フォノンをリアルタイム可視化するフェムト秒動画撮像法

Femtophotography for Real-Time Visualization of Phonons

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As recognized by the 2014 Nobel Prize in chemistry, there have been breathtaking innovations in improving the spatial resolution of microscopic imaging, resulting in an impressive arsenal of nanoscopy tools that can break the diffraction limit of light. Equally important, but overlooked is the temporal resolution of imaging systems. High temporal resolution in microscopic imaging is essential for blur-free observation and characterization of fast dynamical processes in a diverse range of physical and chemical phenomena since it is required even for imaging of slow events within a small field of view. Unfortunately, the speed of conventional cameras based on detector-array-based image sensors is significantly constrained by their mechanical and electrical operation and limited storage.

In this talk, I introduce a method for motion-picture femtophotography that circumvents the technical challenges of the traditional imaging methods and provides frame rate and shutter speed far beyond what can be reached by them. This method known as Sequentially Timed All-optical Mapping Photography (STAMP) is based on an exploitation of spatiotemporal dispersion for repetitive “optical” shuttering of the incoming continuous image that enables sequential frame acquisition at an unprecedented rate of more than one trillion frames per second. In this talk, I discuss the history and physical limitations of the traditional imaging methods, the principles of the method, and discuss an entirely new class of applications it is anticipated to bring us, including real-time visualization of phonons for characterization of phonon devices.

Figure: Trend for the continuing evolution of motion-picture photography.