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A Hamiltonian and its Birkhoff normal form for water waves

A 1968 paper by VE Zakharov gives a formulation of the equations for water waves as a Hamiltonian dynamical system, and shows that the equilibrium solution is an elliptic stationary point. This talk will discuss two aspects of the water wave equations in this context. Firstly, we generalize the formulation of Zakharov to include overturning wave profiles, answering a question posed to the speaker by T. Nishida. Secondly, we will discuss the question of Birkhoff normal forms for the water waves equations in the setting of spatially periodic solutions. We transform the water wave problem with nonzero surface tension to third order Birkhoff normal form, and in the case of zero surface tension in deep water, to fourth order Birkhoff normal form. The result includes a discussion of the dynamics of the normal form, and a quantification of the function space mapping properties of these transformations.