Abstract: The physical world is filled with cellular structures – both man made, like truss bridges, and of natural origin, like porous bone tissue. These entities, along with many other examples, large and small, are demonstration of a material response being optimized through topology rather than composition. Cellular materials have received significant attention over the last several decades for their thermal, electrical, and optical properties as well as for their potential as lighter weight replacements for bulk materials. Conventional material design relies on manipulation of chemistry or phase fractions (for multi-phase systems) or microstructural length scales, such as grain size distributions. However, with the advent of additive manufacturing (AM) it is now possible to manipulate the architecture of the cellular material to impart order and periodicity into materials at the mesoscopic scale and go beyond the notion of simply seeding random porosity. The ability to organize the structure and composition at the mesoscopic scale allows the custom design of materials by applying structural engineering principles, like truss theory, at the micron length scale. This will open up the possibility of designing and engineering material properties to precisely meet the demands of the intended application. Recent reports in the literature have shown impressive mechanical properties for such architected materials. These studies have tended to focus on the linear elastic behavior of such structures, but at LLNL we also have a strong interest in the non-linear response. The presentation will focus on issues such as wave propagation through an open structure, in contrast to a bulk solid, as well as the contrast between the topologically-informed collective response vs the local (or nodal) response of lattice structures. These issues will be highlighted using recent in situ experiments at various synchrotron x-ray light sources around the US.

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Biography: Dr. Mukul Kumar leads the Mechanics of Materials Group in addition to being the LLNL Point-of-Contact to the Dynamic Compression Sector at the Advanced Photon Source (Argonne National Laboratory). His project work has spanned materials development for high temperature and radiation environments, dynamic behavior of materials, in-situ monitoring of materials response under various loading conditions, and microstructural characterization using various microscopy tools. He earned his PhD from the University of Cincinnati and also spent time at Johns Hopkins University as a post-doctoral fellow prior to joining LLNL.