Cornell High Energy Theory Group

Department of Physics, Institute for High Energy Phenomenology
Cornell Laboratory for Accelerator-based Sciences and Education

Cornell Particle Theory

Cornell University

Faculty and Postdocs

Csaba Csáki (Professor; PhD MIT 1997, Adviser: Lisa Randall)

Beyond the Standard Model. Recent work includes Randall-Sundrum models, buried Higgs, EWSB and SUSY breaking through monopole condensation. Current students: David Curtin (2011), Flip Tanedo.

Yuval Grossman (Professor; PhD Weizmann 1997, Adviser: Yosef Nir)

Flavor physics beyond the Standard Model. Recent work includes lepton flavor symmetries, leptogenesis, CP violation, composite neutrinos, and spin determination. Current students: Itay Nachshon, Yuhsin Tsai, Josh Berger, Dean Robinson, Mario Martone.

Liam McAllister (Asst. Professor; PhD Stanford 2005, Adviser: Shamit Kachru)

String theory and cosmology. Recent work includes inflation and the CMB, sequestering, SUSY breaking, holographic RG. Current students: Gang Xu (2011), Thomas Bachlechner, Sohang Gandhi, David Marsh, Ben Heidenreich

André LeClair (Professor; PhD Harvard 1987, Adviser: Luis Alvarez-Gaumé)

Applications of QFT to condensed matter systems. Recent work with graduate students includes quantum gases, high Tc superconductivity, and symplectic fermion models. Current students: Pye-Ton How (2011)

Maxim Perelstein (Assoc. Professor; PhD Stanford 2000, Adviser: Lance Dixon)

EWSB and experimental phenomenology. Recent work includes dark matter, SUSY sum rules, collider physics of the LHC.
Current students: Bibhushan Shakya, Mike Saelim

Henry Tye (Professor; PhD MIT 1974, Adviser: Francis Low)

String theory and string cosmology. Recent work includes gluon/graviton scattering amplitudes, resonant tunneling in QFT, multi-field inflation, brane inflation. Currently director of the Institute for Advanced Study in Hong Kong. Current students: Dan Wohns (2011), Yang Zhang (2011)

Eanna Flanagan (Professor; PhD Caltech 1993, Adviser: Kip Thorne)

GR and QFT in curved spacetime. Recent work includes gravitational lensing, post-Newtonian gravity, brane-world models, Chern-Simons gravity. Current students: Naresh Kumar, Jolyon Bloomfield, Justin Vines.

Paul Ginsparg (Professor; PhD Harvard 1981, Adviser: Ken Wilson)

2002 MacArthur Fellow. Current interests include quantum field theory, digital knowledge networks. Recent work includes the use of statistical mechanical techniques for new clustering algorithms for arXiv.org.

Toichiro Kinoshita (Professor Emeritus; PhD Tokyo 1952; Sakurai Prize 2001)
Sakurai & Wick prizes, National Academy of Sciences. Tom is an expert on high-loop QED corrections to the anomalous magnetic moment of the electron.

Peter Lepage (Professor, Dean of College of Arts & Sciences ; PhD Stanford 1978)
Currently the Dean of the College of Arts & Sciences, Peter Lepage has made major contributions to lattice QCD.

Kurt Gottfried (Professor Emeritus; PhD MIT 1955)
In addition to his work on elementary particle physics, Kurt Gottfried is the founder of the Union of Concerned Scientists.

Tung-Mow Yan (Professor Emeritus; PhD Harvard 1968)
Tung-Mow Yan co-authored a well-known quantum mechanics text with Kurt Gottfried and is known for his work in heavy quark physics.

Brando Bellazzini (Postdoc: 2008-2011; PhD INFN Pisa; Adviser: Riccardo Barbieri)
'Double protection' models, buried and charming Higgs models.

Monika Blanke (Postdoc: 2009-2012; PhD TU Munich 2009; Adviser: Andrzej Buras)
Flavor physics, Randall-Sundrum models, SUSY sum rules at colliders.

Paul McGuirk (Postdoc: 2011-2014; PhD Wisconsin-Madison 2011; Adviser: Gary Shiu)
Theory and phenomenology of warped compactifications.

Enrico Pajer (Postdoc: 2008-2011; PhD Munich 2008; Adviser: Dieter Lüst & Michael Haack)
Non-Gaussianity in the CMB, brane inflation models.

Javier Serra (Postdoc: 2011-2014; PhD Universitat Automa de Baarcelona 2011; Adviser: Pomarol)
Composite Higgs and composite top models.

