Computational Science Moves to Interdisciplinary Research

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Center for Planetary Science, Kobe, 14 December 2010
Dense Stellar Systems as a Laboratory for Fundamental Physics

We can study *elementary particles* through their interactions:
- bound states
- scattering experiments

Other extreme forms of matter: *black holes* and *neutron stars*

We can study these, too, through their interactions:
- bound states: double stars
- scattering experiments: collisions between stars

There is a natural laboratory: *dense stellar systems*
Dense Stellar Systems

- Interactions between individual stars important
  - Two-body relaxation time $< \text{Age of the system}$
  - binary--single-star encounters; physical collisions

- Locations:
  - star-forming regions
  - old open star clusters
  - globular clusters
  - galactic nuclei
MODEST

MOdeling DEnse STellar systems

or

MODefying Existing STellar codes

http://www.manybody.org/modest.html
FREDERICK PHINEAS AND SANDRA PRIEST
ROSE CENTER FOR
EARTH AND SPACE
Featuring the New Hayden Planetarium
A Brief History of Science

~ 2000 years ago:  Theory -- Greek mathematics

~ 400 years ago:  Theory & Experiment -- Modern Science

~ 50 years ago:  Theory, Experiment & Simulations -- ?
<table>
<thead>
<tr>
<th>Period</th>
<th>Category</th>
<th>Notes</th>
</tr>
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<tbody>
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<td>~ 2000 years ago</td>
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<td>?</td>
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Science is the first “open source” project.

Experiments: a new lab culture had to be developed
-- make detailed lab notes, keep raw data
-- report failures as well as success

Simulations: a new `virtual lab' culture is now emerging
-- we don't yet have a good way to share code
-- we don't yet know how to share knowledge
The Art of Computational Science

A series of books on how to build a computational lab

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www.artcompsci.org

An open source project
The Gravitational Million–Body Problem
A Multidisciplinary Approach to Star Cluster Dynamics

Douglas Heggie and Piet Hut

4 Introductions: astrophysics
theoretical physics
computational physics
mathematics

Moving Stars Around

A Preliminary Version of what will expand into Volumes 1, 2, 3 of the series

The Art of Computational Science

Piet Hut & Jun Makino

3 themes: exploring N-body algorithms
writing N-body codes
performing N-body experiments
(www.artcompsci.org)