

SEMINAR

Wednesday 06/03/19, 11:00 am

Building 211, seminar room

SPEAKER:

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from Ben Gurion University

TOPIC:

Plasmonic photo-catalysis - “Hot electrons” or just heating?

What happens to electrons in a metal when they are illuminated? This fundamental problem is a driving force in shaping modern science since the discovery of the photo-electric effect. In recent years, this problem resurfaced from a new angle, owing to developments in the field of *nano-plasmonics*, where metallic nanostructures give rise to resonantly enhanced local electromagnetic fields (surface plasmons). Presumably, these plasmons can transfer their energy to the electrons in the metal very efficiently, creating “hot electrons”, i.e. energetic electrons out of equilibrium. Such energetic electrons have been demonstrated to be useful in a variety of ways, most recently in catalysis of chemical reactions. Or have they?

In this talk, we argue that what appears to be hot-electron-mediated photo-catalysis is really a simple heating effect. We present a theory for plasmonic hot-electron generation, which takes into account non-equilibrium as well as thermal effects. Specifically, we consider the effect of both photons and phonons on the electron distribution function, and calculate self-consistently the full electron distribution and the increase in electron and lattice temperatures above ambient conditions (as observed experimentally), thus going well beyond the limit of existing theories. Calculating the efficiency of hot-electron generation, we find that it is extremely small, and most power goes into heating. We use this theory to re-interpret data from central experiments claiming hot-electron generation, and find that the data fits remarkably a simple theory of heating. Finally, we suggest control experiments to further test our conclusions, and discuss the prospect of using the hot electrons for photocatalysis.

