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Extended Lagrangian approach for the defocusing Non-Linear Schrödinger equation

Monday, September 2, 2019 4:30 PM (30 minutes)

We study the defocusing Non-Linear Schrödinger (NLS) equation written in hydrodynamic form through the Madelung transform. From the mathematical point of view, the hydrodynamic form can be seen as the Euler-Lagrange equations for a Lagrangian submitted to a differential constraint corresponding to the mass conservation law. The dispersive nature of the NLS equation poses some major numerical challenges. The idea is to introduce a two-parameter family of extended Lagrangians, depending on a greater number of variables, whose Euler-Lagrange equations are hyperbolic and accurately approximate NLS equation in a certain limit. The corresponding hyperbolic equations are studied and solved numerically using Godunov type methods. Comparison of exact and asymptotic solutions to the one-dimensional cubic NLS equation ('grey' solitons and dispersive shocks) and the corresponding numerical solutions to the extended system was performed. A very good accuracy of such a hyperbolic approximation was observed. This is a joint talk with Firas Dhaouadi and Nicolas Favrie.

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