

## On the Matrix Calculus of Renormalization in pQFT

**K. Ebrahimi-Fard**

*Physics Institute  
University of Bonn  
Bonn, Germany*

Connes and Kreimer uncovered a Hopf algebraic structure on Feynman graphs. The process of renormalization in perturbative quantum field theory is captured by an algebraic Birkhoff decomposition of regularized Hopf algebra characters. We use matrix representation in the context of complete filtered Rota-Baxter algebras to formulate the combinatorics of renormalization. A Rota-Baxter anti-homomorphism from the regularized functionals of the Feynman graph Hopf algebra to triangular matrices with entries in a Rota-Baxter algebra is given. We derive an algebraic Birkhoff decomposition for matrices, using Spitzers identity. This simple matrix decomposition is applied to characterize and calculate perturbative renormalization.

### References

- [1] **KE-F, J. M. Gracia-Bondia, L. Guo, and J. C. Varilly**, *Combinatorics of Renormalization as Matrix Calculus*, preprint: August 2005 hep-ph/0508154.
- [2] **KE-F and L. Guo**, *Matrix Representation of Renormalization in Perturbative Quantum Field Theory*, preprint: August 2005, hep-th/0508155.
- [3] **A. Connes and D. Kreimer**, *Renormalization in quantum field theory and the Riemann-Hilbert problem. I. The Hopf algebra structure of graphs and the main theorem*, Comm. in Math. Phys. **210**(2000), 249273. arXiv:hep-th/9912092.