

DAMOP16-2016-000248

Abstract for an Invited Paper  
for the DAMOP16 Meeting of  
the American Physical Society

### **Coherent and incoherent dipole-dipole interactions between atoms<sup>1</sup>**

FRANCIS ROBICHEAUX, Purdue University

Results will be presented on the collective interaction between atoms due to the electric dipole-dipole coupling between states of different parity on two different atoms. A canonical example of this effect is when the electronic state of one atom has S-character and the state of another atom has P-character. The energy difference between the two states plays an important role in the interaction since the change in energy determines the wave number of a photon that would cause a transition between the states. If the atoms are much closer than the wave length of this photon, then the dipole-dipole interaction is in the near field and has a  $1/r^3$  dependence on atomic separation. If the atoms are farther apart than the wave length, then the interaction is in the far field and has a  $1/r$  dependence. When many atoms interact, collective effects can dominate the system with the character of the collective effect depending on whether the atomic separation leads to near field or far field coupling. As an example of the case where the atoms are in the far field, the line broadening of transitions and strong deviations from the Beer-Lambert law in a diffuse gas will be presented. As an example of near field collective behavior, the radiative properties of a Rydberg gas will be presented.

<sup>1</sup>Based upon work supported by the National Science Foundation under Grant No. 1404419-PHY in collaboration with R.T. Sutherland.