

## **Ultrafast Electron Emission Physics and Space Charge Waves**

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Electron emission physics and beam transport are fundamentally important to the development of advanced electron sources, vacuum electronics, electromagnetic radiation sources, pulsed power systems, and particle accelerators. This talk presents recent advances in our generalized quantum mechanical modeling of electron emission from surfaces under various combination of background field (DC or RF bias) and optical field (different laser wavelength, laser intensity, pulse duration, carrier-envelope phase (CEP), multi-color mixture, etc), by exactly solving the time-dependent Schrödinger equation (TDSE). The effects of laser heating, cathode surface coating, and resonant tunneling will be addressed. Also highlighted are our recent studies of quantum pathways interference during electron emission, direct density modulation of photo-assisted field emission from an RF cold cathode, as well as dispersion of space charge waves on the emitted beams.