Applied Mathematics Seminar

Unconditional uniqueness for the cubic Gross-Pitaevskii hierarchy via quantum de Finetti

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Abstract: The derivation of nonlinear dispersive PDE, such as the nonlinear Schroedinger (NLS) or nonlinear Hartree equations, from many body quantum dynamics is a central topic in mathematical physics, which has been approached by many authors in a variety of ways. In particular, one way to derive NLS is via the Gross-Pitaevskii (GP) hierarchy, which is an infinite system of coupled linear non-homogeneous PDE. The most involved part in such a derivation of NLS consists in establishing uniqueness of solutions to the GP. Erdös-Schlein-Yau developed an approach for proving uniqueness based on use of Feynman graphs. A key ingredient in their proof is a powerful combinatorial method that resolves the problem of the factorial growth of number of terms in iterated Duhamel expansions. Motivated by the idea that techniques from nonlinear PDE might be useful at the level of the GP, recently with T. Chen, C. Hainzl and R. Seiringer we obtained a new, simpler proof of the unconditional uniqueness of solutions to the cubic Gross-Pitaevskii hierarchy in $\mathbb{R}^3$. In our work, we employ the quantum de Finetti's theorem (which a quantum analogue of the Hewitt-Savage theorem in probability theory) as a direct link between the NLS and the GP hierarchy. In the talk, we will present a brief review of the derivation of NLS via the GP, describing the context in which the new uniqueness result appears, and will then focus on the uniqueness result itself. The talk is based on the joint work with T. Chen, C. Hainzl and R. Seiringer.

Monday, November 17 at 4:00 PM in SEO 636