Proposition de Stage M2 / Thése

Supergravity and Exceptional Geometry

Henning Samtleben, professeur, Laboratoire de Physique de l'ENS de Lyon
henning.samtleben@ens-lyon.fr —— http://perso.ens-lyon.fr/henning.samtleben

String theory is a theory to describe nature at the smallest length scales, which replaces the concept of point-like elementary particles by extended strings. Its consistency requires supersymmetry and the presence of ten space-time dimensions. At low energies, and after compactification of the extra dimensions, the theory gives rise to four-dimensional effective field theories, so-called gauged supergravities. String theory is fully understood only in the perturbative regime on flat backgrounds. The natural framework beyond this regime is the so-called M-theory, the as yet unknown eleven-dimensional theory unifying the various consistent string theories. It should make the large hidden quantum symmetry groups (U-duality groups) of string theory manifest. Several recent developments have nourished the hope that the study of the underlying fundamental symmetry structures may lead to considerable progress in our understanding of the full nature of string and M-theory.

Supergravity theories have been studied as field theories in their own right since the early 1980's with supersymmetry notably improving the notorious UV behaviour of quantised gravitational theories. In particular, supergravity theories with a maximal amount of supersymmetry are still among the candidates for a consistent theory of quantum gravity. Recent computations indicate spectacular and still somewhat mysterious cancellations among the potentially fatal divergencies in their higher loop amplitudes. Among the outstanding properties of these supergravity theories are the exceptional symmetry groups (descending from string duality symmetries) that appear to organise their particle content and couplings. Only very recently some deeper understanding of these exceptional symmetries has emerged from and triggered new mathematical developments in so-called generalized and exceptional geometry. These structures generalize the concepts of Riemannian geometry underlying Einstein's gravity.

The resulting so-called exceptional field theories render manifest the duality symmetries underlying supergravity theories. They provide new and very powerful tools to study consistent truncations of higher-dimensional supergravity on non-trivial backgrounds. The goal of this project is the application of these new techniques to the study of specific string compactifications, in particular, for backgrounds that break supersymmetry, generate a cosmological constant and are of interest in the holographic gauge/gravity dualities.

[1] E. Cremmer, B. Julia and J. Scherk, Supergravity theory in eleven-dimensions, Phys. Lett. B 76 (1978) 409.
[2] C.M. Hull and P.K. Townsend, Unity of superstring dualities, Nucl. Phys. B 438 (1995) 109 (1995)
[3] E. Cremmer and B. Julia, The SO(8) supergravity, Nucl. Phys. B 159 (1979) 141.
[4] O. Hohm and H. Samtleben, Exceptional form of D=11 supergravity, Phys. Rev. Lett. 111 (2013) 231601