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Probing Complex Structural Behaviour in Dynamically Compressed Matter Using Ultrafast X-ray Diffraction[1]

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Over the last 25 years, the static compression community has found that structural complexity is almost ubiquitous in high-density matter, even in the elemental metals. And modern structure prediction methods have reported that this complexity continues to ultra-high pressures. The prediction that aluminum will adopt an incommensurate hostguest structure at multi-TPa pressures is particularly noteworthy [1]. As such compressions can only be achieved dynamically, two fundamental questions arise. Firstly, are such complex structural forms able to form on the nanosecond timescales of dynamic compression experiments, and, secondly, if they do, how can we determine their structures? We are currently conducting campaigns at both NIF and LCLS to address and answer these questions, using nanosecond and femtosecond x-ray diffraction to detect phase changes, including melting, and determine the detailed structural response to dynamic compression. A particular aim is to obtain structural data on a par with that long available in static compression research. An overview of recent results from these campaigns, and comparisons to previous studies, will be given. [1] C.J. Pickard and R.J. Needs. Nature Materials **9**, 624627 (2010).

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