Chez Pierre

Presents ...

Monday, November 5, 2012
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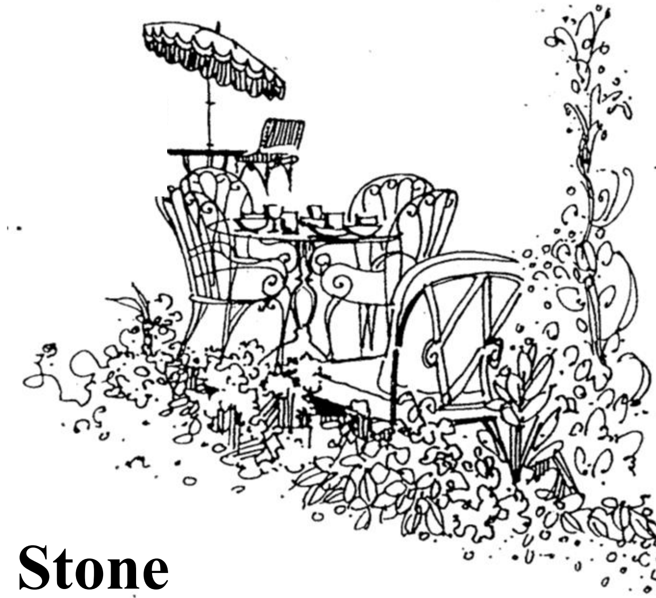
MIT Room 4-331



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"Steady-State Ab Initio Laser Theory: New developments"

We review a new approach to solving the non-linear coupled partial differential equations describing steady state laser emission, Steady-state Ab initio Laser Theory (SALT). The method is based on non-hermitian states of the electromagnetic field, which provide a quantitative and tractable description of arbitrarily complicated laser systems, including complex and open resonator geometries, such as photonic crystal and random lasers. The SALT equations directly determine self-consistently the non-linear steady-state lasing properties (e.g. number of modes, frequencies, field patterns, output power) without having to integrate the standard lasing equations in time, and hence lead to a much more efficient solution algorithm. The SALT formulation, which is essentially a non-linear scattering theory of steady-state lasing, provides much additional physical insight into lasing properties, and unifies many different laser systems

Recently several exciting developments have emerged from extensions of SALT. 1) The SALT equations have been generalized to include coherent inputs and hence to describe quantitatively the injection locking of lasers. This provides a completely different approach from the standard Adler equation method with distinct predictions.
2) SALT has been combined with the input-output theory of quantum optics to describe quantum fluctuations effect in the active cavity and nonlinear regime. The approach leads to a novel generalization of the Schawlow-Townes-Petermann linewidth formula.
3) The scattering formulation of lasing suggested the possibility of constructing a time-reversed or "anti-laser", which we term a coherent perfect absorber (CPA); a linear device in which the gain medium of the laser is replaced with a loss medium such that the cavity will perfectly absorb the incoming (time-reversed) modes of the corresponding laser at threshold. Recently we have experimentally demonstrated such a device in a simple silicon cavity, which acts as an absorptive interferometer, in which narrow-band absorption can be both increased to ~ 99% and reduced to ~30%. The extension of this concept to multiple scattering media implies the possibility of shaping the wavefronts of incident radiation so as to penetrate an opaque material to reach a buried absorption region or detector inaccessible to all other incident waveforms.