Physlets and Open Source Physics for Quantum Mechanics: Visualizing Quantum-mechanical Revivals

Mario Belloni
Assistant Professor of Physics
mabelloni@davidson.edu

Wolfgang Christian
Professor of Physics
wochristian@davidson.edu

Davidson College
Davidson, NC 28035

Abstract

In this paper we describe our five-year effort to create interactive curricular

2 Tc -0y3s(7mb n4al f2036 0 Td(T)D- 1s(7mrffinislineBe

advances in computational power, however, have made many here

The Physlet paradigm, an example of which is shown in Figure 1, is based on the Model-View-Control (MVC) design pattern which is one of the most successful software architectures ever invented. The model maintains data and provides methods by which that data can change; the control gives the user the ability to interact with the model using the keyboard and the mouse; and the view presents a visual representation of the model's data. Java is ideal for the implementation of models and views because these objects are often complex and computational speed is important. But since the control object is accessed infrequently and should be customizable, it can be implemented differently. A scripting language such as JavaScript embedded into an HTML document provides an ideal solution. The advantage of using JavaScript and HTML to control a model and its views is that a common user interface can be created to ease the learning curve across pedagogical contexts. This unique approach has contributed to butel(ntj10.02 0 0 10.02 191.9 5.70443.80022 Tm(bute10.02 0 0 10.02 195.460106425.7.0

Launcher

Like Physlets, OSP provides a framework for embedding programs into HTML page

Java-based curricular material has traditionally been distributed over the Internet using applets. Sun Microsystems has recently released a new technology known as Java Web Start that combines the

Well-crafted computer simulations, however, can. The following OSP examples show the time evolution of wave packet dynamics in the infinite square well. We focus on the quantum 'bounce' and quantum-mechanical revivals and use the time dependence of the expectation values (Robinett, 2000), so-called quantum carpets (Grossman, Rost, & Schleich, 1997, Loinaz & Newman, 1999) and, in the future, the joint position-momentum quasi-probability density using the Wigner function (Belloni, Doncheski, &

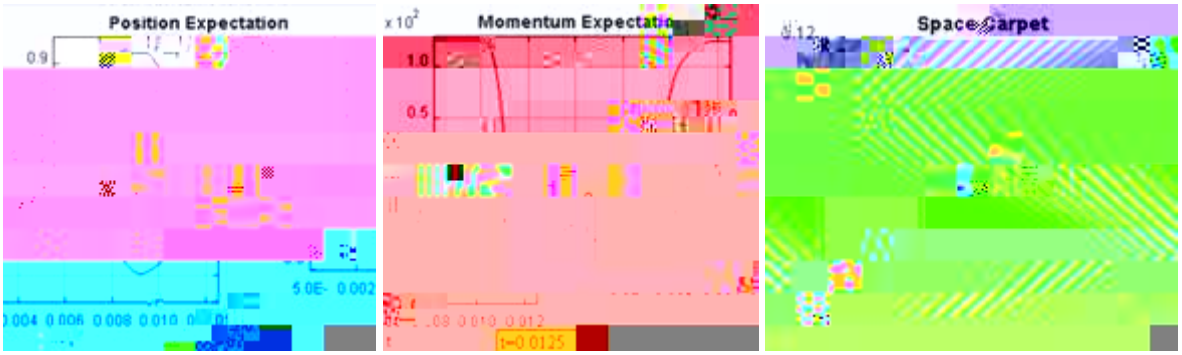


Figure 10: The time evolution of the same quantum wave packet in shown in Figure 9 between *t* = 0 and *t* = *T*cl (*T*rev is set to 1) usin

