Nanoscale manipulation of coherent electron waves from a nano-tip

Hirofumi Yanagisawa,

Ludwig-Maximilians Univeristy, D-85748 Garching, Germany

Email: hirofumi.yanagisawa@mpq.mpg.de

In this presentation, we will overview our work on laser-induced electron emission from a tungsten tip. In particular, we will focus on optical control of electron emission sites on a scale of nanometers and their application for optical control of Young's electron interference.

Illuminating a sharp metallic tip with femtosecond laser pulses produces spatially and temporally confined electron pulses by plasmonic effects at the tip apex [1]. We have found that these plasmonic effects induce asymmetric electron emissions from the tip apex as schematically shown in Fig. 1. They also allow one to select the electron emission sites on a nanometer scale by changing the laser polarization [2]. Using this technique, we can manipulate electron emissions within their coherence time and area, which then enables us to control coherent electron emission in time and space. In a demonstration, we realized optical control of Young's electron interference [3]. The interference emerged between the two adjacent electron beams. The intensity of the interference could be successfully controlled by changing the laser polarization and intensity. The underlying physics that drove the interference was revealed by measuring the energy spectra [4, 5] and also by simulating the temporal evolution of the electron waves by solving a two-dimensional time-dependent Schrödinger equation [3]. Using a site-selective coherent electron source, we expect to create time-resolved electron holography with a possible time resolution in attoseconds.

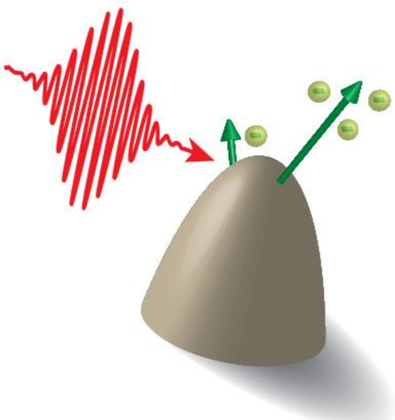

Figure 1: A schematic diagram of the laser-induced field emission.

References

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