

# Matter under Extreme Conditions

Chi-Chang Kao

## SLAC National Accelerator Laboratory

Understanding the structures, properties and behaviors of matter under extreme conditions is motivated by a wide variety of reasons, ranging from astrophysicists trying to understand the origin of high energy x-rays in the universe, condensed matter and atomic/molecular physicists trying to understand electron correlations, Geophysicists trying to understand the interior of planets, to materials physicist trying to improve devices by understanding how things fails.

The study of matter under extreme conditions is coupled strongly to the advances in our ability to create these conditions, observe/measure the structure, property and behavior of matter under those conditions, and develop theoretical understanding and simulation tools to guide the experimental efforts. And, these developments often have impact beyond the original applications.

In this lecture, I will focus the discussion to a few areas of matter under extreme conditions studies which are enabled by the x-ray free electron lasers (FEL). The very short pulse duration and the high x-ray intensity within the pulse allow the study of structures of matter, both electrons and ions, and the evolution of these structures with unprecedented spatial and temporal resolution. Selected examples, including plasma physics, condensed matter physics, materials physics will be used to illustrate the range of conditions in temperature, pressure and electric and magnetic fields can be achieved and the structural information can be obtained.