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Braided monoidal categories, braces, and the quantum Yang-Baxter equation

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Abstract

In this talk we give an introductory overview of braided monoidal categories, braces, and their role in the study of the quantum Yang–Baxter equation. Braided monoidal categories were introduced by A. Joyal and R. Street as tensor categories equipped with a categorification of the flip operator, namely a braiding. This structure allows one to define and study bimonoids and Hopf monoids within a purely categorical framework, and it provides solutions to the braid equation, known in the context of vector spaces as the quantum Yang–Baxter equation, which plays a central role in mathematical physics.

Braidings on the monoidal category of (co)modules over a bialgebra are classified by (co)quasitriangular structures on the underlying bialgebra. The classification of all solutions of the quantum Yang–Baxter equation on an arbitrary vector space remains a difficult and largely open problem. In this direction, V. Drinfeld proposed the study of set-theoretic solutions, which can be linearized to produce solutions of the quantum Yang–Baxter equation.

As a Hopf-theoretic generalization of skew braces, Hopf braces were introduced by I. Angiono, C. Galindo, and L. Vendramin. In the cocommutative setting, these structures are equivalent to matched pairs of actions on cocommutative Hopf algebras, thereby providing solutions to the quantum Yang–Baxter equation.

Generalizing cocommutative Hopf braces, Yetter–Drinfeld braces were introduced in joint work with D. Ferri by extending the correspondence with matched pairs of actions beyond the cocommutative setting, leading to new solutions of the quantum Yang–Baxter equation. Finally, S. Majid's transmutation of coquasitriangular Hopf algebras provides examples of Yetter–Drinfeld braces, whose associated solutions correspond to a braiding on the category of bicomodules.