PHY655: Introduction to String Theory

2025-26, Semester - I

The formulation of a theory of quantum gravity remains the outstanding problem in theoretical physics. Methods of ordinary quantum field theory fail when applied to gravity. By positing that tiny one-dimensional strings replace point particles as fundamental objects, string theory produces a finite theory of quantum gravity. This course would introduce the ideas and methods of string theory.

Lecture outline: $40 \times (t_1 = 50$ Minutes$) = 27 \times (t = 75$ Minutes$)$.

Topics	**Details**	t
Introduction	Why String theory? Basic ingredients, Relativistic point particle	3
Quantum strings	Action and symmetries, String spectrum, Open & closed strings, Critical dimensions, D-branes	4
2D CFTs	Massless scalar, OPE, Virasoro algebra Vertex operators, Free CFTs	4
Polyakov path integral	Gauge fixing, Weyl anomaly, Scattering amplitudes, Strings in curved spacetime	4
String interactions & amplitudes	Moduli and Riemann surfaces, measure for moduli, Veneziano amplitude, Virasoro-Shapiro amplitude	4
Compactification	KK reduction in field theory, Compactification for closed strings, T-duality, Orbifolds, Open strings	4
Further developments	BRST quantization of the string, Superstrings One loop amplitudes	4

Pre-requisites: PHY681A: Quantum field theory - 1.

Evaluations : Assignments [25%]. Midsemester examination [35%] and Endsemester examination [40%].

References :

1. *String Theory Volume 1 : An Introduction to the Bosonic String*, Joseph Polchinski; **2.** *String Theory Volume 2 : Superstring Theory and Beyond*, Joseph Polchinski **3.** *Superstring Theory Volume 1*, Green, Schwarz & Witten.