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Quantum Hooke's Law to Classify Pulse Laser Induced Ultrafast Melting[1] HAO HU, University of Utah, Xi'an Jiaotong University, HEPENG DING, FENG LIU, University of Utah — We investigate the ultrafast crystal-to-amorphous phase transition induced by femtosecond pulse laser excitation by exploiting the property of quantum electronic stress (QES) induced by the electron-hole plasma, which follows quantum Hooke's law. We demonstrates that two types of crystal-to-amorphous transitions occur in two distinct material classes: the faster nonthermal process, having a time scale shorter than one picosecond (ps), must occur in materials like ice having an anomalous phase diagram characterized with $dT_m/dP < 0$, where T_m is the melting temperature and P is pressure; while the slower thermal process, having a time scale of several ps, occurs preferably in other materials. The nonthermal process is driven by the QES acting like a negative internal pressure, which is generated predominantly by the holes in the electron-hole plasma that increases linearly with hole density. These findings significantly advance our fundamental understanding of physics underlying the ultrafast crystal-to-amorphous phase transitions, enabling quantitative a priori prediction.

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