Physics 850 - Introduction to String Theory - Syllabus

I Introduction to Course

- Main ingredients in our theory of fundamental physics
- Open questions
- What is the Planck scale
- Effective field theory of gravity
- Why strings?

II Basic introduction to string theory

- Particle action and geodesic equation
- Nambu action, string length scale
- Polyakov action
- Quantum particle via path integral
- Polyakov path integral

III Bosonic string spectrum in various forms

- Symmetries of Polyakov action
- Light cone gauge
- Virasoro constraints and critical dimension
- Open string spectrum
- Closed string spectrum
- D-branes
- Circle compactification
- T-duality
- Orbifolds

IV Spacetime physics

- String scattering
- Low energy effective action from scattering results
- Physical significance of dilaton and anti-symmetric tensor fields
- Strings in curved spacetime and beta function
V Superstrings

- Worldsheet fermions
- Worldsheet SUSY
- super-Virasoro constraints and critical dimension
- Type I spectrum
- Type II spectrum
- Heterotic string

VI Supergravity

- $D = 10$ supergravity theories
- p-branes in supergravity
- D-branes in Type I and Type II superstrings

VII String Compactifications

- Kaluza-Klein theory
- Torus compactifications
- Supersymmetry and Calabi-Yau compactifications

VIII String Dualities

- Electric-Magnetic duality in Maxwell theory
- Electric-Magnetic duality with ’t Hooft-Polyakov monopoles
- S-duality of Type IIB
- $D = 11$ and strong coupling limit of Type IIA
- Type I and Heterotic $SO(32)$
- Horava-Witten and strong coupling limit of Heterotic $E(8) \times E(8)$