

Program for AAPT Topical Conference:  
Computational Physics for Upper-Level Physics Programs.

Davidson College,  
Davidson, NC – July 27-28, 2007



### **Goal and Purpose**

The goal of this conference is to enrich undergraduate physics programs by integrating computational methods into courses and undergraduate research. Its purpose is to acquaint participants with contemporary issues dealing with computation in undergraduate physics and to help them learn how to use computational physics in their own teaching. Participants are university and college faculty interested in integrating computation into the physics curricula at their home institutions. Some participants already teach or have taught computational physics to undergraduates and some are looking for ways to integrate computational physics into their existing physics curricula.

### **Expectations**

Each participant will contribute and discuss curricular materials in which computation would enhance physics understanding and will identify algorithms that ought to be part of their students' repertoires. They will draw these examples from the core subjects such as mechanics, electricity and magnetism, quantum mechanics, and statistical and thermal physics. Participants will prepare and edit their material for posting on an AAPT website such as ComPADRE. Visiting experts will give talks on how computational physics relates to current research practice in physics, science, and engineering, and on how computational approaches may be used to present key concepts to undergraduates.

Participants are invited to prepare a poster describing how computational physics is incorporated into teaching, what projects are assigned to students at different levels, and how computation has enhanced the physics curriculum. Posters will remain available throughout the conference. The conference/workshop will also provide an opportunity to affect the agenda for the 2008 Gordon Research Conference on Computation and Physics Education and the associated *American Journal of Physics* theme issue.

### **Program**

The conference program is arranged (1) to stimulate discussion among participants, (2) to inspire them to use their own computational and instructional experience, and (3) to develop specific activities that they can use in their courses and within their departments during the coming academic year. In the process of doing so they will generate valuable information that the conference organizing committee will incorporate into a white paper reporting on a better understanding of the rationale, methods, and strategies that can enhance computational physics education.

This conference is sponsored by the American Association of Physics Teachers (AAPT) and *Computing in Science and Engineering* (CISE). Partial funding for this conference is being provided by NSF grant DUE- 442581.

## Speakers and Organization

### **THURSDAY, JULY 26, 2007**

4:00 – 8:00 Registration, dorm check-in.

7:00 – ??? Informal gathering at Brick House Tavern.

### **FRIDAY, JULY 27, 2007**

7:30 – 8:00 Registration and set up posters

Registration and check-in are continued throughout the morning for late arrivals.

#### **Session I: The Role of Scientific Computing in Physics and Related Fields**

- **How should research using computational tools influence the undergraduate curriculum?**
- **Are there any ways of thinking, algorithms or other specific computational tools which undergraduates should learn that would help them eventually in graduate school and research?**

8:00 – 8:15 Welcoming remarks.

8:15 – 8:45 **Norman Chonacky**, Yale University: “Motivation for Curricular Reform from Computational Applications to Physics, Other Sciences, and Engineering.”

8:45 – 9:15 **Robert Swendsen**, "What students (and professors) can learn about physics with a computer."

9:15 – 9:30 Question and discussion session chaired by Jan Tobochnik

9:30 – 10:00 coffee break, poster discussions

10:00 – 10:30 **Steven Gottlieb**, “One Lattice Gauge Theorist’s Perspective on Important Skills and Concepts for Computational Physics Courses”

10:30 – 11:45 Question and discussion session chaired by Harvey Gould

10:45 – 12:00 Poster Summaries: Poster presenters will give short talks (~3 minutes each) to generate interest in their topics. Moderated by Mario Belloni

12:00 – 12:10 Group Picture

12:10 – 1:30 Poster session and sandwich (buffet) lunch in poster area.

#### **Unstructured Time and Hands on Tutorials**

1:30 – 4:00

#### **Further discussions with poster presenters.**

#### **Explore Davidson and Lake Norman area.**

Tour Davidson, Davidson College, and the Davidson College Physics Department  
College gym and physical fitness facilities are available

#### **Hands on tutorials 2:00-3:30**

- Easy Java Simulations
- Francisco Esquembre

- Physics High Performance Computing (HPC) Education  
Scott Lathrop, Dave Joiner, and Thomas Loughran

## **Session II: Integrating Computational Physics into the Curriculum**

- **How does computational physics support broader physics education goals?**
- **Is there a “core” of computational physics that all physics majors ought to know?**

3:30 – 4:00 coffee in Dana lobby.

4:00 – 4:45 **Francisco Esquembre**, University of Murcia, Spain: “Integrating Computer Modeling into the Curriculum.”

4:45 – 5:30 **Amy Bug**, “Integrating Computation and Research into the Liberal Arts Physics Curriculum”

5:30 – 5:45 Question and discussion chaired by Anne Cox

5:45 – 7:00 Supper

7:15 – 8:00 **Eric Warren**, “Using Computational Methods to Push the Envelope in Motorsports.”

8:00 – 8:15 Question and discussion chaired by Bob Panoff

Conference participants choose a breakout session:

**8:15 – 9:15 Breakout session 1:** Identify problems that hinder the inclusion of computational physics in the curriculum. Identify and develop:

1. insertion strategies for traditional courses
2. dedicated computational physics courses
3. mathematical/numerical and computer science topics
4. software carpentry with open source tools

Outline model syllabi incorporating these.

**8:15 – 9:15 Breakout session 2:** How should physics research inform what we do in the undergraduate curriculum and what computer models should be taught in core subject areas?

1. Mechanics
2. E & M
3. Quantum Mechanics
4. Statistical and Thermal Physics
5. Numerical modeling for instruction
6. Undergraduate Research
7. Advanced Laboratory Work

Outcomes: Canonical computational physics problems that should be part of every student’s repertory.  
Computational physics research problems that are accessible to undergraduates.

## **SATURDAY, JULY 28, 2007**

### **Session III: Computational Physics Education**

- **What are the virtues and disadvantages of computational packages (such as Mathematica, Maple, MathCAD and so on) versus coding from scratch?**
- **What is the role of packages such as Open Source Physics in computational physics education?**
- **What are the virtues and disadvantages of various ways of incorporating computational physics into the curriculum, specifically a focused**

**computational physics course (or courses) versus “computation across the curriculum”?**

- **Should physics departments work with other STEM departments on “scientific computing” programs that cut across disciplines?**

8:30 – 9:00 coffee in Dana lobby.

9:00 – 9:45 **Rubin Landau**, Oregon State University: “Computational Physics as an Improved Model for Physics Education”

9:45 – 10:00 Question and discussion session chaired by Bruce Mason.

10:00 – 10:45 Coffee break, poster discussions

10:45 – 11:15 **Angela Shiflet**, “Reaching Out to Science Students with Computational Science and Modeling”

11:15 – 11:45 **Julien C. Sprott**, “Simple Models of Complex Chaotic Systems.”

11:45 – 12:00 Question and discussion chaired by Bob Hilborn.

12:00 – 1:00 lunch

1:00 – 2:30 Breakout sessions: How much coding from scratch (if any) is necessary to implement numerical computations in upper-level courses? What connections can be made from a beginning computational course to further development in upper level courses? Consolidate ideas from previous discussions and develop model syllabi incorporating these.

2:30 – 2:45 Break

2:45 – 3:45 Each breakout group presents its work to the entire workshop.

3:45 – 4:00 Wrap-up and Future Plans:

ComPADRE

CISE

AJP and AJP Theme Issue

GRC

MPTL -13 and GIREP 2008 in Crete

4:00 Adjourn

Saturday evening and Sunday morning shuttles leave for the AAPT Summer Meeting in Greensboro NC. Participants may stay in Davidson dorms through Sunday morning.