SYLLABUS FOR MA 822, SPRING 2018

Professor: Maciej Szczesny
Office: MCS 273
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Office Hours: W 1-3, F 1-2
Lecture: CAS 221, TTh 9:30-10:45

Text:

- "Renormalization and effective field theory" by Kevin Costello.

Other suggested references:

- Pavel Mnev's notes "BV formalism in TQFT".
- Pavel Etingof's notes "Mathematical ideas and notions of QFT".
- Andy Neitzke's notes "Applications of QFT to geometry".
- Bruce Bartlett's thesis "Categorical aspects of TQFT".
- Kevin Walker's notes on TQFT.
- The two-volume work on "Factorization algebras in QFT" by Kevin Costello and Owen Gwilliam.

Links to these are provided on the course webpage.

Brief Synopsis: The quantities of interest in a quantum field theory are formally defined by physicists in terms of certain infinite-dimensional integrals called "path integrals". These objects are generally ill-defined mathematically, but one can make sense of their asymptotic expansions. We will explore an approach to this developed by Kevin Costello. When the theory of interest has (gauge) symmetries, additional complications arise which are dealt with using the machinery of the BV formalism. We will attempt to frame the results in the language of modern symplectic/derived geometry

Evaluation: Weekly homework will be assigned and collected. Students will be asked to submit a final project on a topic selected in consultation with the instructor.

Material to be covered:

(1) Classical field theories and examples.
(2) Functorial QFT and path integrals.

(3) Finite-dimensional Gaussian integrals and their asymptotic expansions via Feynman diagrams.
(4) Fermionic integrals and supersymmetric localization in 0 dimensions.
(5) Perturbative QFT in $d \geq 1$ dimensions and the problem of divergences.
(6) Effective field theories and renormalization.
(7) Gauge theories and the BV formalism.