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Well-posedness and the method of commuting flows

Completely integrable partial differential equations are regularly used as effective models for a wide array of phenomena seen in nonlinear optics, magnetohydrodynamics, Bose-Einstein condensates, and for both surface and internal waves in fluid mechanics. These equations exhibit a wide range of physical behaviors, most notably the elastic interaction of solitary waves and the soliton resolution phenomenon. While these behaviours were first witnessed in the completely integrable settings, they are robust enough to also be observed in non-integrable analogues.

Because of their significance, much effort has been devoted to the development of a complete well-posedness theory for completely integrable models. This is the question of the existence and uniqueness of solutions, as well as the continuous dependence of the solution on the initial data. Surprisingly, unlike their non-integrable cousins, completely integrable PDE have stubbornly resisted such a complete theory. In this talk I will introduce several completely integrable models, outline why they have proven so recalcitrant, and discuss recent breakthroughs on the well-posedness question that employ the method of commuting flows.