

**EXERCISE III**  
**(APRIL 24 2013, TO BE HANDED IN MAY 08 2013)**

DYSON SCHWINGER EQUATIONS (KREIMER, SUMMER '13)

- 1.  
Consider  $X(\alpha) = 1 + \alpha B_+(X^n(\alpha))$  for a one-cocycle  $B_+$ .  
Set  $X(\alpha) = 1 + \sum_{j=1}^{\infty} c_j \alpha^j$ .  
Show: the  $c_j$  generate a sub Hopf algebra. Give its co-product.  
(Hint: read *Hopf algebras in renormalization theory: Locality and Dyson-Schwinger equations from Hochschild cohomology* Christoph Bergbauer, Dirk Kreimer, IRMA Lect.Math.Theor.Phys. 10 (2006) 133-164, hep-th/0506190.)
- 2.  
Give the DSE for quantum electrodynamics in your preferred notation for those Green functions which need renormalization.  
What are the one-co-cycles?
- 3.  
Read *The Hopf Algebra of Feynman Graphs in QED*, Walter van Suijlekom, LMP 77 (2006) 265-281, hep-th/0602126.