Laser physics simulation program

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Abstract: A simulation program to study various laser dynamics has been written. It explore all main equations of laser physics. The students, playing around with the laser parameters such as pump power, cavity losses and population dynamics can visualize the different behaviors of the laser output power, spectrum and time evolution.
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Summary:

Laser physics is a very attractive field for the students in graduate schools. Continuous wave, Q-switch and mode-locked laser sources can give rise to very peculiar time and spectral evolution easy to demonstrate in the labs. The modeling of the atomic or molecular level populations for materials under optical pumping and the laser cavity properties are both well understood and all the analytical equations can be derived in a classroom. Thus, we developed a simulation program to gives the student a better knowledge of the specificity of the laser physics, make them explore the various behaviors and even compare their simulation with their data obtained in the lab. This program runs on a standard PC and the user interface is presented in the fig 1.

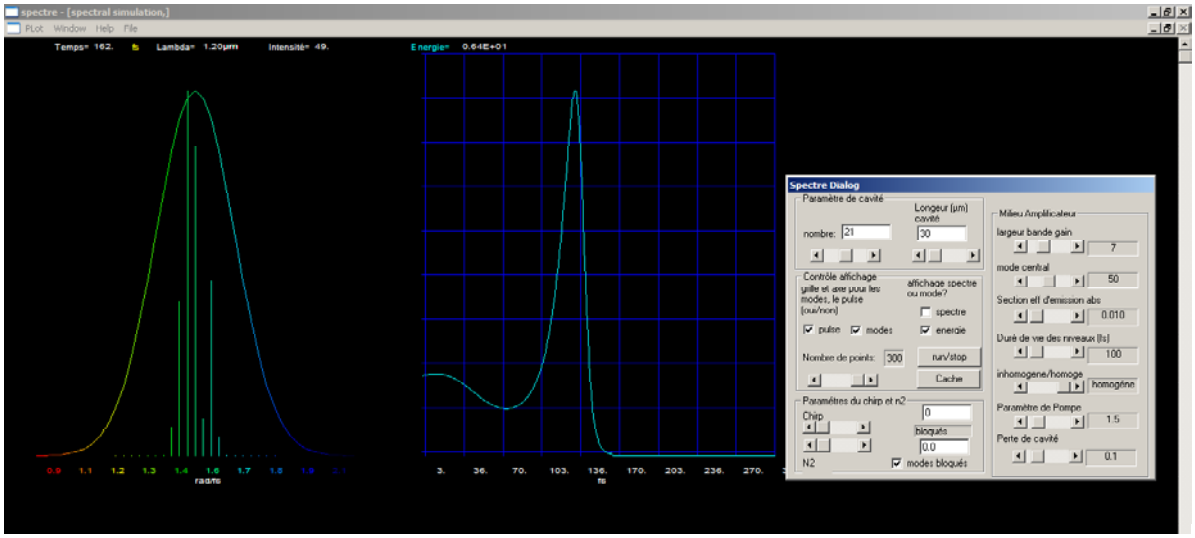

Fig. 1. Simulation of transient behavior of cw system. Spectrum evolution and power output are displayed

Various windows display the spectrum, time evolution of the laser field and/or energy, inside and outside the laser cavity. A complete control on the simulated laser can be done through normalized numbers feeding a chart to account for the pump power, cavity losses and length and spectroscopic data (absorption and emission cross section, radiation lifetimes, feeding parameters, broadening, emission spectral width). From the continuous wave laser emission including transients to the mode locking process with the nonlinearity and dispersion, the control buttons can be tested and commented in a very pedagogical manner while switching on and off the pump laser.

The cases will be specially discussed: First as seen in fig 1, a CW system shortly after switch on where the competition between the various cavity modes gives rise to transient oscillations before the C.W operation and second, the evolution of a CW mode locked laser under strong cavity dispersion and non-linearity. (Chirped femtosecond laser oscillator and non Fourier transform limited laser pulses).

Miscellaneous

This program will be available on line thru the web site of our university for an educational use.

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