SCIENCES &
BIOENGINEERING SCIENCES

The Research Group
Mathematics & Data Science

has the honor to invite you to the public defence of the PhD thesis of

Yufei Qin

to obtain the degree of Doctor of Sciences

Joint PhD with East China Normal University

Title of the PhD thesis:
Research on algebraic structures related to solutions of (quantum) Yang-Baxter equation

Supervisors:
Prof. Dr. Leandro Vendramin VUB)
Prof. Dr. Guodong Zhou (East China Normal University)

The defence will take place on

Thursday 25th of June, 2026 at 4.00 p.m.
VUB Etterbeek campus, Pleinlaan 2, Elsene, building I, in room I.0.01.

The defence can be followed through a live stream:
https://teams.microsoft.com/meet/314905219621681?p=9o4X87kPvYjxoiOW8y

Members of the jury

Prof. dr. Dominique Maes (VUB, Chair)
Prof. dr. Julia Plavnik (VUB & Indiana University, USA)
Prof. dr. Naihong Hu (East China Normal University, CN)
Prof. dr. Marcelo Aguiar (Cornell University, USA)
Prof. dr. Francesca Fedele (University of Leeds, UK)

Curriculum vitae

Yufei Qin obtained his master's degree in Mathematics in 2022 at East China Normal University. After graduating, he continued his joint PhD in Mathematics at East China Normal University and the Vrije Universiteit Brussel, supervised by Guodong Zhou (ECNU) and Leandro Vendramin (VUB).

With his research, he has contributed to the study of noncommutative algebra, mathematical physics, and the representation theory of associative algebras. More specifically, his work focuses on Gröbner-Shirshov bases, Yang-Baxter equations, operads, and homological algebra. His research has resulted in six papers published or accepted in peer-reviewed journals. He has also presented his work at several national and international conferences and seminars.

Abstract of the PhD research

The (quantum) Yang-Baxter equation is a fundamental equation in mathematical physics, originating in quantum and statistical mechanics. This thesis is divided into three parts and presents a concise study of several algebraic structures related to its solutions, with particular emphasis on Rota-Baxter structures on 3-Lie algebras and associative algebras, as well as on L-algebras.

The first part concerns 3-Lie algebras, which provide a natural framework for higher-order generalizations of Lie algebras and have important applications in mathematical physics. Within this set- ting, solutions to the classical 3-Lie Yang-Baxter equation are closely related to Rota-Baxter structures. We develop the representation theory, cohomology, and formal deformation theory of Rota-Baxter and modified Rota-Baxter 3-Lie algebras of arbitrary weight. We also construct two $L_\infty[1]$-algebras whose Maurer-Cartan elements correspond to relative and absolute modified Rota-Baxter 3-Lie algebra structures of non-zero weight, and compare this framework with the deformation-controlling $L_\infty[1]$-algebra introduced by Hou, Sheng, and Zhou.

The second part is devoted to associative algebras. Skew-symmetric solutions of the associative Yang- Baxter equation are closely related to double Lie algebras and cyclic Rota-Baxter algebras, especially for matrix algebras. We extend these correspondences to the homotopy setting by studying pre-Calabi-Yau algebras and homotopy double Poisson algebras arising from homotopy Rota-Baxter structures. We introduce cyclic homotopy Rota-Baxter algebras and construct them via cyclic completion. We further define interactive pairs of differential graded algebras and show that, under a suitable cyclic homotopy Rota-Baxter structure on the acting algebra, the base algebra inherits a pre-Calabi-Yau structure, hence a homotopy double Poisson structure. In particular, we show that any differential graded module over a differential graded algebra endowed with an ultracyclic (resp. cyclic) homotopy Rota-Baxter structure naturally carries a (resp. cyclic) homotopy double Lie algebra structure.

The third part studies L-algebras, motivated by set-theoretic solutions of the Yang-Baxter equation and classical logic. We characterize ideals in semidirect products of L-algebras and describe their prime spectra. We also construct a family of finite simple L-algebras, prove that every simple linear L-algebra belongs to this family, and apply these results to linear Hilbert algebras and their symmetric semidirect products.