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Ultrafast compression: past, present, and future[1]

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In the nearly 20 years since the first sub-ps time resolution compression wave measurements, ultrafast compression experiments have progressed from simple demonstrations to robust discoveries of extreme phenomena spanning material plasticity, solid-solid phase transitions, and shock induced chemistry. At strain rates above 10^9 s^{-1}, many usual assumptions about material response no longer apply – virtually every system investigated on sub-ns time scales exhibits phenomena which are unfamiliar to conventional intuition about compression waves. This diverse of range of phenomena reflects the fundamental complexity of dynamic material behavior, but it has also been a significant impediment to a full understanding of material compression. Nonetheless, ultrafast experiments afford a number of practical advantages, primarily related to scale. Using an inexpensive table-top laser, it is possible to obtain information on materials at extreme conditions with a low laser pulse energy and a high data rate. In this talk, I will briefly review the history of ultrafast compression, significant results, and future opportunities.

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