A new look at an old controversy: Interacting electrons in Anderson-Mott insulators

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Mott-Anderson insulators are disordered solids on the insulating side of the Mott and of the Anderson quantum phase transitions. Electron localization on the insulating side makes screening inefficient, so electron-electron interactions become important. They have a profound effect on physical properties. The interaction makes the one-particle density of states (DOS) develop a gap (called Coulomb gap) around the Fermi level. The form of the Coulomb gap has been under dispute for several decades as were its role in determining physical properties; this talk focuses on transport and on relaxation.

Based on the requirement that any transition from the ground state must have a positive energy, two forms were proposed for the DOS. A "soft" gap DOS, N(E)~$|E-E_F|^{d-1}$ was derived for a so called "pseudo-ground" state stable to one-electron excitations and (approximately) a "harder" DOS ln N(E)~$(-E_g/E)^{1/2}$ for the true ground state, stable to many-electron excitations. In something of a puzzle, it is the pseudo-ground gap that is believed to govern the DOS because of support by experimental results and by computer simulations. On this basis a one-particle transport theory was derived and has been widely used in the literature. This poses a number of questions, e.g. why would particles in an interacting system move independently of each other?

The talk will show that, on closer examination, the experiments and the simulations that are thought to favor the "soft" DOS do not truly support it. It will be further shown that the one-particle DOS is irrelevant to transport measurements in the linear response regime. Many-body transport theories that do not invoke the DOS and do agree with transport and relaxation experiments will be outlined.

In summary, the "hard" DOS should not be disputed but is not involved in transport.