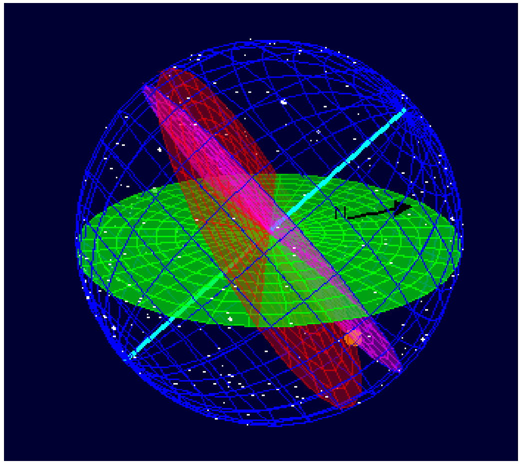
ComPADRE
Digital Library Resources for Teaching Astronomy



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Davidson College, USA

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Teaching with Technology

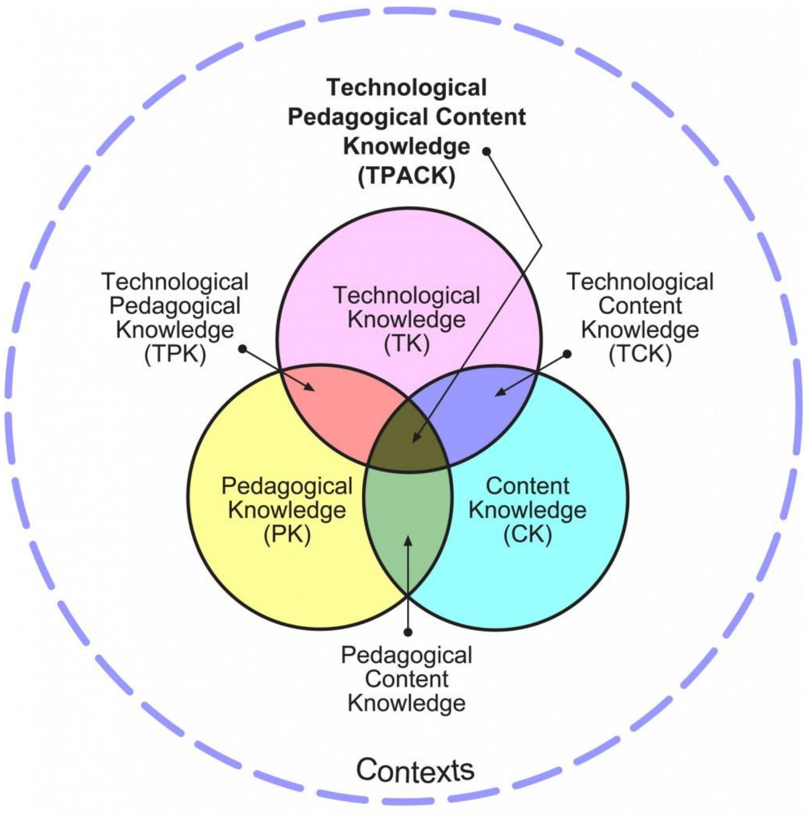
Current technologies allow physics educators the ability to integrate instruction with computer-based modeling. This talk describes technologies that encourage interactive-engagement and limit the amount of programming when designing, implementing, distributing, and using computer models. It is based on:

- **Tracker** video analysis and modeling tool analyzes video clips. Students can both analyze the motion of objects and overlay simple dynamical models on the video and see how well the model matches the real-world. (See poster.)

- **Easy Java Simulations** (EJS) creates interactive simulations in Java without extensive prior programming knowledge.

- **OSP ComPADRE Digital Library** archives and distributes curriculum resources that engage students in physics, computation, and computer modeling.

Technological, Pedagogical and Content Knowledge



The relations between content, pedagogy and technology are complex and nuanced. Technologies often come with their own imperatives that constrain the content that has to be covered and the nature of possible representations. So it may be inappropriate to see knowledge of technology as being isolated from knowledge of pedagogy and content.

