

Field Theory of Nonequilibrium Systems

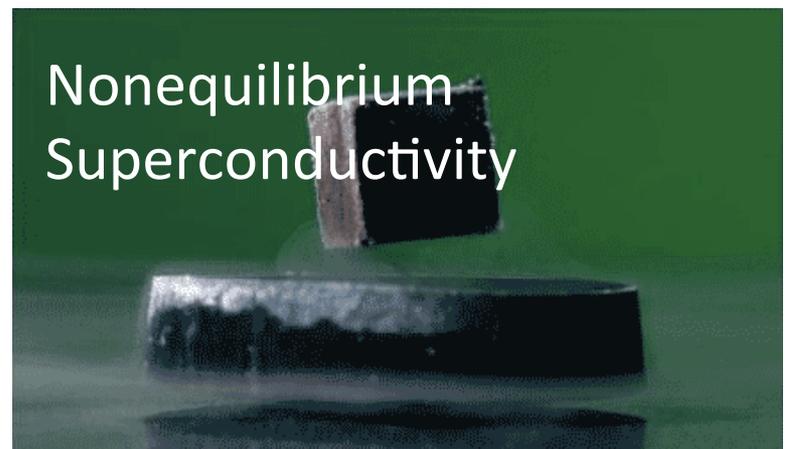
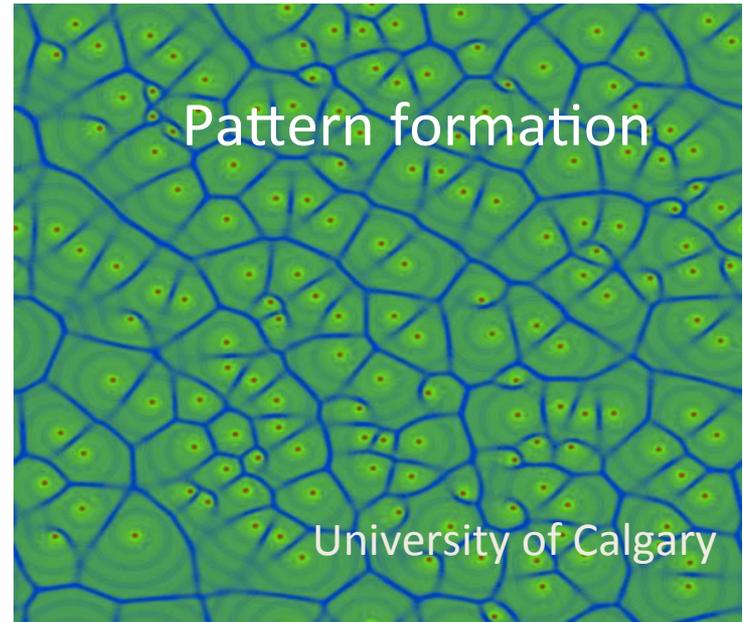
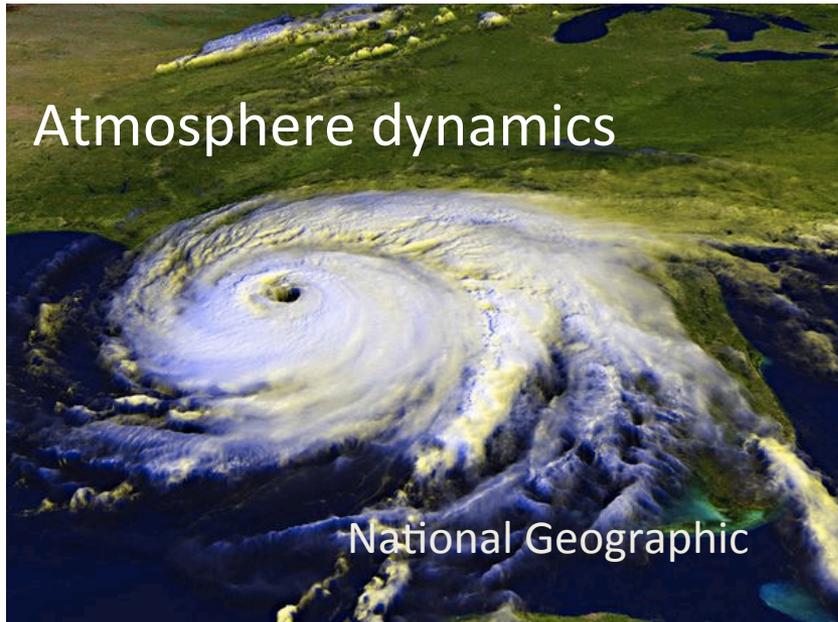
Martin Eckstein

