Experimental HEP at Syracuse

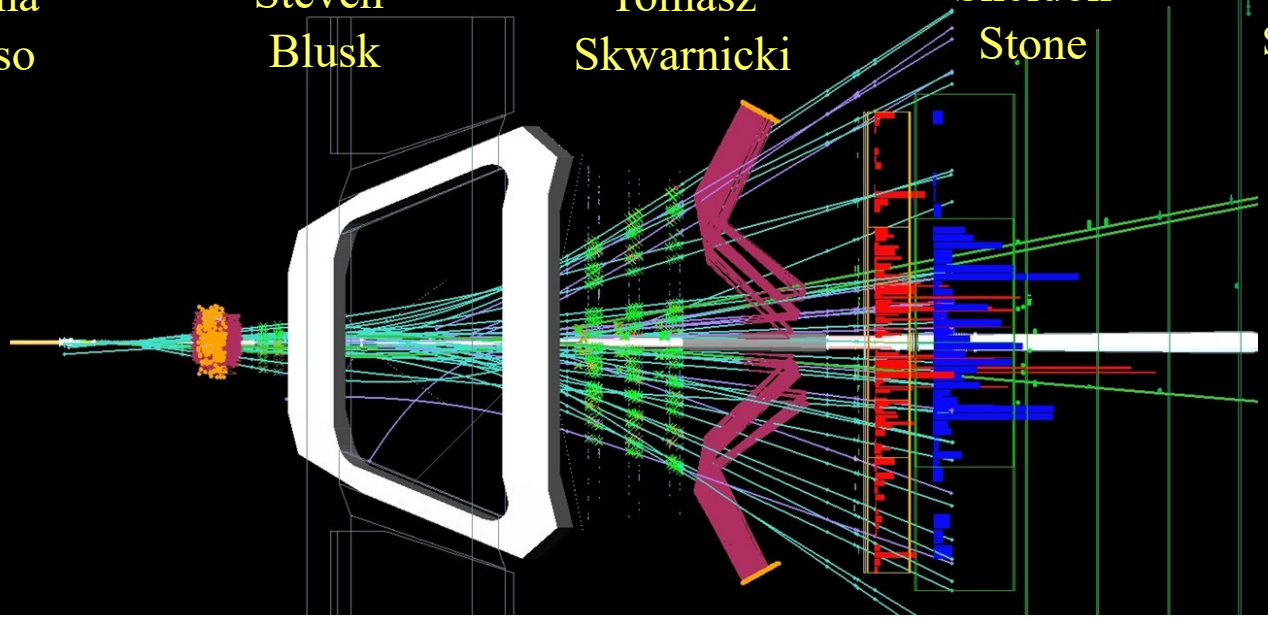
Marina Artuso

Steven Blusk

Tomasz Skwarnicki

Sheldon Stone

Mitch Soderberg



Research Professors

Postdoctoral Researchers

+Anna Phan

(At CERN)

Graduate Students

Welcome

Faculty hosts

Mitch Soderberg

Steven Blusk

Ray Mountain

Undergraduates who will be of help with the labs

Emily Kraus

Erika Cowan

Dylan Hsu

Anna Fadeeva

What is Quarknet

Program funded by NSF and DOE (~15 years)

Primary aims are to provide for teachers:

- a deeper understanding of particle physics
- a deeper appreciation of the machinery of modern science
- Build inquiry-based learning environment … researchers build knowledge through inquiry, discussion, collaboration