Timm Wrase (Postdoc 2010-2012; PhD Texas 2008)
Flux compactifications, dualities.

Research topics (plotted by energy scale)

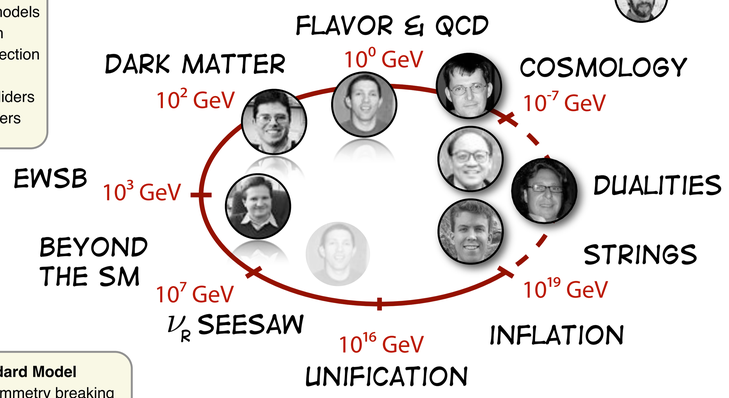
Collider & Cosmological Phenomenology
- BSM collider signatures including SUSY, extra dimensions, little Higgs models
- LHC model discrimination
- Dark matter (in)direct detection
- Dark matter at colliders
- Spin determination at colliders
- Novel signatures at colliders

Flavor Physics
- Discrete flavor groups
- Composite leptogenesis
- Heavy quark flavor physics
- Neutrino mass and mixing
- Flavor signatures of new physics

Home of arXiv.org, the e-print archive

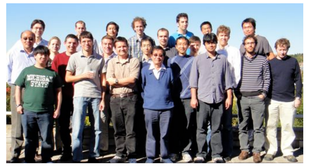
The Cornell Library is currently the home of arXiv.org and is a leader in information science.

Collaboration
- CMS, CDF, CLEO experimentalists
- Cosmology via the space sciences dept.
- Associate members from the Syracuse theory group



String Theory & Cosmology
- Stringy models of inflation and their signatures on the CMB, including brane inflation, axion monodromy inflation, and N-flation
- Geometric transitions
- Supersymmetry breaking (sequestering in string theory)
- Graviton and gauge boson scattering amplitudes
- AdS/CFT
- Holographic condensed matter
- Cosmic strings
- Tunneling phenomena
- The duality cascade
- Flux compactifications

Models Beyond the Standard Model
- Models of electroweak symmetry breaking
- Models of extra dimensions
- Metastable supersymmetry breaking
- Monopole condensation
- Buried and charming Higgs models
- Higgsless models
- AdS/QCD correspondence
- Little Higgs models



2D Conformal Field Theory
- High Tc superconductivity
- Symplectic fermions
- Quantum gases

Particle Phenomenology

Beyond the Standard Model
Our group has a broad range of expertise in particle phenomenology from top-down model building to signatures and model discrimination at experiments (including colliders, flavor factories, and cosmology). Our students have a chance to develop a unique background in particle theory that will prepare them to work at the frontier of theoretical and experimental developments in the next decade.

Working closely with experiments
Members of the group work closely with local experimentalists who work at the Tevatron (CDF) and LHC (CMS). In the past this has included theory graduate students developing computer tools to assist the simulation of new physics (BRIDGE), and regular meetings to discuss topics in collider phenomenology of common interest. Former graduate students have been able to take advantage of the availability of particle experimentalists to develop new model building ideas (e.g. General Gauge Mediation).

Collaborators
Particle theory faculty, postdocs, and students from nearby Syracuse University regularly visit and work closely with our group. Associate members of the LEPP theory group include Jay Hubisz, Scott Watson, Simon Catterall, and Cristian Armendariz-Picon. Our faculty work with a number of theorists from across the country and help students develop their own network of collaborators.

Events
Our faculty have also recently had key roles in organizing several recent conferences and workshops, including the KITP "Physics of the LHC" workshop in 2008, the Aspen Center for Physics "particle physics" 2009 winter workshop, and the Theoretical Advanced Studies Institute 2009. Students often accompany faculty to these events.

Students also organize regular journal clubs to keep abreast of the latest papers and to review key topics in particle physics. Students hold week-long workshops where members are able to collaborate in an in-depth learning environment.

