Time-Resolved Total Scattering Using Mev Electrons

Dr. Xijie Wang[1]
[1]Slac national accelerator laboratory
wangxj@slac.stanford.edu

The MeV electrons produced by the photocathode RF gun made it feasible for MeV ultrafast electron scattering [1-2]. MeV ultrafast electron scattering became a new frontier in ultrafast science due to its capability of following dynamics on femtoseconds scale with the high spatial resolution and sensitivity [3-4]. Furthermore, MeV electrons experience less multiple-scattering, and possess “real” flat Ewald-sphere; MeV ultrafast electron diffraction (MeV-UED) is an ideal tool to explore both structure and dynamics using total scattering technique. MeV-UED had broad and transformative impact on ultrafast science, such as the first 2-D materials ultrafast structure dynamics [5], light-induced transient states of quantum materials [6-7], the first direct imaging of fundamental chemical processes [8-9] and hydrogen bond dynamics in liquid water [10]. Recently, we have demonstrated the first operando experiment in ultrafast [11] and the first successful ultrafast visualization of incipient plasticity in dynamically compressed matter [12]. Total scattering has been explored by X-ray and Neutron scattering communities to study energy materials, the time- resolved total scattering enabled by MeV-UED make it feasible to image energy and charge follow in 2-D heterostructure [13] and revealing the intricate relation between dynamics and function of 2-D perovskite [14].

I will discuss many advantages of MeV electron for total scattering. MeV electron total scattering not only produces stronger diffraction signal and sensitive to the structure change, but also has less background and no geometric correction needed. Furthermore, we have experimentally demonstrated that MeV electron total scattering is capable of probing both electronic and nuclear structure dynamic [15] and sensitive to hydrogen [8]. MeV-UED is the only time-resovled electron scattering technique capable of handling solid, gas and liquid phase samples. I will also outline potential future technology developments to probe chemical and biological process in its native environment (liquid phase) using MeV electron total scattering.

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