Columbia University Physics G8050, Spring 2005
Advanced Mathematical Methods –
Introduction to String Theory

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- Office hour: Tuesdays 10:30 - 11:30 a.m. Appointments at other times are welcome.
- Class meeting times and place: Tuesdays and Thursdays 9 - 10:15 a.m. at 831 Pupin.
- Required textbook: String Theory Volume I by Polchinski. Highly recommended textbook: A First Course in String Theory by Zwiebach. Other recommended textbooks: Superstring Theory Volumes I and II by Green, Schwartz and Witten, and String Theory Volume II by Polchinski. An order has been placed for all of them at the University bookstore.
- This course will be essentially an introduction to the bosonic string. To whet our appetite, we will begin by quickly deriving a few key results of string theory, such as the existence of the graviton and the critical space-time dimension being 26, using light-cone quantization. After that, we will learn step by step how to quantize the Polyakov action in a covariant manner, using the tools of conformal field theory. We will proceed from perturbative calculations to non-perturbative ideas involving duality and D-branes. The approach follows closely that of Polchinski, though the level of pedagogy is probably somewhere between Polchinski, a graduate textbook, and Zwiebach, an undergraduate one. At the end, if time permits, we might discuss some relevant cosmological issues and/or give a brief overview of superstring.
- Prerequisites: it will be assumed the students are familiar with the basic concepts of general relativity (metric and curvature) and scalar field quantization (typically learned in the first semester of a field theory course). Path integral techniques will be used extensively throughout this course, and a brief review will be provided for students not familiar with them (Appendix A of Polchinski contains a nice, concise summary). Some knowledge of gauge field theory and the quantization of fermionic fields will be useful for appreciating certain aspects of the subject, which can be picked up along the way, by for instance taking concurrently the second semester of the field theory sequence (recommended), or by independent reading (Zee's Quantum Theory in a Nutshell is my personal favorite).