Dendritic Growth & Melting in Pure Systems

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Dendritic growth experiments conducted in low-Earth orbit provide copious growth and melting data under convection-free (diffusive) conditions. Video data retrieved from the last space flight were subjected to spectral and coherency analyses that provide evidence for persistent frequencies related to branching waves. These results are in accord with Xu's "trapped-wave" theory that also predicts the occurrence of eigenfrquencies. The video data also show that when dendrites are heated, they fragment into spheroidal crystallites that melt at nearly constant aspect ratios. The melting kinetics of prolate spheroidal crystals (for which moving boundary solutions, such as Ham's similarity solutions, and stability analyses do not exist) were analyzed instead as quasi-static interactions using potential theory. Excellent absolute agreement was found between the video-recorded experiments and the kinetics of melting based on quasi-static diffusion theory . Implications of this research to understanding mushy zone dynamics will be discussed.