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Hydrodynamic X-Waves[1] JAMES N. STEER, ALISTAIR G. L. BORTHWICK, The University of Edinburgh, MIGUEL ONORATO, Universita di Torino, AMIN CHABCHOUB, The University of Sydney, TON S. VAN DEN BREMER, University of Oxford — Stationary wave groups exist in a wide range of nonlinear dispersive media: optics, Bose-Einstein condensates, plasma, and hydrodynamics. Unidirectional hydrodynamic stationary groups have been widely investigated. However, in two-dimensional propagation, the observation of stationary wave groups becomes more difficult because of dispersion, diffraction, and nonlinear effects. Here, we report experimental observations of nonlinear gravity-driven X-waves, i.e., X-shaped wave envelopes that propagate with constant form on the water surface. These can be constructed and described within the framework of higher-dimensional nonlinear Schrödinger equations (NLSEs). The 2D+1 NLSE predicts wave stability and balance between dispersion and diffraction when the envelope consisting of the arms of the X travel at an angle of $\pm\text{atan}(1/\sqrt{2}) \approx \pm 35.26$ to the direction of travel of the carrier wave. Moreover, we analyse in detail the single crossed-wave component and find that group dispersion decreases to a minimum at the nondispersive crossing angle of approximately ± 35.26. Our results may motivate investigations in other physical media, governed by weakly nonlinear evolution equations and improve understanding of extreme event lifetime.

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