Neutral Modes of Electrons and Their Quantum Geometry

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Abstract:

Electrons in solids possess quantum geometric structure that impact the electronic properties of the system. In this seminar I will introduce the general ideas behind this concept, and how it can be applied to neutral, collective modes of electronic materials. From this approach we find that generically these excitations possess their own type of geometric property: a "quantum geometric dipole" (QGD). I will focus on two examples in which a QGD can appear: excitons - bound particle-hole pairs akin to hydrogen atoms; and plasmons - quantized electron density oscillations. In both cases a non-zero QGD implies internal structure in the excitation, in the form of a non-vanishing average electrical dipole moment. This dipole moment allows manipulation of the excitation dynamics through applied static electric fields. It also leads to asymmetric scattering of the excitations from rotationally symmetric scattering centers. I will discuss the conditions under which an excitation hosts a non-vanishing QGD, and some possibilities for physical phenomena which may result from it.