Time dependent Schrodinger Equation

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1 Objective

The objective of the project is to solve the 1-D (or up to 2-D) time dependent Schrodinger equation

$$\left(-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}+V(x)\right)\phi(x)=-i\hbar\frac{\partial\phi(x)}{\partial t}$$

using finite-difference techniques

2 Outline

The Schrodinger equation above will be solved via the Cauchy problem approach. In particular, for a given value of potential $V(x)$, the strategy will be

- specify the initial values of $\phi(x)$ at $t=0$;
- 2nd-order finite difference approximation to the above Schrodinger equation will be derived, with suitable boundary conditions specified;
- the system will be evolved through Crank-Nicholson scheme, possibly with dissipation added.

3 Language and tools

The code will be written in Fortran, more specifically, RNPL (a language developed by the instructor) will be used for solving the time-dependent PDE. The code will be ported to the PIII machines (vn cluster) and sgi's. Visualization and analysis will be mainly done via the ser or scivis.

4 Remarks

A suitable (interesting) potential is still in search. If possible, a 2-D version of the problem may be studied also.

5 References

A preliminary list of references are (more will be added):

- [1] R. Guenther, *A Numerical Study of the Time Dependent Schrodinger Equation Coupled with Newtonian Gravity*

- [2] D. Choi, *Numerical Studies of Nonlinear Schrodinger and Klein-Gordon Systems, Techniques and Applications*

- [3] M. Choptuik, *Numerical Analysis with Applications in Theoretical Physics*

- [4] R. Marsa, *RNPL: The Language*