Seminář oddělení magnetik a supravodičů
Fyzikální ústav Akademie věd České republiky, v. v. i.

✓ Přednáškový sál u knihovny, Cukrovarnická 10, Praha 6
✓ Úterý, **15. 5. 2012** ve **14:30** hod.

Theoretical Approaches to Time Domain Spectroscopies: Learning about Electrons, Lattice, Equilibria, and New States of Matter

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Abstract. The development of state-of-the-art pump-probe experiments enables phantastic capabilities and at the same time challenges our understanding of quantum matter. Roughly speaking, we can now pump highly correlated many-body quantum systems which show rich N-dimensional phase diagrams in equilibrium (N = number of degrees of freedom, like temperature, pressure, chemical doping, etc.) with emergent collective behaviors into the $N+1$-th direction in the "energy landscape": Non-equilibrium, or real time. This implies that we first have to understand what we mean by "pumping the system into the $N+1$-th dimension", a question which has to be answered both in theory and in experiments.

In this talk, I will give a brief overview of theories attempting to model pump-probe spectroscopies such as time-resolved ARPES (tr-ARPES). Questions to be addressed are: (1) What can we learn about equilibrium states from pumping the system? (2) Which new states of matter can we induce by pumping with light? (3) How can we bridge the gap between experiments and theory? (4) How can we foster future close collaborations in order to bridge this gap?