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Nonlinear PDEs and stability theory for water waves

Water waves provide a classical setting in which fundamental physical laws lead to rich mathematical structures. Starting from the Euler equations for an incompressible fluid with a free surface, one can derive reduced model equations in appropriate asymptotic regimes. These models retain essential features such as nonlinearity and dispersion while being more amenable to rigorous analysis, and they possess special solutions such as solitary and periodic travelling waves. A central question is the stability of these coherent wave patterns: do travelling waves persist under small perturbations, or do they break down through instabilities?

I will outline a classical analytical framework for stability—developed by Grillakis, Shatah, and Strauss—and illustrate it on a standard example (the Klein–Gordon equation). I will then discuss two case studies from my work that go beyond this standard setting. The first concerns transverse stability of solitary waves, where perturbations are allowed to vary in a direction orthogonal to the propagation. The second focuses on peaked travelling waves ("peakons"); I will explain mechanisms that lead to instability and what makes the analysis of non-smooth wave profiles distinctive.

March 25, 2026
15:30 – 16:30

HS 11, Architekturgebäude, Technikerstraße 21