Dispersive Equations

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Airy and Schrödinger-type equations on looping-edge graphs

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The aim of this work is to study the Airy and Schrödinger operators on looping-edge graphs, a graph consisting of a circle and a finite number N of infinite half-lines attached to a common vertex. Characterizations of extensions generating unitary and contractile dynamics are provided for the Airy operator in terms of self-orthogonal subspaces and linear operators acting on indefinite inner product spaces (Krein spaces) associated to the boundary values at the vertex. Employing the same abstract techniques used in the former case, we characterize the self-adjoint extensions of the Schrödinger operator on $\mathcal{T}$-shaped graphs, *i.e.*, to graphs that consists of an internal edge that can be identified with $[-L, 0]$ and a finite amount of half-lines $[0, \infty)$ attached to a common vertex identified with $\nu = 0$. The theory established in this manuscript can be considered as a first step towards a better understanding of the dynamics for the remarkable dispersive models NLS and KdV on metric graphs.

Well-Posedness for the Extended Schrödinger-Benjamin-Ono System

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In this study, we investigate the local well-posedness of the initial value problem for the *Schrödinger-Benjamin-Ono type system*:

$$\begin{cases} i\partial_t u + \partial_x^2 u = uv + \beta u|u|^2, \\ \partial_t v - \mathcal{H}\partial_x^2 v + \rho v \partial_x v = \partial_x(|u|^2), \\ u(x,0) = u_0(x), \quad v(x,0) = v_0(x), \end{cases}$$

where $\beta, \rho \in \mathbb{R}$. The analysis is conducted for initial data $(u_0, v_0) \in H^{s+\frac{1}{2}}(\mathbb{R}) \times H^s(\mathbb{R})$ with $s > \frac{5}{4}$.

Our approach leverages energy methods combined with compactness arguments. A notable difficulty stems from the asymmetry of the nonlinear terms, which requires adapting the standard energy functional to control problematic terms arising in the estimates effectively.

To further advance the results and lower the regularity threshold below the Sobolev limit $s = \frac{3}{2}$, we employ a refined Strichartz estimate. This estimate, initially proposed by Koch and Tzvetkov in the context of the Benjamin-Ono equation and subsequently refined by Kenig and Koenig, plays a critical role in addressing challenges associated with reduced regularity.