

Abstract Submitted  
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**The Origin and Evolution of Icicle Ripples** ANTONY SZU-HAN CHEN, STEPHEN W. MORRIS, University of Toronto — Natural icicles often exhibit ripples about their circumference which are due to a morphological instability. We present an experimental study that explores the origin of the instability, using laboratory-grown icicles. Contrary to theoretical expectations, icicles grown from pure water do not exhibit growing ripples. The addition of a non-ionic surfactant, which reduces the surface tension, does not produce ripples. Instead, ripples emerge on icicles grown from water with dissolved ionic impurities. We find that even very small levels of impurity are sufficient to trigger ripples, and that the growth speed of the ripples increases only approximately logarithmically with impurity concentration. With impurities present, the ripple wavelength remains constant under all other variations of the growth conditions. Ripples are observed to travel during their growth. For low impurity concentrations, they travel upward at speeds of mm/hr. For higher impurity concentrations, some ripples moved nonlinearly and different ripples on the same icicle sometimes traveled in opposite directions. Existing theories of ripple formation do not account for the effect of impurities and cannot be easily generalized to include them.

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