(Mishra and Koehler 2006)

Grade School Teaching

North Carolina 4th Grade Standard Course of Study

Earth in the Universe

	Essential Standard	**Clarifying Objectives**	
4.E.1	**Explain the causes of day and night and phases of the moon.**	4.E.1.1	Explain the cause of day and night based on the rotation of Earth on its axis.
		4.E.1.2	Explain the monthly changes in the appearance of the moon, based on the moon's orbit around the Earth.

Astronomy appears in the curriculum sooner than we think -- but grade school science teachers are not trained in physics or astronomy.

Grade School Teaching

North Carolina 5th Grade Standard Course of Study

COMPETENCY GOAL 5: The learner will build understanding of the Solar System.

Objectives

5.01 Analyze the components and cycles of the solar system including:

- Sun.
- Planets and moons.
- Asteroids and meteors.
- Comets.
- Phases.
- Seasons.
- Day/year.
- Eclipses.

5.02 Compare and contrast the Earth to other planets in terms of:

- Size.
- Composition.
- Relative distance from the sun.
- Ability to support life.

Middle School Teaching

North Carolina 6th Grade Standard Course of Study

Earth in the Universe			
	Essential Standard	**Clarifying Objectives**	
6.E.1	**Understand the earth/moon/sun system, and the properties, structures and predictable motions of celestial bodies in the Universe.**	6.E.1.1	Explain how the relative motion and relative position of the sun, Earth and moon affect the seasons, tides, phases of the moon, and eclipses.
		6.E.1.2	Explain why Earth sustains life while other planets do not based on their properties (including types of surface, atmosphere and gravitational force) and location to the Sun.

High School Teaching

Common Core State and NC Essential Standards: Earth and Environmental

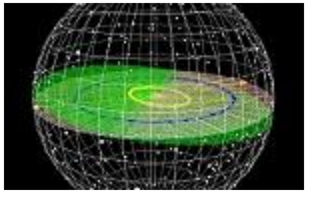
Earth in the Universe			
	Essential Standard	**Clarifying Objectives**	
EEn.1.1	**Explain the Earth's role as a body in space.**	EEn.1.1.1	Explain the Earth's motion through space, including precession, nutation, the barycenter, and its path about the galaxy.
		EEn.1.1.2	Explain how the Earth's rotation and revolution about the Sun affect its shape and is related to seasons and tides.
		EEn.1.1.3	Explain how the sun produces energy which is transferred to the Earth by radiation.
		EEn.1.1.4	Explain how incoming solar energy makes life possible on Earth.

Teaching Effectiveness

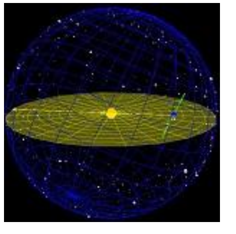
Teacher Modifiable Models

- Phases of Moon Model
  - Teacher Model
  - Lesson Plan
  - Modified jar

[Solar Eclipse]



[Kepler System]



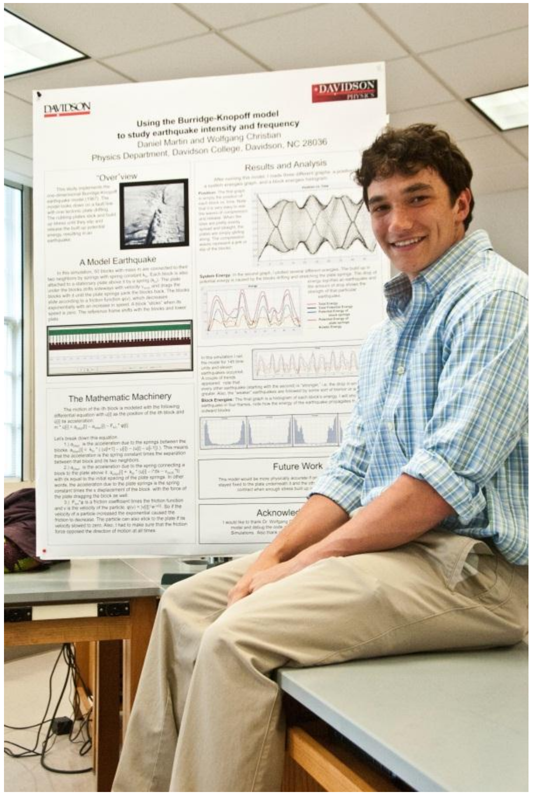
[Earth Orbit]

See Timberlake filing cabinet and Belloni filing cabinet.

