Computation in the Classroom: Open Source Physics Resources

Anne J. Cox, Professor of Physics
Eckerd College, St Petersburg, FL

I am delighted to have this opportunity to talk with you about integrating computation in the classroom. The Gordon Research Conference brought together researchers (practitioners) in computational physics and physics education with the goal of getting more computation into the classroom. I will briefly discuss why this is important, examine some of the barriers to this, and demonstrate some of the ways the Open Source Physics project has tried to address these barriers.

Why Computation in Classroom?

- Analytical skills

•Model building develops analytical skills and helps students understand concepts more deeply. Often when my students say the “program isn’t working” or “I don’t know if my program is working right or not” it is because they don’t understand the physics. They haven’t thought about what they expect (if they program a –k*x^3 force for example– what do they expect? Why?); At the intro level, if they leave the initial velocity zero and initial position zero, then the spring won’t oscillate.

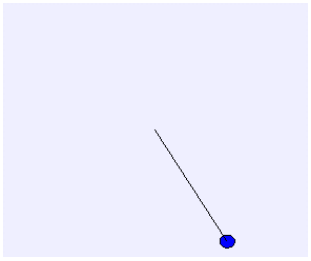
•More realistic problems– a less spherical cow? Computer allows you to solve problems that you don’t have the mathematical tools (or sophistication) to solve– this is why we use it in the first place– students need to see that

•Preparation: Computational physics is an area of research all its own: Theoretical, Experimental, Computational. This is what professional physicists do. We need our undergraduates to be equipped for graduate work.

•Fun– okay, not in the video game sense of fun, but maybe “fun” in that it is “satisfying” when you understand and even more so when you can make the simulation work.

Why Computation in Classroom?

- Analytical skills
- More realistic problems



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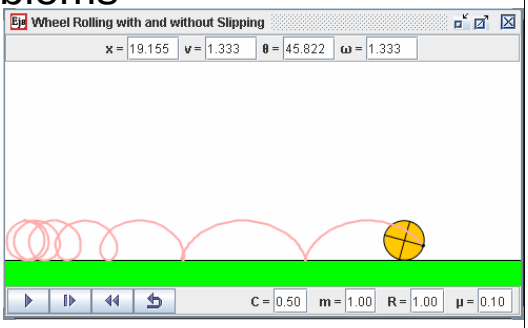

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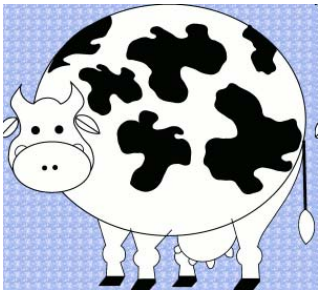

http://en.wikipedia.org/wiki/File:Spherical_cow.gif

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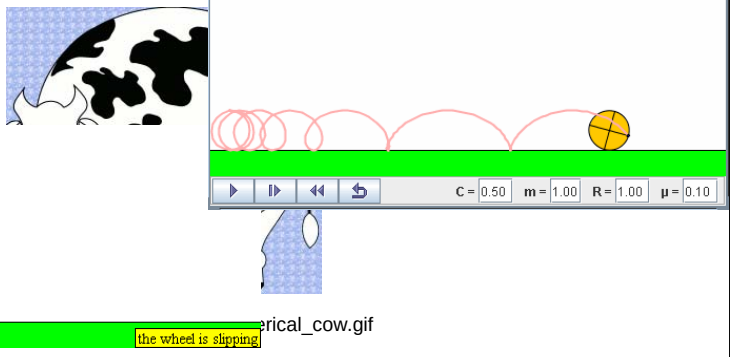

