{-6} London dispersion formula. Aub and Zienau [4] later evaluated the leading non-additive term arising from three-bodies, extending the familiar Axilrod-Teller-Muto triple dipole dispersion potential [5,6], which was found to be the near-zone limit of the result valid for all separations.

We present an expression, obtained using molecular QED, for the retarded N-body dispersion energy shift for atoms or molecules with arbitrary electric multipole polarizability, generalizing a formula that was limited to the electric dipole approximation [7]. Higher-order many-body contributions are now featuring in the interactions between rare gases, alkali and alkaline Earth metal atoms, and combinations thereof [8]. A response theory formulation is adopted in which each species in turn responds through its generalized electric multipole polarizability to the electric displacement field of the remaining N-1 bodies. This approach first entails the solution of the source dependent wave equation for the displacement field [9]. The formula derived is shown to agree with previously obtained generalized expressions for two-[10] and three-[11] body dispersion potentials between species with arbitrary electric multipole polarizable characteristics.

[1] D. P. Craig and T. Thirunamachandran, *Molecular Quantum Electrodynamics*, Academic Press, London, 1984.
[2] A. Salam, *Molecular Quantum Electrodynamics*, John Wiley & Sons, Inc., New York, 2010.
[3] H. B. G. Casimir and D. Polder, *Phys. Rev.* **73**, 360 (1948).
[4] M. R. Aub and S. Zienau, *Proc. Roy. Soc. Lond.* A**257**, 464 (1960).
[5] B. M. Axilrod and E. Teller, *J. Chem. Phys.* **11**, 299 (1943).
[6] Y. Muto, *J. Phys. Math. Soc. Japan* **17**, 629 (1943).
[7] E. A. Power and T. Thirunamachandran, *Phys. Rev.* A**50**, 3929 (1994).
[8] L-Y. Tang, Z-C. Chen, T-Y. Shi, J. F. Babb and J. Mitroy, *J. Chem. Phys.* **136**, 104104 (2012).
[9] E. A. Power and T. Thirunamachandran, *Proc. Roy. Soc. Lond*. A**401**, 267 (1985).
[10] A. Salam and T. Thirunamachandran, *J. Chem. Phys.* **104**, 5094 (1996).
[11] A. Salam, *unpublished results.*