College-Level Computational Physics

College-level curricula should reflect current research and professional practice and astronomy/astrophysics provide many excellent topics. Every undergraduate physics major should know about computational physics, including essential algorithms, minimal level of programming experience, and computational ways of thinking.

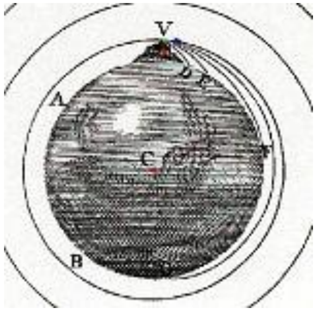
- Differential equations and ODE numerical algorithms: Newtonian orbits to orbits about black holes.
- PDEs and boundary value problems: Laplace and Poisson equations.
- Stochastic models and Monte Carlo algorithms: Random walks to the Ising model.
- Chaos theory: Logistic map to nonlinear problems.
- Final project of the student's choice.



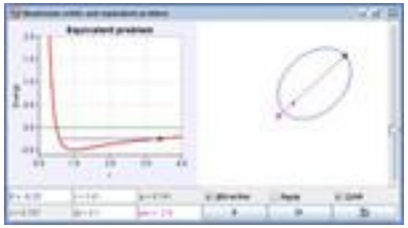
[Colliding Galaxy] [3D] [Solar Photon] [Hyperion]

OSP Contributors

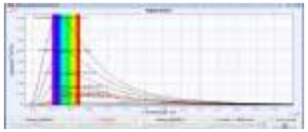
- Newton Cannon (Timberlake)



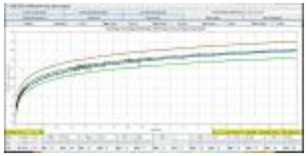
- Keplerian Orbits (*Aguirregabiria)*



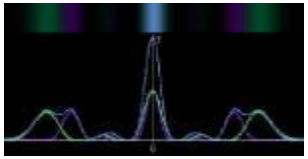
- Radiation (Hwang)



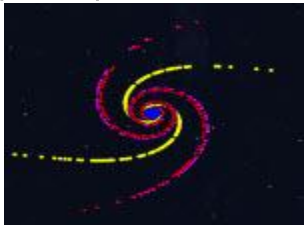
- Supernovae Data Fitting (Moldenhauer et al.)



- Diffraction (Gallis)



- Rotation with Dark Matter (*Pisani)*



Modeling Cycle

- The goal of modeling is to teach in a student-centered environment where students do not solve problems in a formula-centered way.
- Modeling Instruction attempts to enhance student achievement through a process called the **Modeling Cycle**, (following Robert Karplus' Learning Cycle).
- Throughout the Modeling Cycle we rely on student engagement and explanation as the dynamic of learning.
- The start of the modeling cycle is the development phase:
  - Qualitative description
  - Identification of variables
  - Planning an experiment
  - Performing the experiment
  - Analysis of experiment
  - Presentation of results
  - Generalization

Although the Modeling Cycle can be used without computers, it is well suited for computer modeling if we replace the word "experiment" with "simulation" in the development phase.

After the development phase, the model is deployed in a variety of new physical situations in a variety of different ways.

Need for Digital Libraries

A Google search for “***orbit***” returns 20,300,000 pages; while “Earth ***orbit simulation***” returns 23,700 pages (The search for ***Earth orbit simulation*** without the quotes returns 1,080,000 pages).

- Most of the simulations (or animations that “fake” the physics) are inappropriate for teaching.
- There is often no instructional material, no support materials for teachers, and no information about how these materials are correlated to state or national science standards.
- Most of these simulations also support a passive (viewing) pedagogy versus an active (interacting) pedagogy.

In order to be effective for instruction, simulations need to be easy to find, simple, adoptable, adaptable, and coupled with support content for students and teachers.