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Barriers

- Finding materials
- Pedagogy
- Source availability
- High overhead

•Lots of material out there

•Animations and simulations without associated teaching materials

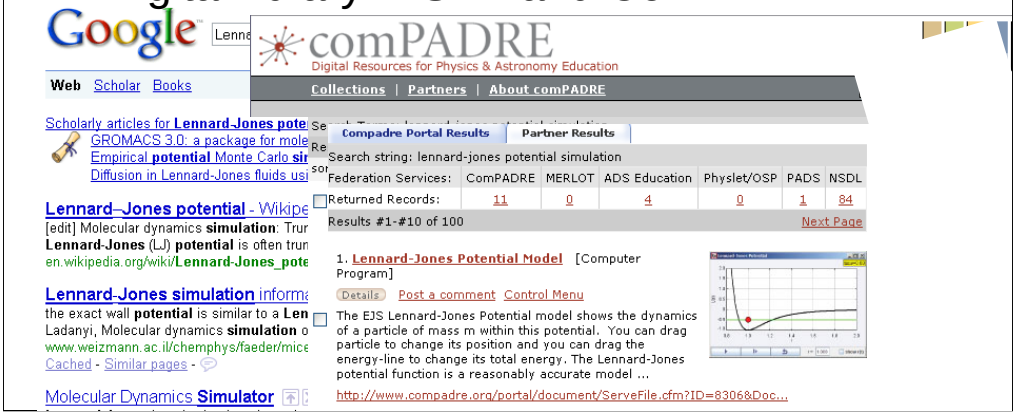
•Simulation without code: it is a simulation or an animation?

•Spend time teaching computational physics in class.

Finding materials

Lennard-Jones Potential Simulation

- Google, wiki
- Digital library: NSDL and ComPADRE



Google 145,000 hits (on 3/4/09 at 3 EST): in first 10 you get the wiki entry, several pdfs (to articles in journals you need to subscribe to), a book and two webpages with links to sims

ComPADRE: 9 hits– all programs

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Pedagogy

- Curriculum
- PER

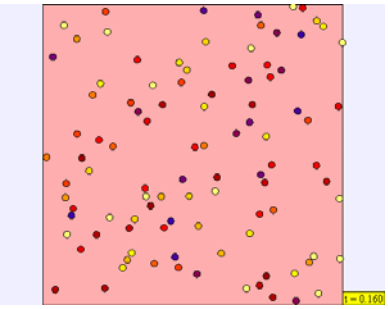
•directed interaction students don’t just “play” with sims on their own (if given “play” time, will Txt, etc)

•Inspired by best practices and informed by PER

•STP Project chapter 1 starts explicit connection between Simulation Curriculum AND algorithm.

Connections

- Curriculum
- PER



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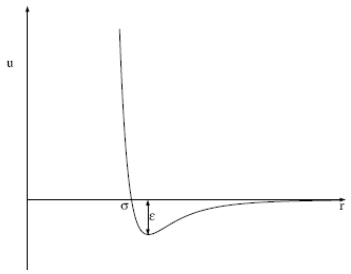
1.4 Some Simple Simulations

