Abstract for the Eurasia-Pacific Summer School and Conference 2012 (Invited talk)

# Variational Approaches to Localization in Strongly Correlated Systems

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In the first part of the talk the role of the total momentum shift operator in the theory of conductivity will be presented. The total momentum shift operator also allows to cast the criterion of conductivity, the Drude weight, in terms of momentum densities. There are at present two distinct views on conductivity, one based on a discontinuity of the momentum shift (the basis of the Landau theory of Fermi liquids), the other based on the localization of charge carriers in the many-body con_guration space (due to Walter Kohn). In the formalism based on the total momentum shift these two views are placed on the same theoretical basis. Subsequently variational approaches to the Hubbard model are discussed. One common such approach is based on the Gutzwiller wavefunction (GWF), in which charge uctuations are projected out of the Fermi sea. The approach complementary to Gutzwiller was proposed by Baeriswyl (BWF), which starts with the large U limit solution, and acts with a kinetic energy projector. An early solution based on combinatorics, due to Gutzwiller, predicts a metal-insulator transition between a correlated metal and an oversimplified insulator. For the GWF the exact solution is always metallic. In the first part of the talk the Gutzwiller combinatorial approach is generalized to momentum space and applied to both wavefunctions. The resulting formalism can be viewed as a momentum density functional theory. For the GWF, a metal-metal transition results between a Hartree-Fock metal and a correlated metal. This result seems to be in better qualitative agreement with the exact results. For the BWF the result is a metal-insulator transition between a Hartree-Fock metal and a correlated insulator dominated by bound excitons. The Baeriswyl wavefunction is then applied to the bosonic Hubbard model, where preliminary results will be presented. In the last segment of the talk the mathematical basis of conductivity will be discussed. With the help of the total momentum shift operator it will be shown that the Landau theory of Fermi liquids and Kohn's theory of localization can be placed on the same footing.