ComPADRE

We are out of the business of web hosting and let the experts do it.

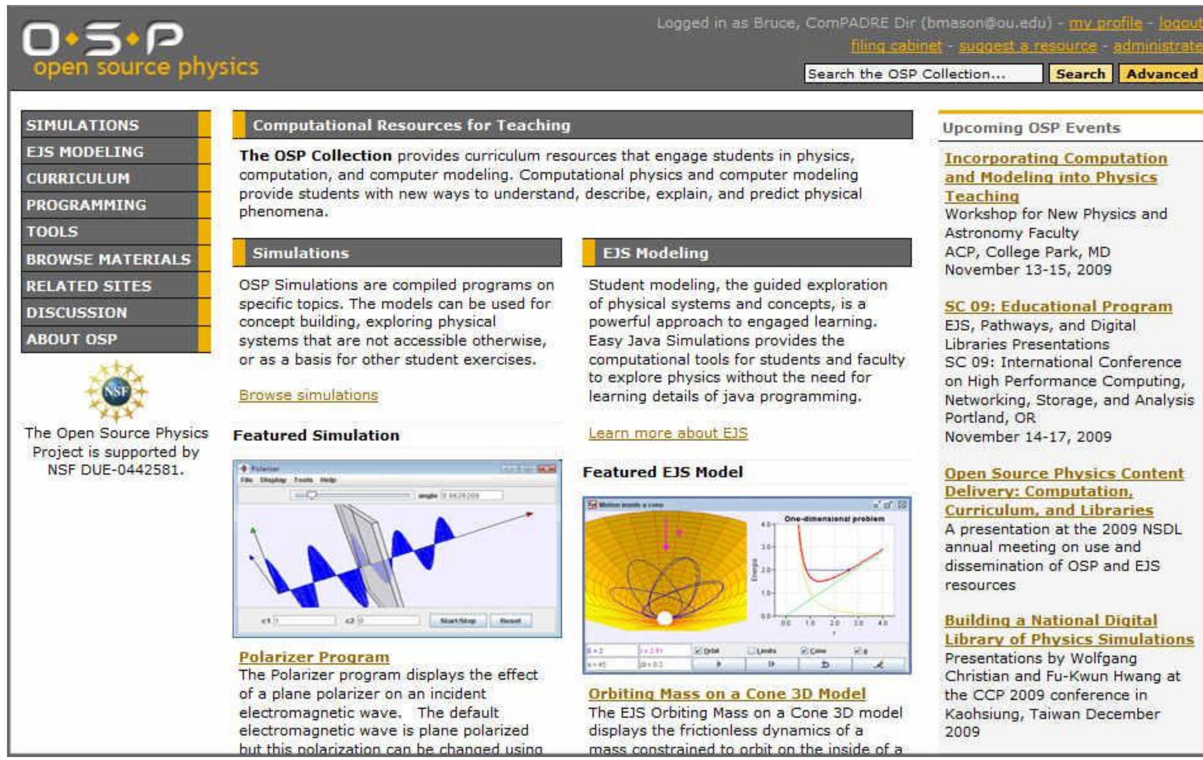
Standard and Custom Library and Web Services

Connections to Users and NSDL

>500 OSP Items

>10,000+ visitors/month

>5,000 simulation downloads/month



Library Information

Phases of Moon Model

written by Todd Timberlake

The EJS Phases of Moon model displays the appearance of Moon and how it changes depending on the position of Moon relative to Earth and Sun. The main window shows Earth (at the center) and Moon, as well as a circle tracing out Moon's orbit. Sun is far to the right in this picture and therefore the right side of Earth and Moon are bright while the left sides are dark. By using the Options Menu the Moon View window shows the appearance of Moon as seen from Earth when Moon is in the position shown in the main window. You can modify this simulation if you have Ejs installed by right-clicking within the plot and selecting "Open Ejs Model" from the pop-up menu item.

The EJS Phases of Moon model includes three supplemental documents (see below) that include a middle school lesson plan, a college level worksheet, and the student version of the program.

EJS Phases of Moon 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 ejs_astronomy_MoonPhases.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 astronomy 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 (JRE).

