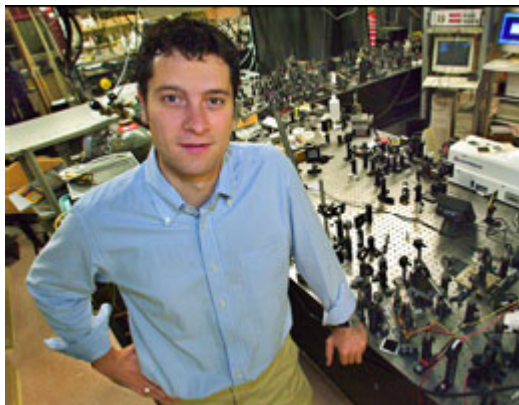


# Photo-control in strongly correlated electron systems

Professor Dr. Andrea Cavalleri

Clarendon Laboratory, Oxford University, and Max-Planck Research Group for Structural Dynamics,  
Center for Free Electron Laser Studies, DESY and University of Hamburg



Strongly-correlated electron systems are solids in which our common intuition of weakly-coupled charge carriers fails spectacularly. Unlike Silicon or Copper, these systems exhibit electron-electron repulsion energies of several eVs, orders of magnitude higher than the thermal energy scale, and a dominant contribution to the internal energy of the system. This fact, combined with strong coupling with other degrees of freedom, leads to a free energy landscape with an enormous number of quasi-degenerate states. These have narrow ranges of stability and even subtle external perturbations (pressure, doping, magnetic field) can result in spectacular changes of the macroscopic properties of the solid. Indeed, this behaviour has sometimes been compared to the chaotic response of some nonlinear systems.

My work is aimed at exploiting the seemingly endless developments of laser technology to control complex solids with light. Is it possible to perturb solids coherently and re-direct them between stable phases? How should we understand cooperative changes when the dynamics is stimulated and when it evolves away from equilibrium? Can we take snapshots of the microscopic properties with the appropriate spatial and temporal resolution? And more, is it possible to optically control new phenomena and functionalities in the solid state? Can we photo-induce superconductivity?

In this talk I will tell you how far we have come in our journey, which was started nearly three decades ago by a handful of pioneers in the US and in Germany. These were the early years of ultrafast science, where ambitious new paths were chosen and pursued with rudimentary technologies. For me, this journey has started in the late 1990's as a Ph.D. student at the University of Essen, a defining time when I have learned some of the problems, many of the tricks, and where I have made these goals my own.