PHYSICS 401 : Spring Semester 2018

Possible Final Projects - due on or before 5:00 pm, Friday, May 4, 2018

A brief (4-6 pages), but complete paper, is expected, not just program listings and results. The final project report should contain:

I. Introduction - a brief paragraph stating the problem that you are trying to solve and why it is interesting or important.

II. Description of the problem - including all equations and physical simplifying assumptions that are necessary to describe the problem or model.

III. Computational Methodology - describe the method you are using to solve the problems, why the method is particularly suited for the problem at hand, and give some technical details about the method.

IV. Results - present the results of your calculation, explain your graphs and tables.

V. Conclusion - what has been learned from solving this problem.

VI. Bibliography - list references that you have consulted in preparing this report, including books, journal articles, magazine, internet sites, etc.. Include at least 3 references.

Possible topics

1. Trajectory calculations. Compare the use of fourth and higher order order symplectic algorithm with Runge-Kutta; pick some projects in Chapter 5, such as 5.18, 5.19, or solve n-body gravitation problems with exactly closed orbits called "chorographic".
2. Chaos. Study some systems in depth, such as the double pendulum, 6.21 or determines the Feigenbaum's constants more accurately, 6.22, or Lyapunov exponents, 6.24, or stadium models, 6.26.
3. Study the phase transition in the two-dimensional Ising model. By simulating at least a 128x128 two-dimensional Ising model and computing its specific heat as a function of temperature, determine its transition temperature and critical exponents. For example, concentrate any one of the following problems: 15.16, 15.17, or 15.18
4. Use higher order symplectic algorithms to solve the radial Schrodinger equation with a v0*sech(r)**2 potential or other nontrivial potentials.
5. Compute the ground state energy of the Helium atom or the hydrogen molecule by use of the Variational Monte Carlo method, 16.25. Invent your own better trial functions.
6. Study quantum mechanical scattering, T and R coefficients in 1-D.
7. Exactly solve for the ground state energy of some simple quantum system, such as the helium atom or hydrogen molecule by use of the Diffusion Monte Carlo algorithm or discretization.
8. Exactly solve for the ground state energy of some simple quantum system, such as Hook's helium, by use of the Path-Integral Monte Carlo method.
9. Topics of your choice, or any other projects in the textbook, using methods taught in class. But you must have my approval of your project choice.