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Wave tank experiments on Peregrine type surface gravity waves

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Today, the existence of oceanic rogue waves and rogue wave holes is no longer doubted. A number of physical mechanisms can describe the sudden occurrence of such extreme wave events. Within the framework of the nonlinear Schrödinger equation (NLS) which describes the evolution in space and time of weakly nonlinear deep-water wave trains, rogue waves result from the nonlinear interactions of an envelope soliton with a carrier plane wave. Breather solitons are well-known as pulsating solutions of the NLS. However, only very recently the Peregrine breather has also been detected experimentally in nonlinear optics, in deep-water surface gravity waves and in multi-component plasma. The special feature of the Peregrine soliton is that it is localized in both space and time, breathes only once and amplifies the amplitude of a plane wave by a factor of three. Therefore, it is considered to be an appropriate prototype for modeling ocean rogue waves or rogue wave holes appearing from nowhere and disappearing without a trace. Results on laboratory studies on such waves are presented. A discussion on the influence of the carrier steepness on the shape of the soliton, thus on the shape of the extreme wave, is presented. Fundamental properties such as the lifetime and travel distance of Peregrine type waves are also discussed. In addition, further experimental results on the Peregrine solution evolving in chaotic wave fields are shown. The nonlinear theory also predicts that in addition to the unique peregrine solution there is an infinite hierarchy of NLS higher-order breather solutions which are also localized in both space and time. A remarkable property of these breathers is that they boost the amplitude of the carrier wave by a factor of five and higher. Some first results on experimental studies of such higher-order breather solutions in a water wave tank are shown.