So far we have
and simple obse
macroscopic sys
large system on
are sufficient to

We first dis
molecules whos
in a closed con
external forces
easily visualize

CHAPTER 1. FROM MICROSCOPIC TO MACROSCOPIC BEHAVIOR 6



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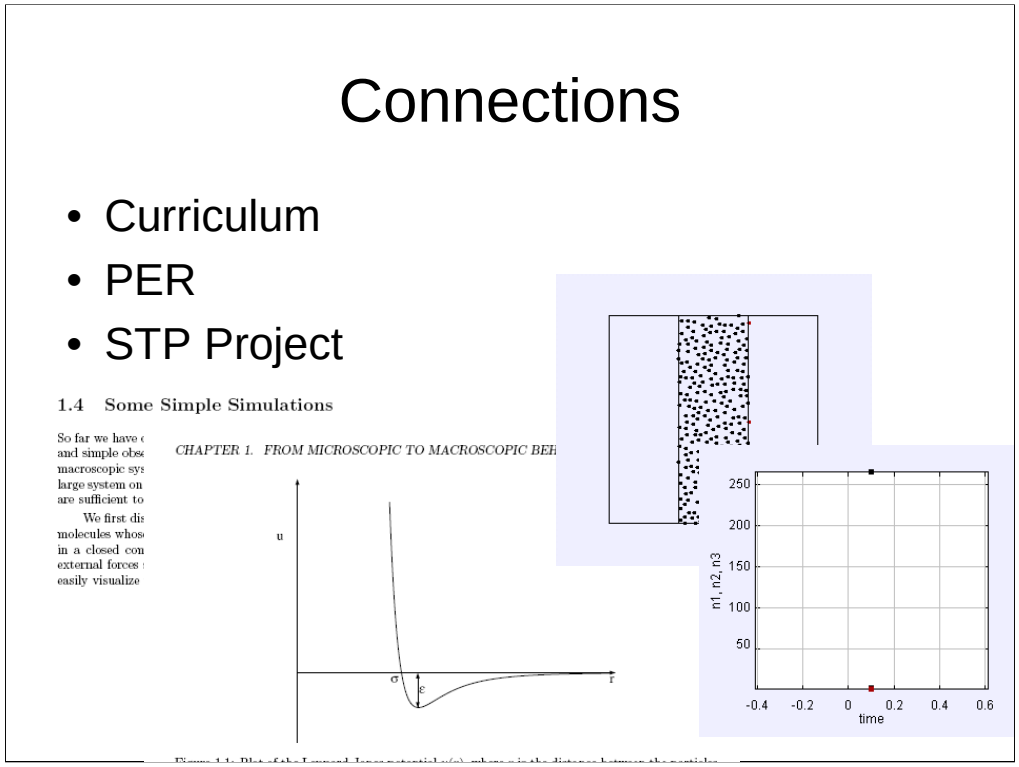

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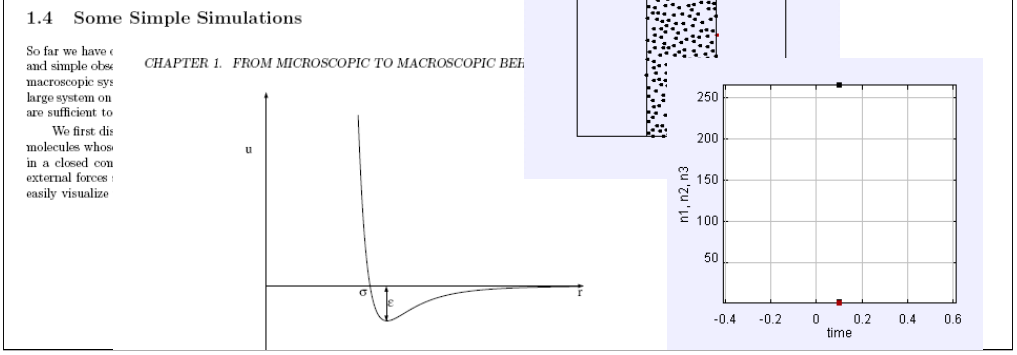

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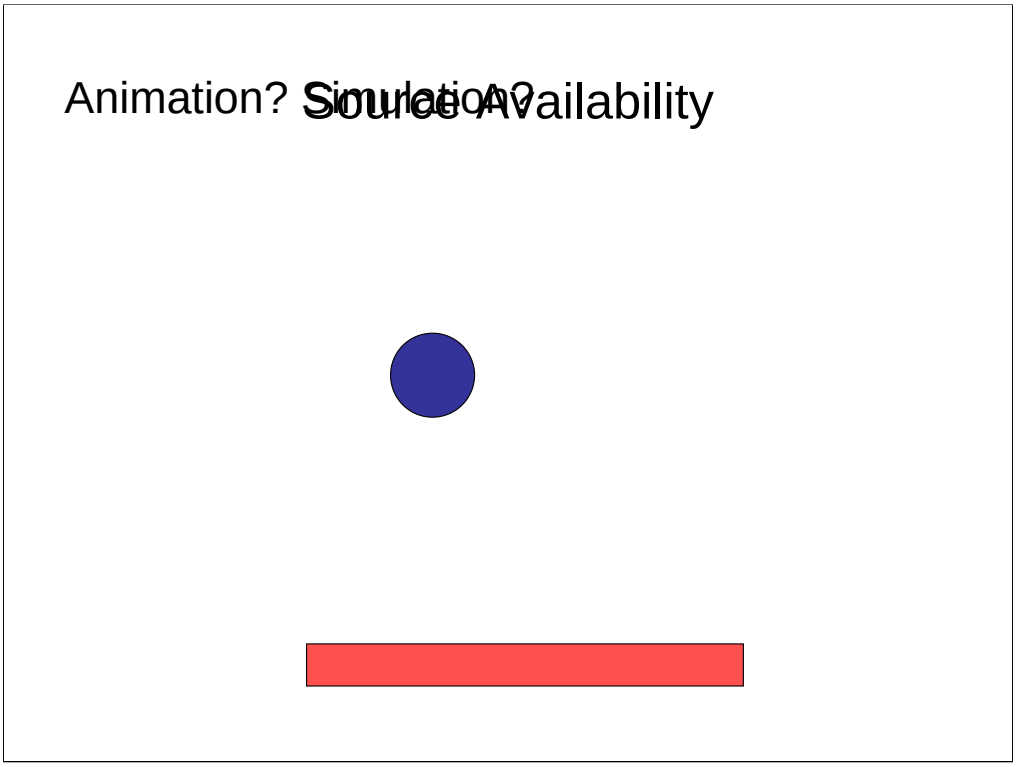

