

Structural Issues for Theorists; DPF (Snowmass) Theory Panel

Snowmass on the Pacific: KITP

May 2013

From letter from Pierre Ramond (then) DPF Chair

- Solicit inputs from US high-energy theorists on general issues which are of concern to them and to you.
- Organize discussions of these issues at meeting(s) leading up to the Community Summer Study (CSS2013) in July 29-August 10, 2013 in Minneapolis
- Write a white paper that would be discussed at CSS2013.
- Revise this paper into a report that would be published in the CSS2013 proceedings

Expansion of the charge

Enumerating areas of opportunity in particle physics theory research in order to set forth a vision for theoretical high energy physics for the next several years.

Discuss range of funding needs for individual PI's to sustain an effective program (students, postdocs, travel, summer salary, equipment needs.)

Examine roles of university and national lab theory groups.

Consider if suitable mechanisms are in place to assure funding of young researchers.

Expansion of the Panel Membership

Representative of the different frontiers,
different elements of the community

- Kahlidi Babu (Oklahoma)
- Sally Dawson (Brookhaven)
- Lance Dixon (SLAC)
- Steve Gottlieb (Illinois**)
- Jeff Harvey (Chicago)
- Daniel Whiteson (UCSB)
- Michael Dine (Chair) (UCSC)

[Theory Panel Web Site](#)

What is at Issue?

The United States has sustained a vigorous high energy physics program for many decades. Support for this effort has come principally from the Department of Energy and the National Science Foundation, with modest additional funding from private sources. This funding has supported several activities central to the theory effort:

- **Training of students:**
- **Salaries of postdoctoral fellows**
- **Travel to conferences and workshops**
- **Summer salary for investigators, freeing faculty from teaching responsibilities in summer months and facilitating concentrated research time.**
- **Labs**
- **This formula has been extremely successful. The theory program in the United States has arguably been second to none for many decades.**

With a changing funding climate, this model is under stress. Both in labs and universities:

- **decline in support for graduate students.**
- **Decline in support for postdoctoral fellows**
- **Severe restrictions on travel.**
- **Caps on summer salary (DOE)**

To Date

- Have received input from members of the community **but hope for significantly more, dealing with any and all of these issues (website above; email me or other panel members directly).**
- Conference calls with DOE (Crawford, Rolli; Yaffe) and NSF (Dienes)
- Meetings with theorists at pre-Snowmass meetings.
- We'll have a presence at Minneapolis

Some preliminary thoughts

- Deeply concerned about implications of funding cuts for student and postdoctoral support; implications for the future health of the field.
- Concern about other activities: travel. Summer support.
- Need to articulate what is being lost to science as a result of this atrophying of the field; what solutions we might propose.
- Agencies are supportive of a broad research program. But we will need to address, esp. with DOE, question of programs at the boundaries.
- Labs: draw significant resources, but unique in their level of support for the experimental program.

We will surely make points about the role of theory

In the triumph of the Standard Model:

- Ever improving understanding of field theory, inherent to our understanding of the Standard Model.
- Calculation of rates for production and decay, including non-leading effects.
- Perturbative QCD calculations especially for colliders
- Theories of and parameterizations for, possible deviations
- Theoretical understanding of heavy quark physics critical for CKM tests
- Non-perturbative understanding of QCD: basic theoretical issues, but striking progress through lattice gauge theory.

The Broader View

What is the role of theory in the future:

- Support for experimental program: QCD computations
- Support for experimental program: defining signals, search targets (e.g. light stops in current LHC experiments)
- Support for experimental program: neutrino physics
- Support for experimental program: cosmic frontier
- Beyond current experiments: questions ranging from what might lie just beyond, to questions at very high energy scales to foundational issues. These are no small part of what makes this field exciting and generate public interest.

Theorists delineate questions, propose solutions, suggest novel phenomena that serve as the basis for future experiments or measurements.

- What is the origin of the great disparities in energy scales in physics?
- Why are there repetitive generations of quarks and leptons? What accounts for the hierarchical structure of the masses and mixings of the quarks, and why does the pattern of neutrino masses and mixings seem so different. What is the energy scale associated with the generation of neutrino mass?
- The observed CP violation in the Standard Model is insufficient to account for the baryon asymmetry of the universe. What phenomena might account for this? Might they be accessible to experiments at the energy or intensity frontiers.
- What is the identity of the dark matter which makes up over 20% of the energy density of the universe
- What is the origin of the dark energy which makes up 70% of the energy density.
- What is the nature of the quantum theory of gravitation?
- From what set of principles or structure do the laws of nature originate?
- For which of these questions might we hope to see experimental answers in the foreseeable future. For which do we need to develop and extend our current theoretical frameworks.