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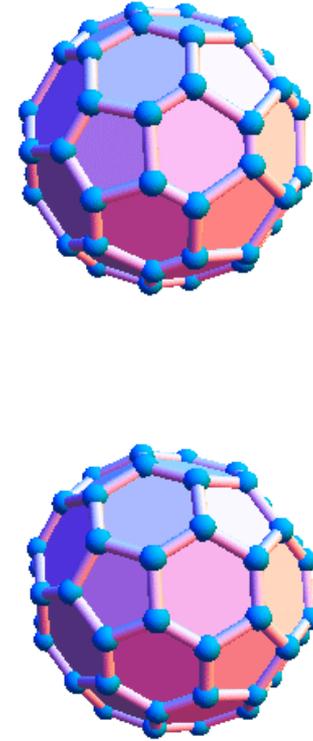
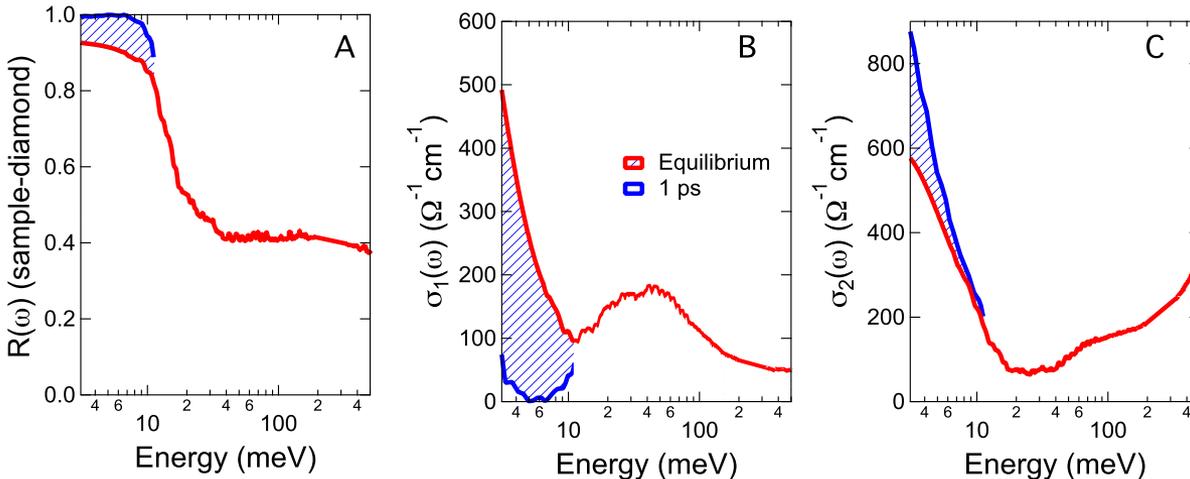
WS 2016/17

Nonequilibrium systems



Open problem: Light-induced states of matter

Lattice control of reflectivity and possible light-induced superconductivity in K_3C_{60}