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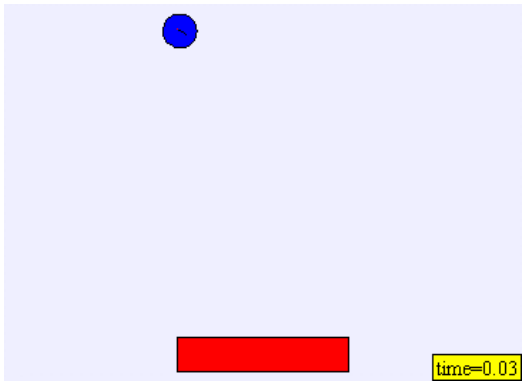
•Eclipse workspace available for OSP materials.

Animation? Simulation?



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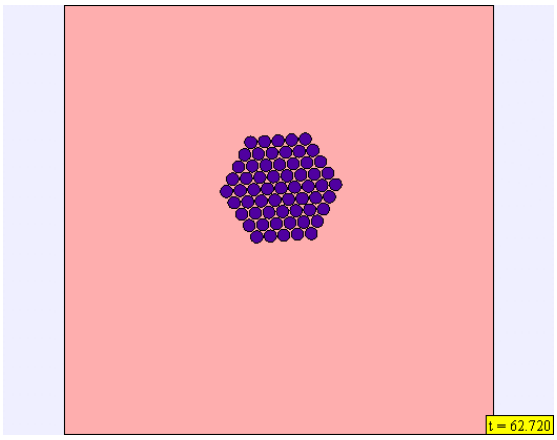

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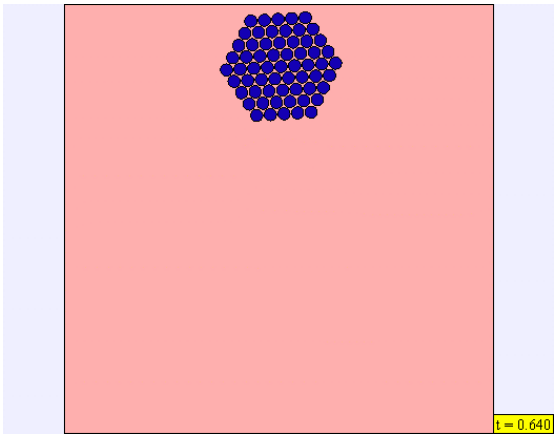

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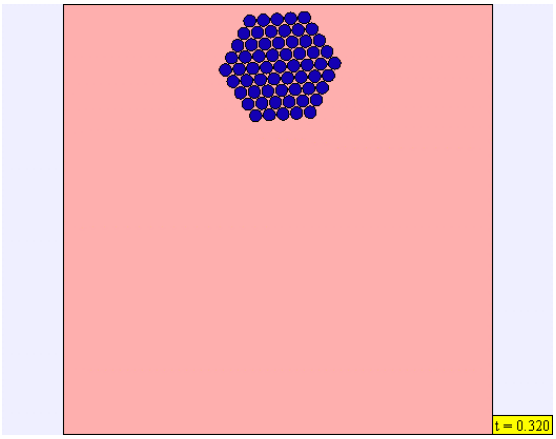

