Disorder and melting in doped solid helium studied by dopant laser spectroscopy

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Optical spectra of foreign atoms and molecules embedded in liquid or solid helium provide information about the local properties of cryogemic fluid/solid quantum matrices. In particular, the embedded metal atoms reside in nanometer-sized cavities known as atomic bubbles and their optical properties are very sensitive to variations of the density and the anisotropic elasticity of the He matrix [1]. The dopants can thus be used as microscopic sensors for time-resolved studies of He solidification and melting.
We present an experimental study of laser-induced fluorescence spectra of Cs-doped solid ^{4}He, heated locally by intense nanosecond laser pulses. The observed spectra are compared with quantum fluid/solid bubble model predictions and with the results of line broadening theory for high density gas phase atomic collisions.
Our results indicate that the fast local heating of crystalline He produces a disordered solid with a large number of defects. The defects have a pronounced effect on the shift and broadening of the atomic bubble spectra that cannot be predicted by conventional atomic bubble models. At sufficiently high laser pulse energies we observe a transient local melting of the crystal that leads to a strongly inhomogeneous sample with embedded micro-bubbles of relatively hot pressurized He fluid. A further increase of the laser power induces a macroscopic melting of the sample.

1. P. Moroshkin, A. Hofer, A. Weis, Physics Reports **469**, 1 (2008).

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