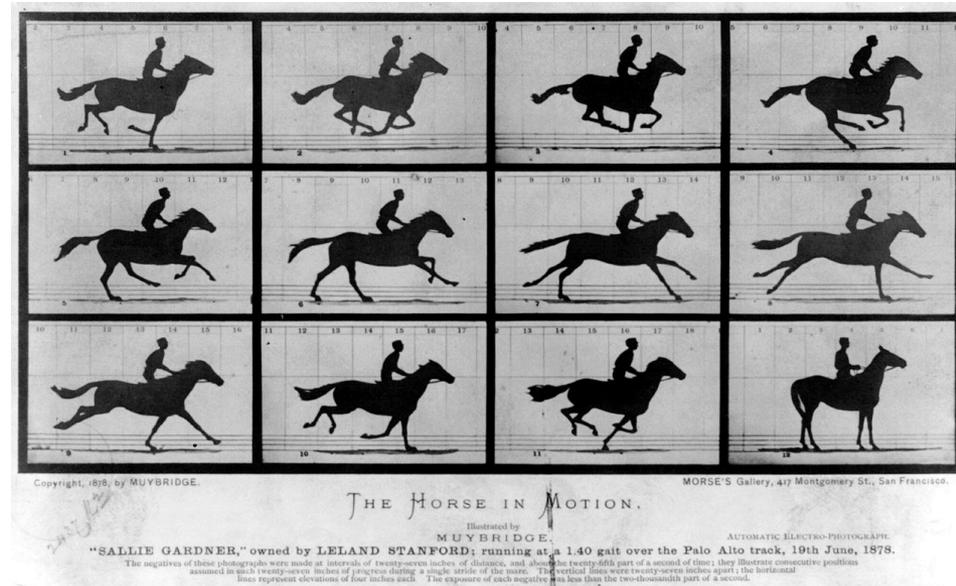


*M. Mitrano et al.,
Nature 530, 461 (2016)*



Pump-probe spectroscopy (1887)

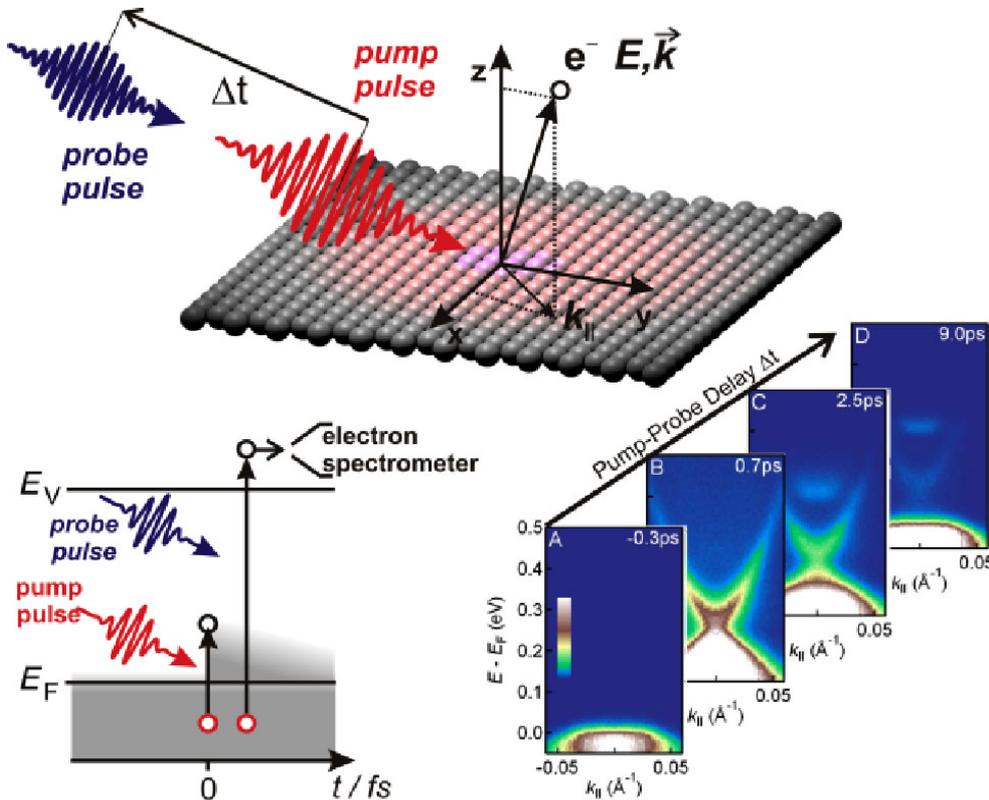
- stroboscopic investigations of dynamic phenomena