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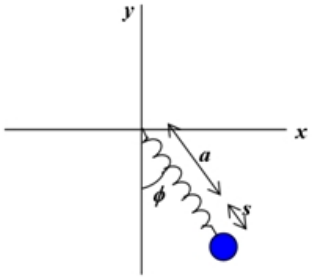

Lowers the programming overhead

Feedback from programming

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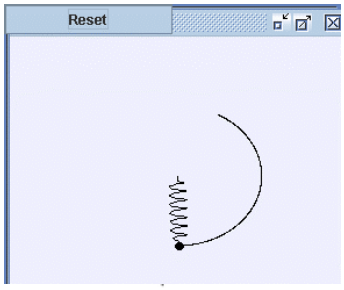

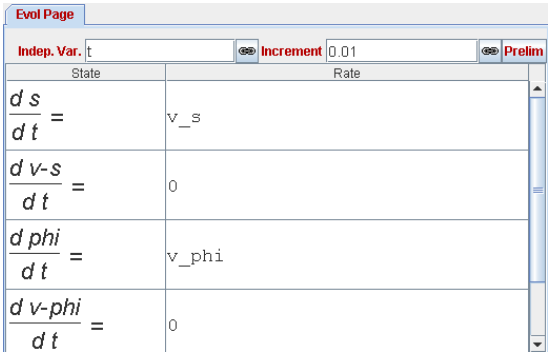

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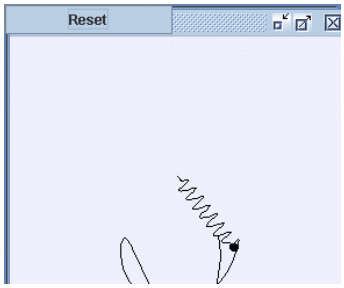

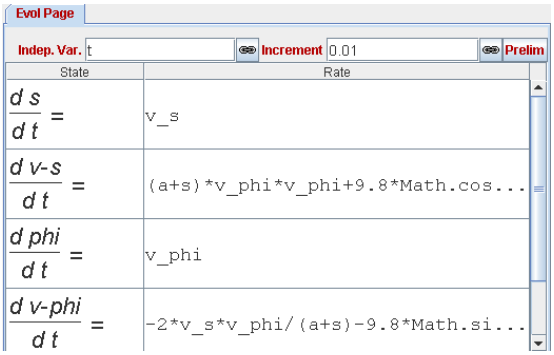

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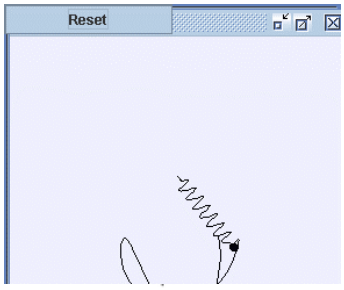

