Nonmonotonic Response of Solid State Laser Arrays to Injection

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Abstract: The total output intensity from the array of solid state lasers may exhibit nonmonotonic behavior as a function of the amplitude of the injection field. We present comprehensive numerical evidence and analytical description of this effect.

Summary: Synchronized arrays of solid state lasers may provide a reliable source of high intensity and high power coherent emission. A promising way to induce synchronization is injection of the electromagnetic field into the cavities of each laser. This technique has been successfully tested in low power semiconductor diodes [1]. Here we study the entrainment (synchronization) of arrays of solid state lasers to external injection [2]. Obviously, for very large entrainment fields, one expects almost perfect synchronization. However, we show that, before reaching the saturation level, the total output intensity may exhibit nonmonotonic behavior as a function of the injected field. An important consequence of this study is that substantial partial entrainment can be achieved for injected fields much weaker than that required for full entrainment.

In our previous work we demonstrated nonmonotonic behavior and amplitude dropout for a system of two coupled solid state lasers [3,4]. Here we extend this study for larger arrays and show that, under certain circumstances, the equations of motion describing the dynamics of large arrays can be reduced to the equations of motion for two coupled lasers, for which we can provide a complete analytical treatment. We support our analysis with extensive numerical simulations.

References:
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