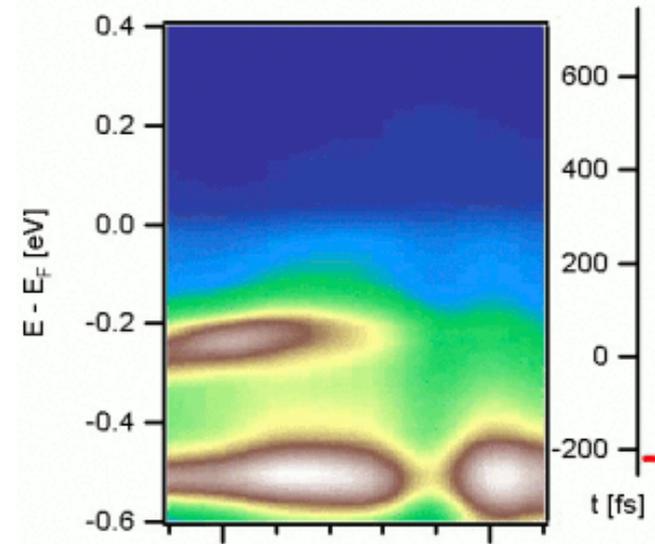
Muybridge 1887

Pump-probe spectroscopy (today)

- stroboscopic investigations of dynamic phenomena



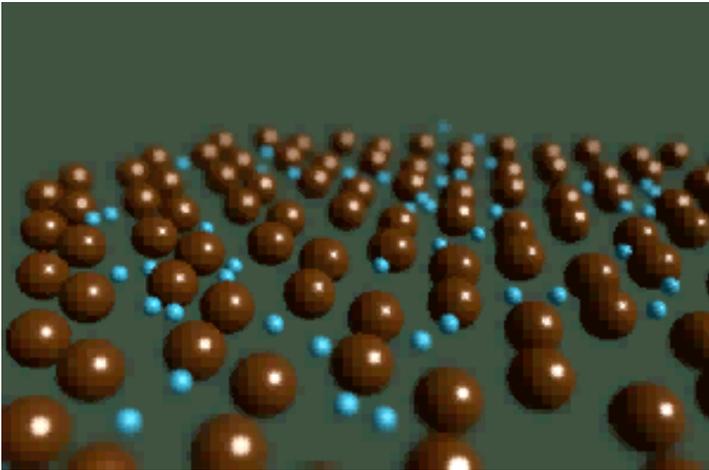
TbTe3 CDW metal



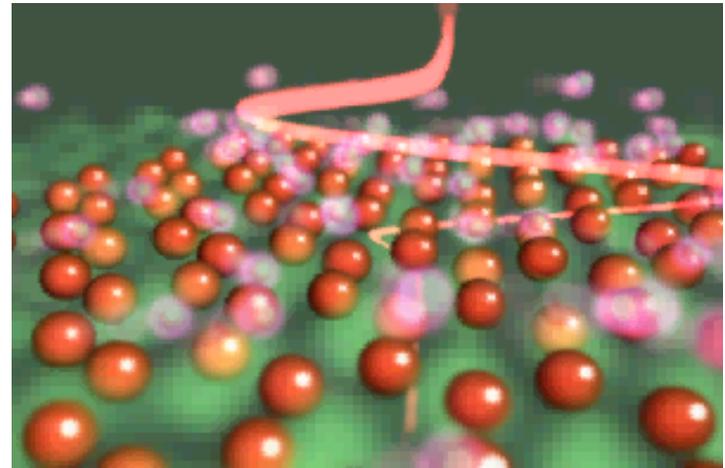
J. Sobota et al., PRL 108, 117403 (2012)
F. Schmitt et al., Science 321, 1649 (2008)
 Image courtesy: J. Sobota / F. Schmitt

