University of Crete
Department of Physics

Physics Colloquium

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Soliton gases in integrable PDEs: theory and experiments

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ABSTRACT

Strongly non-linear media, whether they are quantum or classical, quickly dissipate the fine structure of initial conditions in favor of the emergence of statistical mechanics and hydrodynamics, governed by conservation laws only. On the other hand, nonlinearities make such a thermodynamic description difficult to handle analytically. Integrable partial differential equations (PDEs) offer an unprecedented venue for this program, leveraging exact analytical solutions through the approach of soliton gases, first introduced in the 80's. While appealing, this approach has been known to fail in several important cases, remaining an open challenge until recently.

In this talk, I will examine the limitations of the conventional soliton gas approach, use methods from quantum integrability to tackle the aforementioned pitfalls, and discuss recent experiments in optical fibers realizing the paradigmatic Non-Linear Schrödinger equation.

References:

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A. Bastianello, A. Tikan, F. Copie, S. Randoux, P. Suret, PRA 113 (1), 013514 (2026)
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