.jar
download 923kb .jar
Last Modified: April 14, 2010
previous versions

⊞ View the supplemental documents attached to this resource (3)

⊞ View the source code document attached to this resource

Subjects	Levels	Resource Types
Astronomy - Astronomy Education = Curricula - Fundamentals = Lunar Phases - Solar System = The Moon	- Lower Undergraduate - Middle School - High School	- Instructional Material = Curriculum support = Interactive Simulation - Audio/Visual = Image/Image Set

Intended Users	Formats	Ratings
- Learners - Educators - General Publics	- application/java	★★★★★ Rated **5.0 stars** by 9 people Want to rate this material? Login here!

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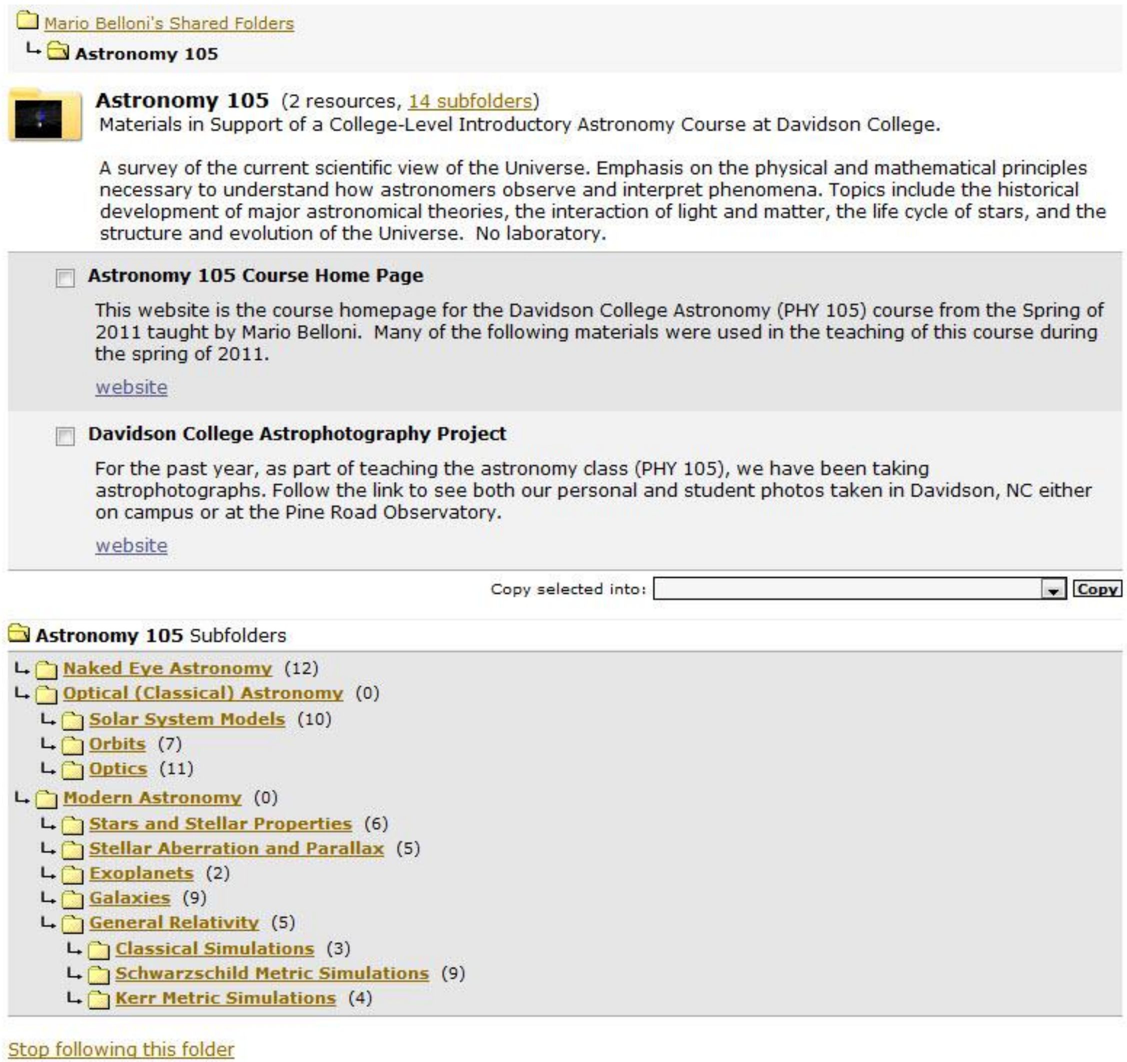