String Theory

Strings and the real world
The string theory group, led by Henry Tye and Liam McAllister, focuses on how string theory---the best candidate for a theory of quantum gravity---could affect the world we see around us today.

String theory and cosmology
One such avenue is through cosmology. Despite the fact that cosmology typically deals with long distances and low energies, there are epochs in the history of the universe that could provide evidence for string theory. In particular, the period of exponentially accelerated expansion in the early universe, called cosmological inflation, was very sensitive to quantum gravity effects. In turn, these effects left an imprint on the cosmic microwave background (CMB) radiation observable today through experiments like WMAP.

The group deals with all aspects of this problem, from constructing viable string theoretical models of inflation (brane inflation, axion monodromy inflation) to predicting the exact patterns that should be visible in the CMB.

The fact that the extra dimensions in string theory can be compactified in many different ways leads to many different vacuum states in the theory. This has been explored phenomenologically to see if tunneling in the landscape can give inflation and explain the smallness of the present day cosmological constant.

Applications of string theory
The group also does research in other areas where the structure of string theory can be applied as a tool in different areas. This includes novel realizations of supersymmetry breaking within string theory (the observable collider spectrum of such models) as well as the use of the AdS/CFT correspondence to understand strongly-correlated condensed matter systems. Another ongoing investigation is the relation of graviton and gauge boson amplitudes using methods borrowed from heterotic string theory.

Grad Culture and Alumni

Training to become an independent researcher. Our group focuses on developing its students to be prepared for an academic career in high energy physics.

- **Community.** Students play an active role in the theory group, participating in and helping to organize group events.
- **Working with faculty.** Students typically work closely with their adviser for their first project but are encouraged to take advantage of the breadth of research specialties in the group by working with other faculty and postdocs.
- **Mentoring**. In addition to faculty and postdocs, senior graduate students provide mentorship and advice on how to navigate one's academic career.
- **Environment**. We have a lively graduate research environment where students frequently discuss physics over chalkboards and collaborate with one another. Students also typically organize social events within the group.
- **Preparation for a postdoc**. Our goal is for our students to develop into independent researchers capable of initiating their own projects. The group provides a support structure for students to make this transition over the course of their PhDs.
- **Collaboration**. The group sets its students up to be part of the larger theoretical physics research community. Students join seminar speakers for lunch and dinner and faculty help students develop their own collaborations.
- **Coursework**. Beyond the normal QFT and Standard Model courses, a special topics course is offered every 1-2 semesters. Past topics include: string theory, modern applications of string theory, beyond the Standard Model, supersymmetry, effective field theory, flavor physics, cosmology, and quantum field theory in curved spacetime.
- **Journal clubs and group dinners**. Beyond coursework, students work closely together to learn new topics and keep up with current literature. Examples include student seminar-dinners, a BSM journal club, and student workshops in winter.
- **Teaching**. Theory students generally have RA positions through the summers and one RA-ship from the group. Teaching loads approximately 14 hours per week during the year. Many students also have support from the university or external sources (e.g. NSF fellowships).
- **Travel support**. Students receive funding from the group and university to travel to conferences or summer schools to present their work.
- **Cornell Physical Sciences Building**. The theory group is now housed in the new Physical Sciences building with an excellent view of campus and Cayuga lake.

Recent Alumni
- 2002 **Richard Hill** (Lepage; faculty, University of Chicago)
- 2005 **Jay Hubisz** (Csaki; faculty, Syracuse)
- 2006 **Seung Lee** (Neubert; postdoc, Weizmann Institute)
- 2006 **Patrick Meade** (Csaki; faculty, Stony Brook)
- 2006 **Gil Paz** (Neubert; postdoc, IAS Princeton)
- 2006 **Sarah Shandera** (Tye; postdoc, Perimeter Institute)
- 2008 **Andrew Noble** (Perelstein; postdoc in Ecology, University of Maryland)
- 2008 **Matt Reece** (Csaki; postdoc, Princeton; Junior Fellow, Harvard)
- 2009 **Christian Spethmann** (Perelstein; postdoc, Boston University)
- 2009 **Andrew Spray** (Perelstein; postdoc, TRIUMF, Vancouver)
- 2010 **Jiajun Xu** (Tye; postdoc, University of Wisconsin-Madison)
- 2010 **Johannes Heinonen** (Csaki; Fermi/McCormick Fellow, U. of Chicago)

Edited by Thomas Bachlechner, Mike Saelim, Flip Tanedo, David Marsh, and Ben Heidenreich.