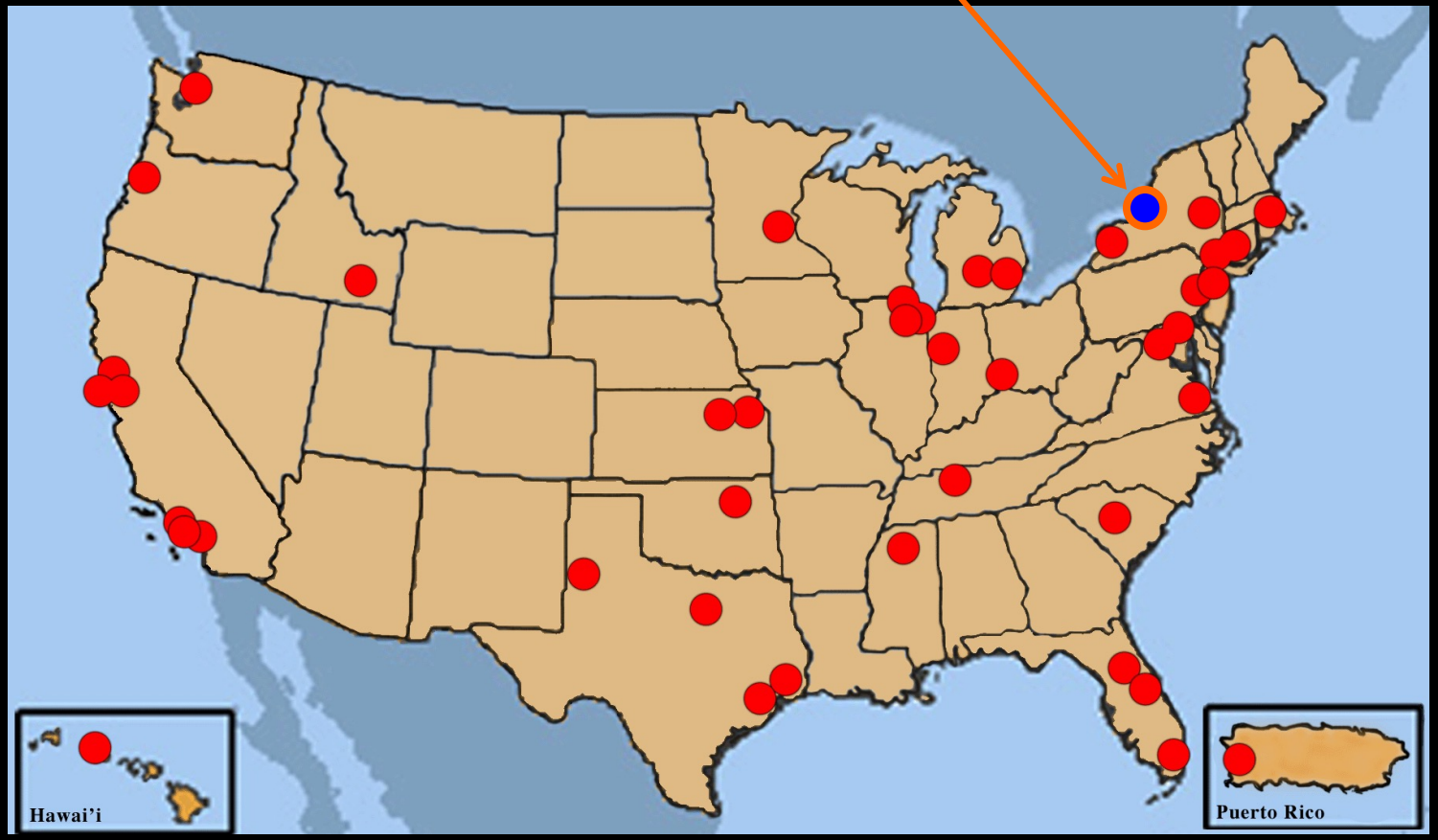
Additional goal:

- Integrate some ideas of particle physics into the classroom.

This doesn't necessarily mean "new topics"
E.g. Conservation of momentum, energy … can use particle collisions

Quarknet Centers

54 Centers at Universities and Laboratories, including Syracuse University



The program – Year 1

- Two teachers for 8-week program
  - Last year, Ranald Bleakley and Josh Buchman spent their summer at CERN
  - Goals were to:
    - Get a taste of what it is like being engaged at the world's most energetic collider
    - Learn a bit about the LHCb experiment
    - Develop an event display to visualize interactions in LHCb (software-based project).
  - Lots to learn, and they did a great job!

Years 2 - ?

- Year 2: Approximately 10 more teachers for 3-week institute (that's now!)
- Years 3 – 5: One-week program at Syracuse.
- Years > 5: Other possibilities, most likely focused on projects that would involve 1-2 teachers + students.

Keep in mind

- If you have any questions, please don't hesitate to ask.
- We'll do our best to answer.
- Learning is "inquiry-based"…
- Do you best to work within your group to answer your questions as a team.
- Then, we'll discuss questions at the end of the day.

General schedule (most days)

- 8:00 – 8:30: Light breakfast
- 8:30 – 9:30: Lecture presentation + Q&A
- 9:45 – 11:45 Work on experiments
- 11:45 – 12:45 Lunch
- 1:00 – 3:00 Work on experiments
- 3:00 – 3:30 Meeting, Q&A, teachers share ideas about how they might integrate what they've learned into the classroom.

