Phonon correlations through Raman virtual processes

REINALDO DE MELO E SOUZA, Univ Fed Rio de Janeiro, ANDRE SARAIVA, BELITA KOILLER, UFRJ — In Raman inelastic scattering phonons are either absorbed or created, in what is respectively called an anti-Stokes (aS) or a Stokes (S) process. While these two processes are generally uncorrelated, it is possible that the same phonon generated by S is subsequently absorbed by aS. This two photon process is referred to as SaS. In a standard Raman process, conservation of energy forbids virtual phonons to play a role. However, in a SaS process these virtual phonons may be relevant as long as their lifetimes exceed the interval between the two scatterings. We derive the effective photon-photon interaction mediated by the phonon field. The effective Hamiltonian is analogue to the one present in BCS superconductivity. The difference lies in the nature of the particles involved – since photons are bosons, there is no Fermi sea instability and no pair condensation. Still it is possible to obtain an attractive photon-photon interaction. Finally, we propose an experiment to detect the correlated photons emerging from a semiconductor. We pinpoint the material properties that might enhance this effect and discuss the possible technological applications of this idea as a correlated photon source.

1This work is part of the Brazilian National Institute for Science and Technology on Quantum Information. We also acknowledge partial support from the Brazilian agencies FAPERJ, CNPq and CAPES.