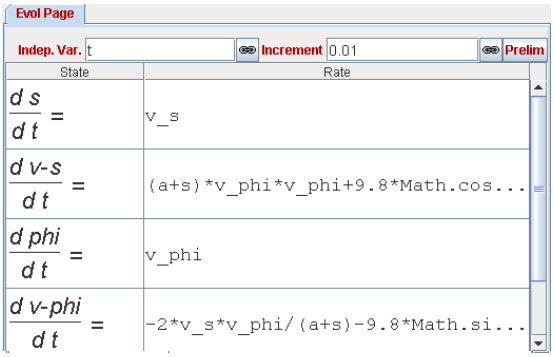

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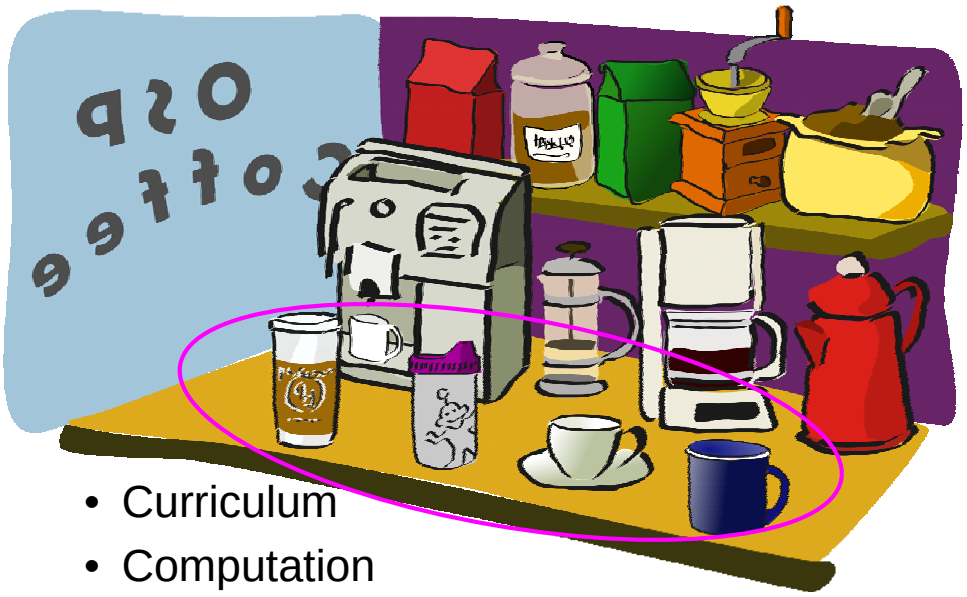
ComPADRE details

- OSP Collection
- Topical
  - STP
  - Quantum Exchange
  - Others coming soon
- uComp- coming soon



- Curriculum
- Computation
- Collection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Statistical and Thermal Physics

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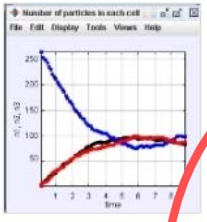
Computer Program Detail Page

STP MD Approach To Equilibrium Three Partitions Program

written by Harvey Gould, Jan Tobochnik, Wolfgang Christian, and Anne Cox



The MDApproachToEquilibriumThreePartitions program simulates a system of particles in two dimensions interacting via the Lennard-Jones potential. The program shows the particles in the box as a function of time once the partitions dividing the box into three sections are removed.

MDApproachToEquilibriumThreePartitions is part of a suite of Open Source Physics programs that model aspects of Statistical and Thermal Physics (STP). The program is distributed as a ready-to-run (compiled) Java archive. Double-clicking the stp MDApproachToEquilibriumThreePartitions.jar file will run the program if Java is installed. Additional Open Source Physics programs for Statistical and Thermal Physics are available and can be found by searching ComPADRE for Open Source Physics, STP or Statistical and Thermal Physics.

Please note that this resource requires at least version 1.5 of Java.

http://www.compadre.org/STP/document/ServeFile.cfm?ID=8159&DocID=8...

