Supersymmetry (L16)

David Skinner

This course provides an introduction to the role of supersymmetry in quantum field theory, with the emphasis on mathematics rather than phenomenology. We study representations of the super Poincaré algebra in $d = 4$. We introduce superfields and construct supersymmetric actions for gauge and matter theories. The associated quantum theories are often easier to study than their non-supersymmetric cousins and some observables can even be computed exactly via localization. We also study Seiberg's non-renormalization theorems and phases of SYM theories.

Further topics may include the Witten index for SQM on a Riemannian manifold, and its relation to the Atiyah–Singer index theorem, $\mathcal{N} = 2$ theories in $d = 2$, their chiral rings and the associated A and B models, and Seiberg–Witten theory from extended supersymmetry in $d = 4$.

Pre-requisites

You will need to familiar with the material in both the QFT and General Relativity course from Michaelmas. In particular, we will assume knowledge of differential geometry to the level of Prof. Reall's notes, available at

http://www.damtp.cam.ac.uk/user/hsr1000/lecturenotes_2012.pdf

or the Lent term Part III course on Applications of Differential Geometry to Physics. It is also strongly recommended that you attend the Lent AQFT course in parallel with this one; the material on path integrals introduced in that course will be needed for this one.

Literature

1. K. Hori, S. Katz, C. Vafa *et al. Mirror Symmetry* Clay Math Monographs, AMS (2003).
2. P. Deligne, E. Witten *et al.*, *Quantum Fields and Strings: A Course for Mathematicians* vols. 1&2, AMS (1999).
3. J. Terning, *Modern Supersymmetry*, International Series of Monographs on Physics, OUP (2009).
4. E. Witten, *Supersymmetry and Morse Theory*, J. Diff. Geom. **17**, (1982) no. 4, 661-692. Also available at

   https://projecteuclid.org/euclid.jdg/1214437492

5. E. Witten, *Phases of* $\mathcal{N} = 2$ *theories in two dimensions*, Nucl. Phys. **B403** (1993) 159-222. Also available at

   https://www.sciencedirect.com/science/article/pii/055032139390033L

Additional support

Three examples sheets will be provided and three associated examples classes will be given. There will be a revision class in the Easter Term.