Overview of presentations/topics

- General Overview – Particle Physics & Cosmology
- Relativity
- Quantum Physics
- Accelerators and Detectors
- Standard Model overview
- Strong & EM forces
- Weak forces and decays
- High energy collisions as microscopes
- Top quark and Higgs
- Neutrinos
- Applications of Particle physics in the “real” world

Today

- Introductory Presentation – S. Blusk
- Coffee break
- Presentation on Relativity – M. Soderberg
- Lunch
- Introduction to the Experiments – R. Mountain
- Breakout – Look over lab writeups, work on any assigned “HW” problems

Overview of Particle Physics

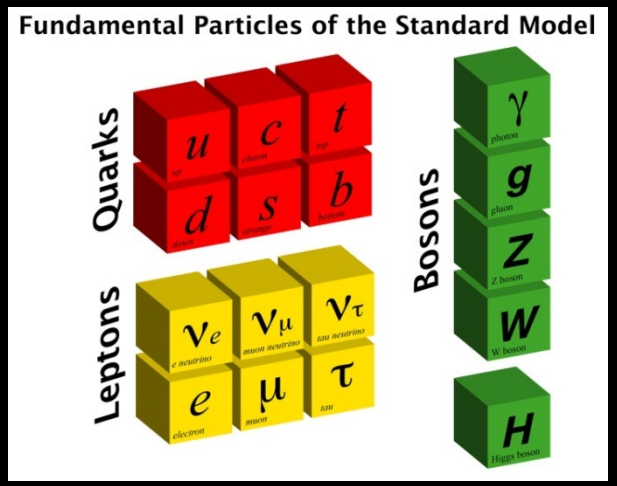
- "Laws" or theories used to describe nature
  - Driven by observation (measurement)
  - Postdictive & (hopefully) predictive

- Particle Physics
  - Aims to describe the most fundamental objects in nature and the force laws that govern their interactions.
  - Currently: Standard Model (SM)
    - 6 Quarks, 6 leptons, and force carriers (γ, gluon, $W^{\pm}$, Z)
    - Works very well, but certainly an effective theory

  - #1 Goal in Particle Physics: Expose & elucidate the most fundamental theory of matter…. and many reasons to believe the SM is not it !

  - 'New Physics' is any observation that is not in accord with the SM.

The sub-standard model !



Many key questions unanswered by SM

- Why 3 generations?
- Hierarchy problem?
- Explanation/origin of masses?
- Unification ?
- How does gravity fit in?
- Matter dominance over antimatter ?
- … + more

Many key question unanswered in Cosmology

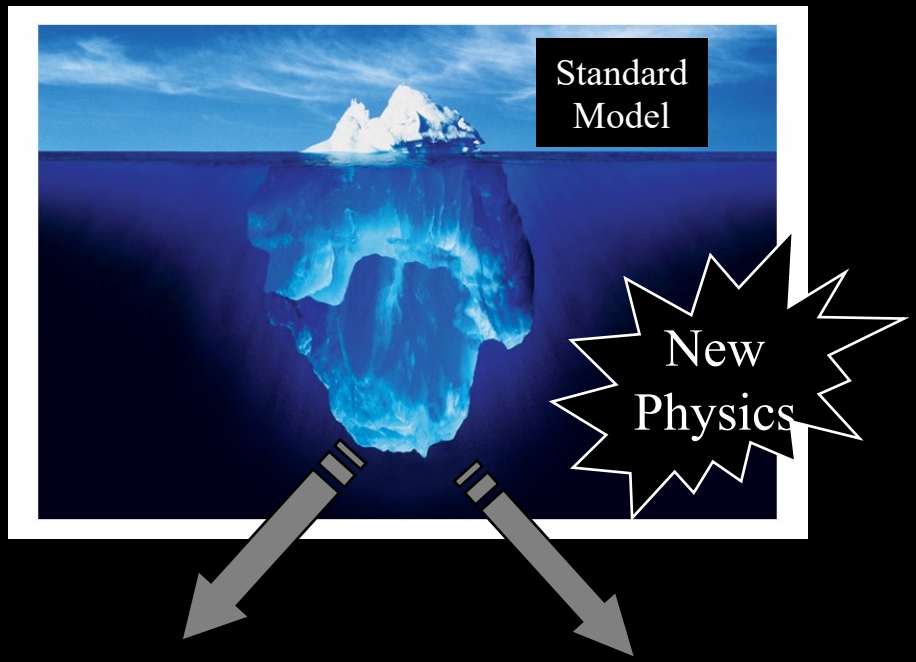
- What is the dark matter in the Universe?
- What is the dark energy in the Universe?
- What caused inflation?
- ...+ more

The Connection: Expected that whatever the "New Physics" is that addresses SM questions also provides a candidate particle that forms the Dark Matter in the Universe

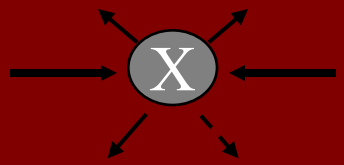
This "new particle" ought to be observable in accelerator-based experiments

The future of Particle Physics

- Primary mission is to uncover and elucidate the New Physics that will help answer the fundamental shortcomings of the Standard Model
  - more complete theory of matter.
- Need to understand neutrinos, mass, oscillations.
- Also need to find the Higgs boson
  - Origin of mass in SM
  - Still on the loose!



Direct Searches for New Particles (CMS & ATLAS)



Precision measurements & rare decays (e.g B decays)