Electronic structure of transition metal oxides

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Transition metal oxides (TMOs) form a class of compounds with a uniquely diverse range of electronic phenomena: these include magnetism, insulator-metal transitions, charge and orbital ordering, superconductivity, semiconducting properties and chemical reactivity. This wealth of properties makes TMOs useful in many applications such as catalysis, electronic, optoelectronic and spintronic. Some properties of TMOs are known since long time but the first attempts to characterize, understand and classify the electronic structure of TMOs began in the late 1930s with the application of quantum theory to condensed matter physics. Still, TMOs continue to surprise and some important aspects of their electronic properties remain elusive and are the subject of an intense research.

The aim of this lecture is to review and describe the range of electronic properties found in TMOs and to discuss the various models that have been proposed to interpret them. Given the variety and complexity of the subject matter I will not attempt to provide a complete survey but an attempt will be made to select several representative phenomena, compounds and theories so as to provide a balanced account also including the most recent advances in the field.

The lecture is structured in four sections: (1) Basic properties of TMOs and electronic structure models; (2) Insulating and magnetic oxides; (3) Metallic oxides and insulator-to-metal transitions; (4) Defects and low-dimensional oxides. Time permitting, some of the concepts and phenomena will be exemplified with computational experiments.