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Related Materials

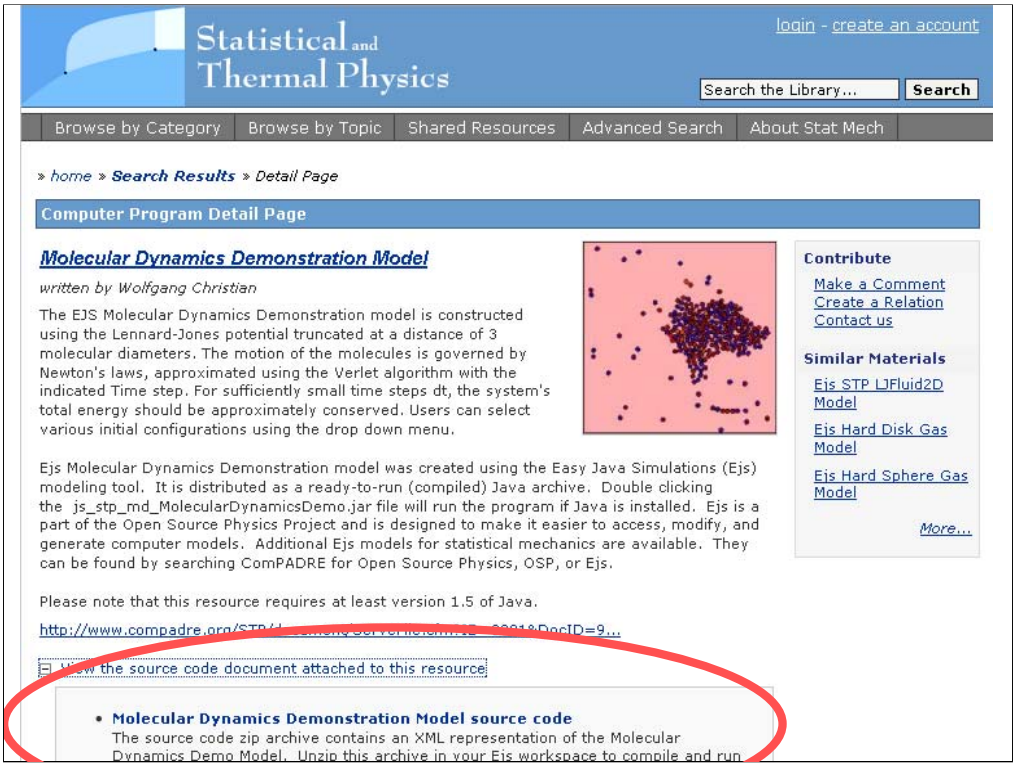
References
STP Textbook Chapter 1: From Classical to Statistical Mechanics

Is Part Of
Statistical and Thermal Physics (STP) Application

See details...

Similar Materials

STP MD Approach To Equilibrium Two Partitions Program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Computer Program Detail Page
Molecular Dynamics Demonstration Model
written by Wolfgang Christian
The EJS Molecular Dynamics Demonstration model is constructed using the Lennard-Jones potential truncated at a distance of 3 molecular diameters. The motion of the molecules is governed by Newton's laws, approximated using the Verlet algorithm with the indicated Time step. For sufficiently small time steps dt, the system's total energy should be approximately conserved. Users can select various initial configurations using the drop down menu.
Ejs Molecular Dynamics Demonstration model was created using the Easy Java Simulations (Ejs) modeling tool. It is distributed as a ready-to-run (compiled) Java archive. Double clicking the js_stp_md_MolecularDynamicsDemo.jar file will run the program if Java is installed. Ejs is a part of the Open Source Physics Project and is designed to make it easier to access, modify, and generate computer models. Additional Ejs models for statistical mechanics are available. They can be found by searching ComPADRE for Open Source Physics, OSP, or Ejs.
Please note that this resource requires at least version 1.5 of Java.
View the source code document attached to this resource
Molecular Dynamics Demonstration Model source code
The source code zip archive contains an XML representation of the Molecular Dynamics Demo Model. Unzip this archive in your Ejs workspace to compile and run
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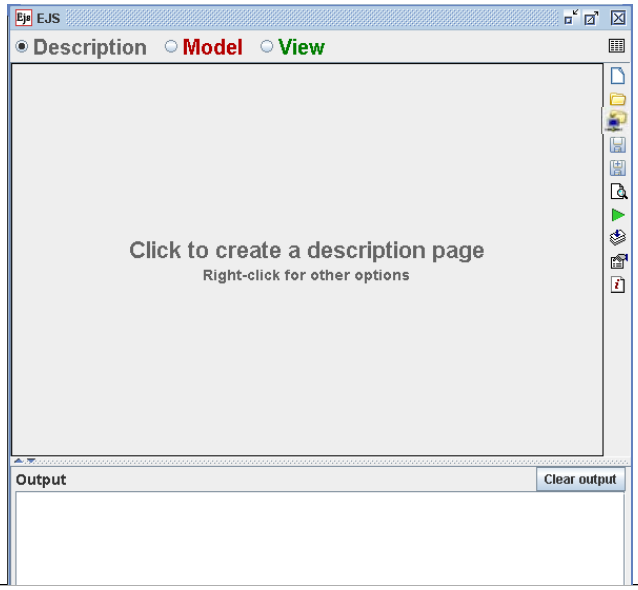

