8.821 F2008: Applied String Theory
Approximate Course Outline

McGreevy

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1. what we know about string theory
2. D3-branes at small and large g_sN [MAGOO hep-th/9905111 §1.1]
3. AdS/CFT from scratch, no strings [Horowitz-Polchinski, gr-qc/0602037]
4. what holds up the throat? [Denef-Kachru-Polchinski, hep-th/0701050]
5. how to defend yourself from a supersymmetric field theory [Ed'H-DZF hep-th/0201253 §2–4]
6. about the $\mathcal{N} = 4$ SYM theory [Ed'H-DZF hep-th/0201253 §3]
7. big picture of correspondence [MAGOO hep-th/9905111 §3.1.2];
   strings and Strong Interactions [Maldacena, TASI 2003, hep-th/0309246, §2, §3.0]
8. 't Hooft counting [Coleman, '$\frac{1}{N}$', in *Aspects of Symmetry* or linked on course website main page; MAGOO hep-th/9905111 §1.2; Maldacena, TASI 2003, hep-th/0309246, §2]
9. scale and conformal invariance in field theory [Ginsparg, hep-th/9108028 §1, MAGOO hep-th/9905111 §2.1, Callan, "Introduction to Conformal Invariance" (linked on course website main page), perhaps Nishida-Son, 0706.3746 [cond-mat]]
10. CFT in $D > 2$ cont'd. [same refs as previous lecture]
11. geometry of AdS [*e.g.* MAGOO hep-th/9905111 §2.2, Kiritsis, Appendix K, hep-th/0309246, §3, Petersen, hep-th/9902131 §2]
12. geometry of AdS cont'd.[Petersen, hep-th/9902131 §2]; wave equation in AdS [hep-th/0309246, §3]
13. masses of fields and dimensions of operators [hep-th/0309246 §4; MAGOO 3.3]; BF-allowed tachyons.
14. how to compute two-point correlators of scalar operators [hep-th/0309246 §4; MAGOO 3.3; primary sources: GKP, hep-th/9802109, Witten, hep-th/9802150 §2.4, 2.5]
15. preview of real-time issues; two-point functions in momentum space, cont'd [same refs as previous lecture]; more on low-mass^2 fields in AdS [Klebanov-Witten, hep-th/9905104]

16. three-point functions, anomalies [MAGOO §3.2.2, §3.3.2; hep-th/0201253 §8.4, 8.5; primary sources: Freedman-Mathur-Matusis-Rastelli, hep-th/9804058; Witten, hep-th/9802150 §2.4, 2.5]; expectation values [Klebanov-Witten, hep-th/9905104, p. 9]

17. Wilson loops [Kiritsis §13.9, MAGOO §3.5]

18. Wilson loops, cont'd [same refs, plus hep-th/9904191, hep-th/9809188.]

19. pointlike probes of the bulk [MAGOO §3.5.2, Graham-Witten, hep-th/9901021, Fidkowski et al, hep-th/0306170]; baryons and branes in AdS [MAGOO §4.2, hep-th/0003075]; 'non-spherical horizons' [MAGOO §4.1]

20. brief survey of other examples of the correspondence (M2, M5, D1-D5, Dp, branes at singularities) [MAGOO §4.1, §6.1, IMSY, hep-th/9802042];

    a model of confinement [MAGOO §6.2, hep-th/0306246 §6].

21. confinement, cont'd: how to measure the spectrum, proof of mass gap [hep-th/9803131 §3.3, MAGOO §6.2, hep-th/0306246 §6];

22. black hole mechanics, classical and quantum [Jacobson, §2, 3; Townsend, *Black Holes*, gr-qc/9707012, Chapter 6.]

23. AdS black holes and thermal gauge theory: equation of state, free energy and stress tensor

24. Hawking effect for interacting field theories and BH thermodynamics [Jacobson §3, Susskind-Lindesay ch. 3]

25. AdS black holes and thermal gauge theory: Polyakov-Susskind loop, screening, quasinormal modes [MAGOO §3.6]

    Hawking-Page transition [hep-th/9803131]

Literature: Unfortunately, there isn't a textbook yet which follows the path in store for us. Books and papers which we may find useful include:

Juan Maldacena, "TASI lectures on AdS/CFT," hep-th/0309246.
MAGOO, "Large N Field Theories, String Theory and Gravity," hep-th/9905111.
Eric D' Hoker and Dan Freedman, "Supersymmetric gauge theories and the AdS / CFT correspondence," hep-th/0201253.
Igor Klebanov, "TASI lectures: Introduction to the AdS/CFT correspondence," hep-th/0009139.
Lenny Susskind, James Lindesay, *An Introduction to Black Holes, Information, and the String Theory Revolution: The Holographic Universe*, World Scientific, 2005.
Daniela Bigatti, Lenny Susskind, "TASI Lectures on the Holographic Principle," hep-th/0002044.
Jacobson, 'Introductory Lectures on Black Hole Thermodynamics,'

`http://www.glue.umd.edu/~tajac/BHTlectures/lectures.ps`

Juan Maldacena, "Black holes in string theory" hep-th/9607235.
Dam Son and Andrei Starinets, "Viscosity, Black Holes and Quantum Field Theory," 0704.0240 [hep-th].
Pavel Kovtun, lectures on hydrodynamics, to appear, hopefully before the end of the semester.
Elias Kiritsis, *String Theory in a Nutshell*, Princeton, 2007.
Beckers, Schwarz, *String Theory and M-Theory: A Modern Introduction*, Cambridge.