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Megaelectron-Volt ultrafast electron microscope – the future of electron imaging

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Aberration correction electron optics and cold field-emission electron source made the transmission electron microscope (TEM) a popular tool to image atomic and nano-scale objects. Cryogenic electron microscopy (Cryo-EM) revolutionized the bio-structure science, and recently it is explored to investigate radiation-sensitive battery and energy materials. But non- physiological environments, sample damage and electron beam induced sample movement greatly limit the science impact of both TEM and Cryo-EM. To address those challenges, we propose to develop ultrafast electron microscope based on megaelectron electron beams (MeV-UEM). The development of high-brightness electron sources made it feasible to explore megaelectronvolt electrons for Ultrafast Electron diffraction and Microscope (MeV-UED/UEM) [1-2]. MeV-UED had broad and transformative impact on ultrafast science, such as the first 2-D materials ultrafast structure dynamics, light-induced transient states, molecular movies of canonical interception & ring-opening, and the first hydrogen bond structure dynamics in liquid water [3]. The proposed MeV-UEM will capable of single-shot imaging with atomic spatial resolution (0.3 nm) and sub-nanosecond temporal resolution. We will present the plan of employing accelerator technologies, such as high-brightness MeV electron source, novel electron optics and high field magnet, to realize the MeV-UEM.

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Footnotes

1. X.J. Wang et al, Phys. Rev. E , 54, No.4, R3121 -3124 (1996).
2. X.J. Wang et al, Proceedings of the 2003 Particle Accelerator Conference, 2003, pp. 420-422 Vol.1, doi: 10.1109/PAC.2003.1288940.
3. J. Yang, X.J. Wang et al., Nature 596, 531–535 (2021). https://doi.org/10.1038/s41586-021-03793-9.

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Yes

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