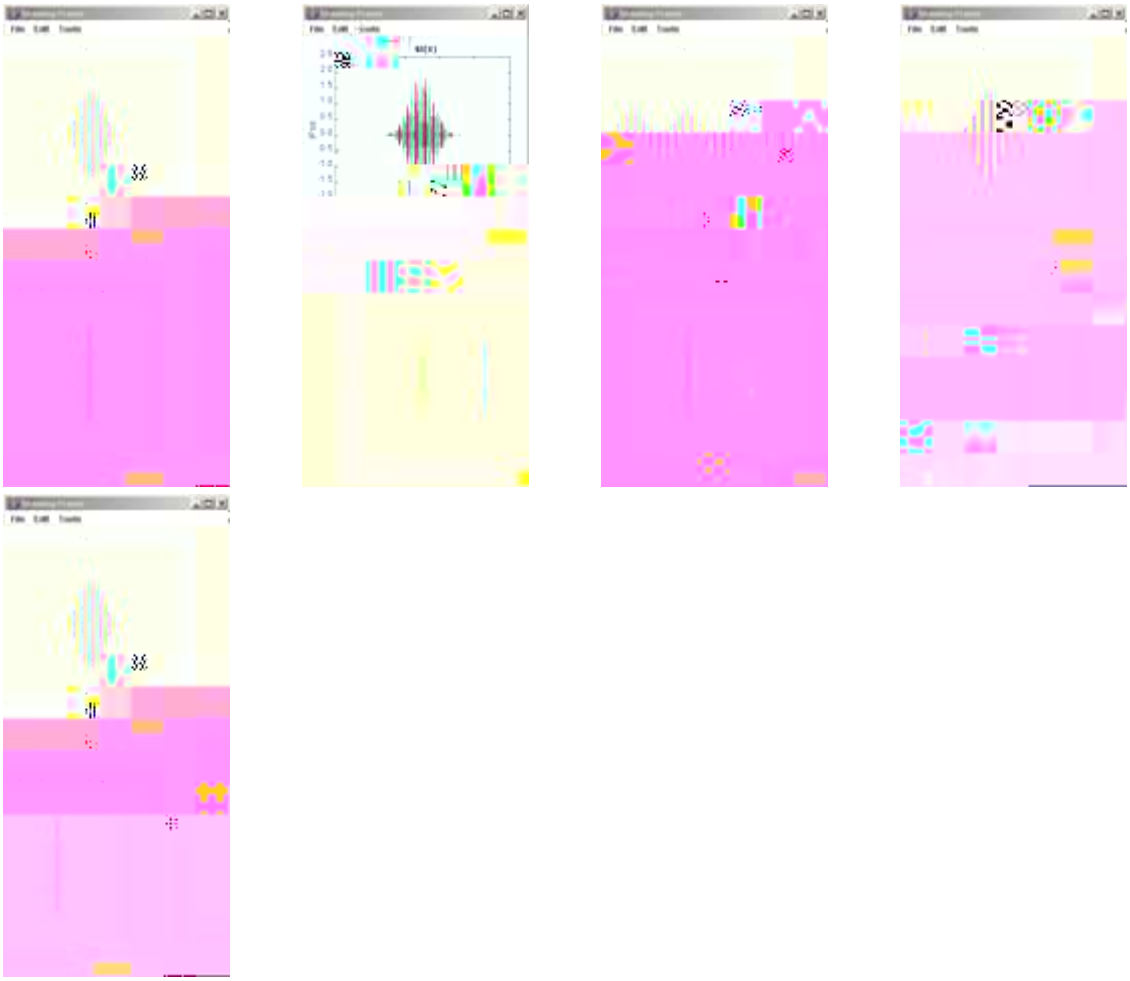
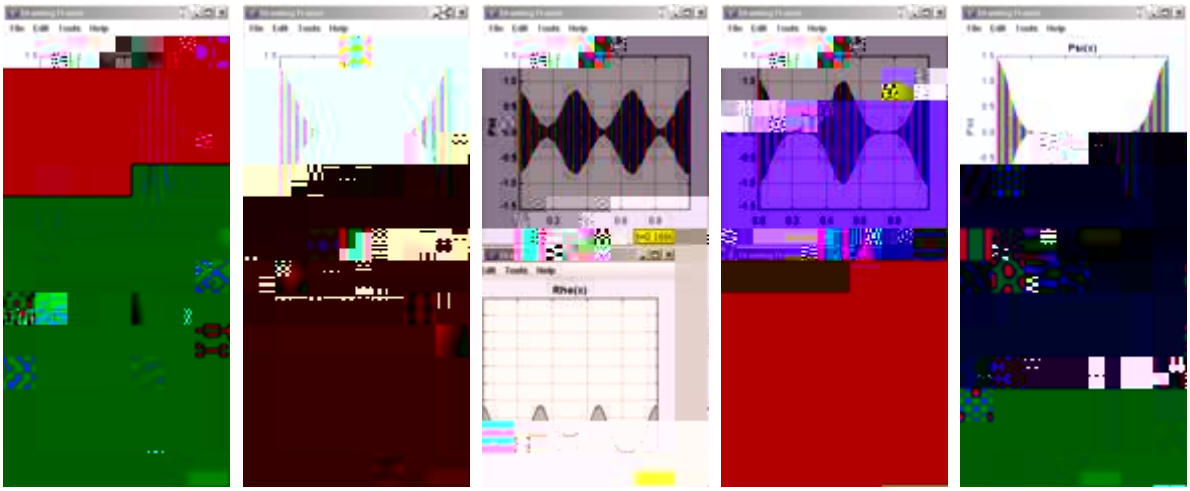


Figure 11:

Time Evolution of a Quantum Wave Packet on a Ring



Esquembre, F., Martín, E., Christian, W. y Belloni, M. (2004) Fislets: Enseñanza de la Física con Material Interactivo, Prentice-Hall, España.

Grossmann, F., Rost, J. M. & Schleich, W. P. (1997). Spacetime Structures in Simple Quantum Systems," J. Phys., A30, L277-L283.

Hake, R. (1998). Interactive-engagement vs. Tradi