PHY 858, Fall 2007
Theory and Phenomenology of Extra Dimensions

General Information:
Class location/time: Mondays and Wednesdays, 10 to 11.15 am., Room 4208, Physics Building

Instructor: Kaustubh Agashe, 4119 Physics Building, Phone: (301) 405-6018, E-mail: kagashe@umd.edu

Office Hours: Mondays and Wednesdays after class and by appointment

Motivation:
Theories with the fields of the Standard Model (SM) of particle physics propagating in extra dimensions have been widely studied in the past few years. In this course, the motivations for such a scenario will be explained, which include solving problems of the SM such as the enormous hierarchy between the Planck and the weak energy (or mass) scales and the puzzle of the pattern of quark and lepton masses and mixing angles. There are also cosmological implications of extra dimensions, in particular new dark matter candidates. Signals for these models in high energy collider and also low-energy experiments will be explored. As and when required, brief review of SM theory and phenomenology will be given. The main message of this course is that extra dimensions appear as towers of new, heavy particles called Kaluza-Klein (KK) modes - one for each SM particle - and with quantum numbers identical to the SM particles. These KK modes simply correspond to the non-trivial excitations of the SM particles in the extra dimension and lead to the new effects mentioned above. One of the goals of this course will be to learn how to calculate such effects.

Who should take this course:
The target audience is graduate students who wish to do research in the area of elementary particle theory (and to a lesser extent cosmology theory). It might also be useful for those planning to do research in high energy *experiments*.

Prerequisites:
Familiarity with Quantum Field Theory and Particle Physics, in particular the Standard Model.

References:
For lectures on extra dimensions, see:
http://scipp.ucsc.edu/ haber/tasi_proceedings/dienes.ps (K. Dienes)
http://arxiv.org/abs/hep-ph/0404096 (C. Csaki)
http://arxiv.org/abs/hep-th/0508134 (R. Sundrum)

For reviewing Standard Model, see:
Introduction to High Energy Physics (Perkins)
Gauge Theory of Elementary particle Physics (Cheng and Li)
Dynamics of the Standard Model (Donoghue, Golowich and Holstein)

Tentative Outline of Lectures:

- Lectures 1-5:
  Review of Standard Model, including Glashow-Iliopoulos-Maiani (GIM) mechanism and Custodial Isosoin Symmetry

- Lectures 5-10:
  Basics of Kaluza-Klein Decomposition in *Flat* Spacetime; Fermion Chirality from Orbifold; Solution to Flavor *Puzzle* using Exponential Fermion Profiles in Extra Dimension

- Lectures 10-15:
  Flavor *Problem* from Fermion Profiles; Solution using Large Brane Kinetic Terms

- Lectures 15-20:
  Electroweak Precision Tests; Solution to ρ Parameter Problem using Custodial Isospin Symmetry in Extra Dimension; Collider Phenomenology

- Lectures 20-25:
  Relation of Flat Extra Dimensional Model to *Warped* Spacetime; a "Complete" Model

- Lectures 25-...:
  Other Types of Extra Dimensional Models