Optical Thermodynamics of Nonlinear Highly Multimode Systems

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Abstract: The past few years have witnessed a resurgence of interest in multimode structures, predominantly driven by the ever-increasing demand for higher information capacities. This renaissance, in turn, incited a flurry of activities in the general area of nonlinear multimode optics. The sheer complexity associated with the presence of hundreds or thousands of nonlinearly interacting modes that collectively act as a many-body system, has led to new opportunities in observing a multitude of novel optical effects that would have been otherwise impossible in single-mode settings. In this talk, a thermodynamic theory capable of describing complex, highly multimoded, nonlinear optical systems is presented. It is shown that the mode occupancies in such nonlinear multimode arrangements follow a universal behavior that always tends to maximize the system's entropy at steady-state. This thermodynamic response takes place irrespective of the type of nonlinearities involved and can be utilized to either heat or cool an optical multimode system. Aspects associated with adiabatic compressions and expansions will be discussed along with the possibility for all-optical Carnot cycles.