The explanation of the programs that calculate the amplitudes of two states that are coupled due to interaction with the oscillating electric field of a laser. I have included fortran (.f) and C++ (.cpp) files that numerically solve these equations. AbdAl created two mathematica programs that let you explore these equations without Fortran or C++. I welcome anyone giving a matlab or other mathematica program to solve these equations. There are 4 programs of each type: with/without the rotating wave approximation and with time varying E-field or constant E-field.

The equations that need to be solved are:

$dc_1/dt = -i\,\Omega\,F(t)\cos(\omega t)\,e^{-i\,\omega_0 t}\,c_2$ and $dc_2/dt = -i\,\Omega\,F(t)\cos(\omega t)\,e^{i\,\omega_0 t}\,c_1$

when NOT making the rotating wave approximation (RWA).

The RWA equations are

$dc_1/dt = -i\,\Omega\,F(t)\,½\,e^{-i\,(\omega_0 - \omega)\,t}\,c_2$ and $dc_2/dt = -i\,\Omega\,F(t)\,½\,e^{i\,(\omega_0 - \omega)\,t}\,c_1$

The numerical method that the programs use to solve these equations is the leap frog algorithm. The basic idea of this algorithm is to replace the derivative by a central difference which has an accuracy of order δt^2.

$dc/dt \sim [c(t + \delta t) - c(t - \delta t)]/[2\,\delta t]$

For example, the step for the c_1 becomes

$c_1(t + \delta t) = c_1(t - \delta t) - 2\,i\,\delta t\,\Omega\,F(t)\cos(\omega t)\,e^{-i\,\omega_0 t}\,c_2(t)$

The advantage of using the rotating wave approximation (besides physical insight) is that a much larger time step can be performed. Without the RWA, the time step needs to be small compared to the laser period because the right hand side of the equations are varying on this time scale. With the RWA, the time step needs to be small compared to 1/detuning and 1/Rabi frequency, Ω, which are usually much larger steps. For optical transitions, the difference in the time step is $\sim 10^4$-10^5.