Scuola tematica "Modern Trends in Pure and Applied Mathematics"



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S. Cenatiempo (Gran Sasso Science Institute, L'Aquila) - Seminar "Macroscopic behaviour of dilute Bose gases: the Gross-Pitaevskii equation"

Friday, 30 May 2025 12:10 (45 minutes)

Since the early experiments on Bose-Einstein condensation in cold atomic gases, the Gross-Pitaevskii equation has emerged as a unique tool for describing both the equilibrium and dynamical properties of dilute Bose gases at low temperature. From a mathematical perspective, pioneering works by Lieb, Seiringer and Yngvason (2000) and Erdös, Schlein and Yau (2010) have shown that the Gross-Pitaevskii equation can be rigorously derived from the many-body Schrödinger equation in a suitable scaling limit, known as the Gross-Pitaevskii regime. In this regime N interacting bosons are trapped in a region with volume of order one, and interact through a two body potential whose scattering length is of order 1/N, and N tends to infinity.

In this talk we discuss recent methods, developed since 2019, for characterizing fluctuations around the effective description provided by the Gross-Pitaevskii equation. These methods - valid for integrable interactions - offer a rigorous implementation of an heuristic theory due to Bogoliubov (1957), in a regime where Bogoliubov's approximations do not hold. Based on joint works with C. Boccato, C. Brennecke, C. Caraci, B. Schlein.