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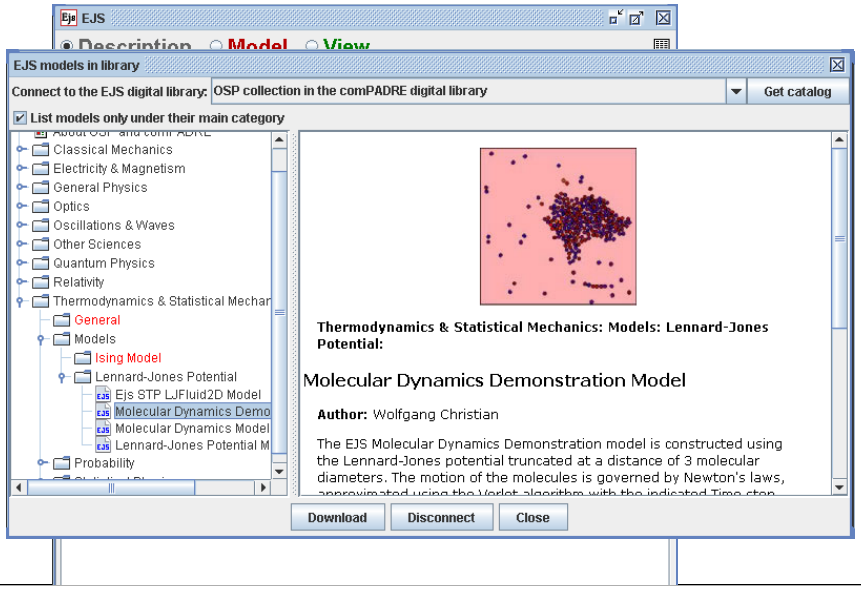
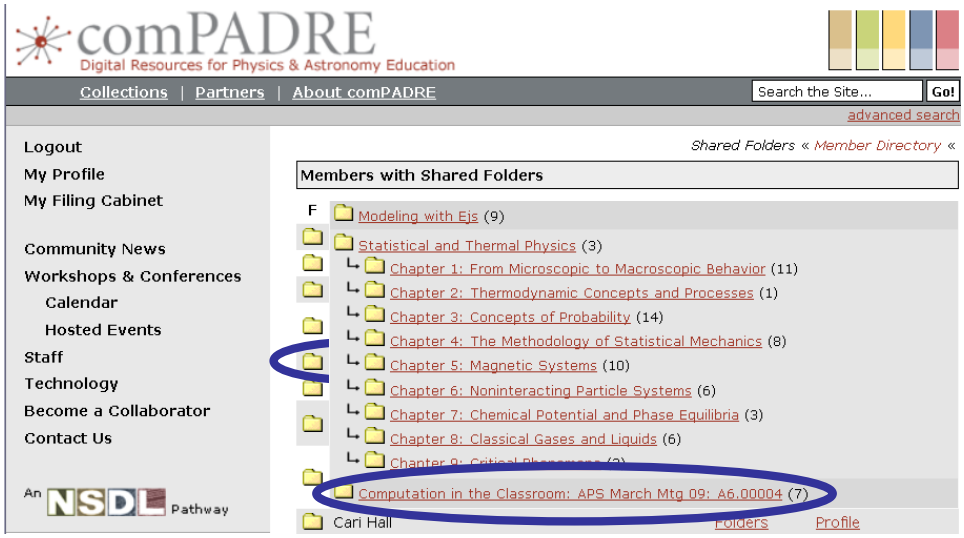


Filing Cabinets

Shared Resources

Shared Resources



Acknowledgements

Mario Belloni, Wolfgang Christian, Harvey Gould, Jan Tobochnik, Bill Junkin, Doug Brown

Lyle Barbarto, Bruce Mason, Matt Riggsbee

NSF DUE-0442581.

www.compadre.org/OSP