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Low regularity Fourier integrators

Nonlinear Schrödinger equations are usually solved by pseudo-spectral methods, where the time integration is performed by splitting schemes or exponential integrators. Notwithstanding the benefits of this approach, its successful application requires additional regularity of the solution. For instance, second-order Strang splitting requires four additional derivatives for the solution of the cubic nonlinear Schrödinger equation.

In this talk, we introduce as an alternative low regularity Fourier integrators. They are obtained from Duhamel's formula in the following way: first, a Lawson-type transformation eliminates the leading linear term and second, the dominant nonlinear terms are integrated exactly in Fourier space. For nonlinear Schrödinger equations, first order convergence of such methods only requires the boundedness of one additional derivative of the solution, and second-order convergence the boundedness of two derivatives. This allows us to impose lower regularity assumptions on the data. Numerical experiments underline the favorable error behavior of the newly introduced integrators for low regularity solutions compared to classical splitting and exponential integration schemes.

This is joint work with Marvin Knöller and Katharina Schratz (KIT, Karlsruhe).