OSP Collection Team

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AAPT American Association of Physics Teachers | AMERICAN INSTITUTE OF PHYSICS

AAS American Astronomical Society | APS physics American Physical Society

Summary

The **OSP-ComPADRE platform** removes many of the complicated tasks involved in integrating computation into the classroom allowing teachers to focus on the science.

- OSP provides the computational structure, including a computational physics textbook, for our project.
- OSP allows learners to engage in computational physics modeling.
- OSP encourages the sharing of curricular materials by allowing instructors to adapt existing EJS models to their particular needs.
- ComPADRE supports distribution and collaboration by providing an internet portal and a web service of models that are directly downloadable into the EJS and Tracker modeling tools.

The OSP Collection in ComPADRE is a repository where programs, models, and curricular materials can be organized and shared by developers and instructors around the world.

Science
Education Prizes

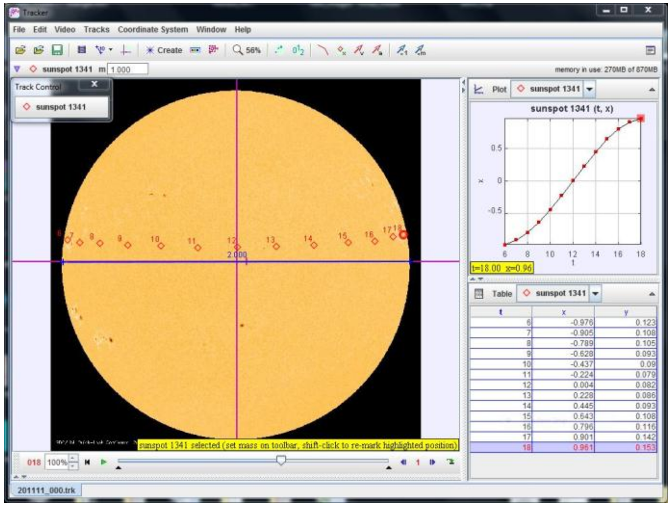
Open Source Physics

In 2011, the OSP Collection had over 500,000 page views and 10,000 visitors who visited the site six or more times. More importantly, usage has grown 42% in the past year. There were 50,000 simulations downloaded using Web browsers and an additional 5,000 downloads from within EJS into users' workspaces. The OSP Collection is also recognized by over 22% of United States physics faculty as a research-based instructional strategy they are familiar with or have used.

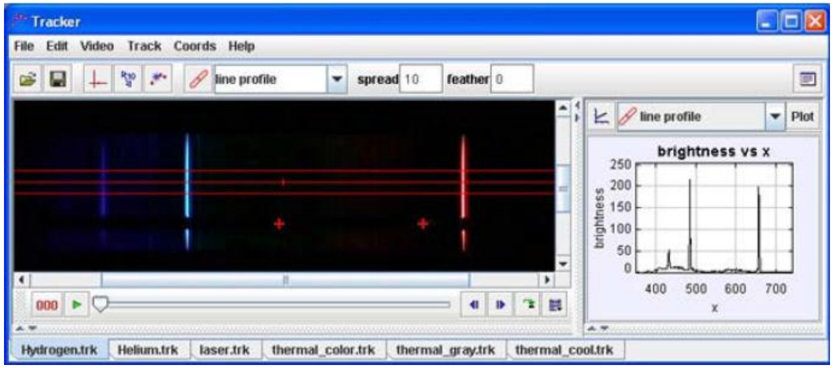
www.compadre.org/osp

Learn more at: Tracker Video Analysis Poster

Sidereal Day Measurements



Sunspot Measurements



Spectral Line Measurements

See Poster #1 for video analysis details.