Challenge

movies by Koichiro Tanaka (Kyoto university)



many-body problem
(electrons + ions)

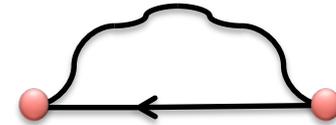


nonequilibrium many-body problem
(electrons + ions + photons)

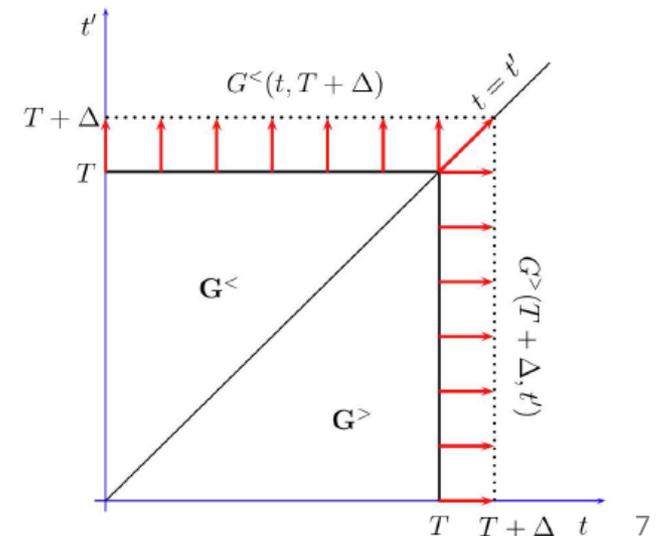
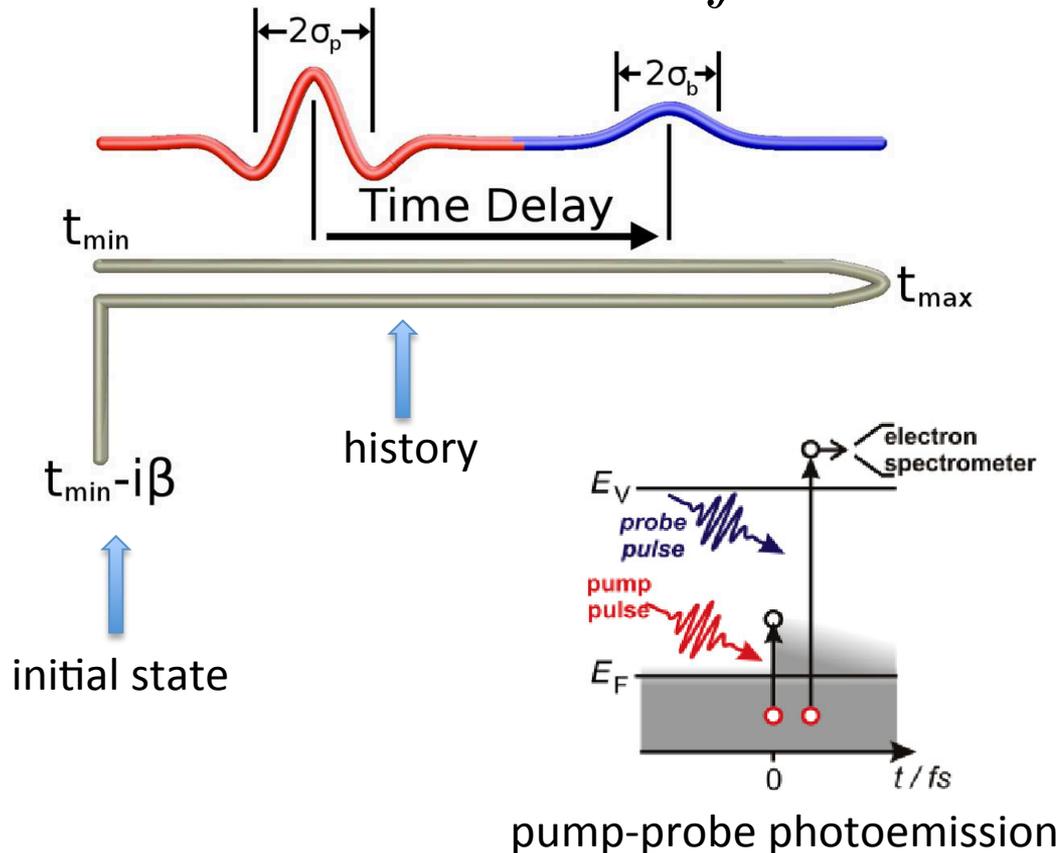
One method: Nonequilibrium Green's functions

