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On 3-D Freak Waves Caused by Modulational Instability

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We pursue the idea that freak waves might result from evolution of the modulational (Benjamin-Feir) instability. The study is carried out within the framework of a simplified weakly nonlinear model, that of the Davey-Stewartson equations for the envelope of a narrow-banded wave train. We examine the perturbations which *attain large amplitudes at the moment of observation* due to instability of initial infinitesimal perturbations of a uniform train *and then again disappear*.

We address the following questions:
(i) What is the most general mathematical description of the generic perturbations of this type? (ii) What is the maximal amplitude of such perturbations in 2-d and 3-d settings? (iii) What specific conditions should the initial conditions for perturbations obey for the perturbations to attain substantial amplitudes?

Employing the inverse scattering transform technique we find that the simplest representative of the class of generic perturbations satisfying our conditions is the so-called Ma soliton, while the most general form of such motions is described by "N-Ma-soliton" solutions. We show that the highest wave amplitude of *generic* perturbations emerging from infinitesimal initial perturbations always equals thrice the amplitude of the unperturbed wave in both two and three dimensions. We also establish the criterion selecting small initial perturbations evolving into "generic freak waves".