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Freezing a rivulet ANTOINE MONIER, Sorbonne Universit, CNRS, UMR 7190, Institut Jean Le Rond d'Alembert; F -75005 Paris; France, AXEL HUERRE, CHRISTOPHE JOSSERAND, Laboratoire d'Hydrodynamique (LadHyX), UMR 7646 CNRS-Ecole Polytechnique, IP Paris, 91128 Palaiseau CEDEX, France, THOMAS SON, Sorbonne Universit, CNRS, UMR 7190, Institut Jean Le Rond d'Alembert; F -75005 Paris; France, LABORATOIRE D'HYDRODYNAMIQUE (LADHYX), UMR 7646 CNRS-ECOLE POLYTECHNIQUE, IP PARIS, 91128 PALAISEAU TEAM, SORBONNE UNIVERSIT, CNRS, UMR 7190, INSTITUT JEAN LE ROND D'ALEMBERT; F -75005 PARIS; FRANCE TEAM — We study experimentally the solidification of a water rivulet flowing down an inclined plane cooled to subzero temperatures. The growth of the ice is described by two successive regimes with different dynamics. First, the ice grows as if the water was not flowing, well described by a classical 1D Stefan problem. Then, thermal convection from the constant water supply starts to play a role in the solidification process. Finally, the system reaches a stationary state where water flows on a peculiar ice structure. The surprising linear geometry of this structure, with distance from the water injection point, is explained trough scaling arguments. The physical explanation relies on the growth of the water boundary layer with respect to the finite size of the water rivulet. When the thickness of the thermal boundary layer reaches the free surface, the surface temperature of the water decreases with the plane position, allowing us to recover the linear behavior of the ice structure.

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