$$G_k(\omega) = G_k^0(\omega) + G_k^0(\omega)\Sigma(\omega)G_k(\omega)$$

$$G_{\mathbf{k}}(t, t') = G_{\mathbf{k}}^0(t, t') + \oint dt_1 dt_2 G_{\mathbf{k}}^0(t, t_1) \underline{\Sigma(t_1, t_2)} G_{\mathbf{k}}(t_2, t')$$



self-energy Σ :
 electron-electron scattering
 electron-phonon scattering
 ...



Outline

Correlation functions and response

Kubo formalism, Fluctuation dissipation theorem

Field theory for quantum many-particle systems

path integrals, second quantization, coherent state path integrals, concepts of many-body perturbation theory

Keldysh formalism

field theory for nonequilibrium systems

Classical stochastic equations

Langevin equation, semiclassical equations of motion in a dissipative environment

Kinetic equations

Derivation of the quantum Boltzmann

From collisionless dynamics to kinetic theory

Dynamics of BEC condensates, superconductors

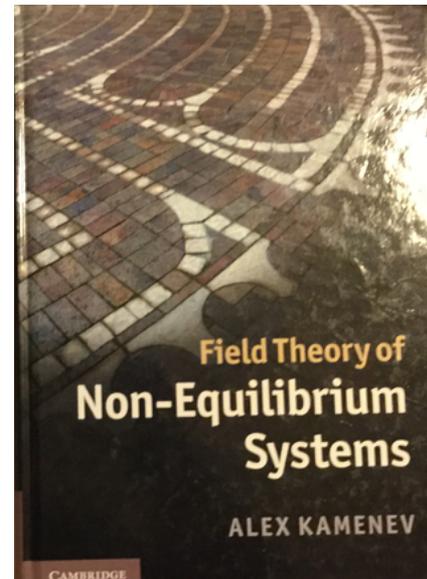
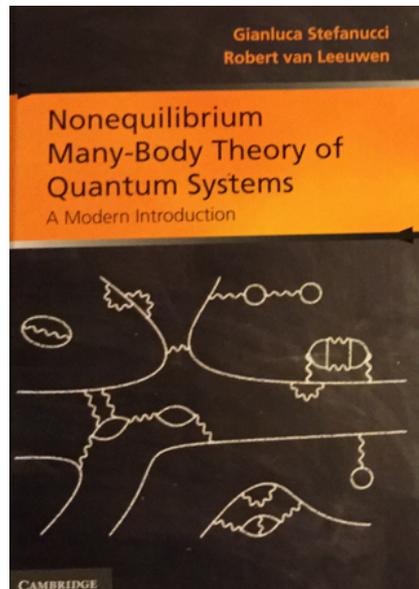
Quantum Transport

Landauer formula, transport and the Kondo effect

Driven systems

Parametric instabilities of many-particle systems

Literature



Keldysh formalism

