Beyond boson normal ordering: Hopf algebra structures

P.Blasiak[1], G.H.E.Duchamp[2], A. Horzela[1], K.A.Penson[3] and A.I.Solomon[3,4]

Speaker: A. Horzela

[1]H.Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland
[2]Institut Galilée, LIPN, Université Paris-Nord, Villetaneuse, France
[3]Laboratoire de Physique Théorique de la Matiere Condensée, Université Pierre et marie Curie, Paris, France
[4]Physics and Astronomy Department, Open University, Milton Keynes, UK

Abstract

Recent work on the structure of Perturbative Quantum Field Theory (PQFT) has revealed an astonishing interplay between analysis (Riemann Zeta functions), topology (Knot theory), combinatorial graph theory (Feynman diagrams) and algebra (Hopf structure). Our intention is to display some of these structures in the context of a zero-dimensional field theory; *i.e.,* a quantum theory of non-commuting operators which do not depend on spacetime. Using combinatorial solutions to the boson normal ordering problem we demonstrate that the latter may be described by graphs analogous to the Feynman graphs of PQFT, which we show possess a Hopf algebra structure. We illustrate our approach on the example of partition function for a boson gas for which the underlying Hopf algebra is the algebra of Bell polynomials (BELL) suitable as a basis for generalizations which may be used to describe more complex physical systems.

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