Demetrios Christodoulides:

Optical Thermodynamics of highly-multimoded nonlinear photonic systems

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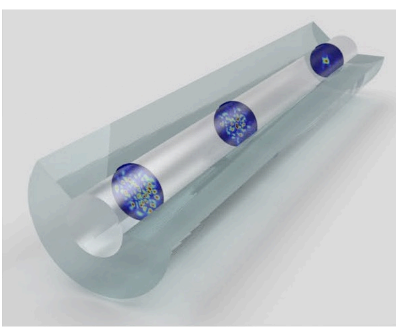
Abstract: Lately, there has been a resurgence of interest in nonlinear multimode optical systems. The sheer complexity emerging from the presence of a multitude of nonlinearly interacting modes has led not only to new opportunities in observing a host of novel optical effects but also to new theoretical challenges in understanding their collective dynamics. Here, we present a consistent thermodynamical framework capable of describing in a universal fashion the exceedingly intricate behaviour of such photonic configurations. In this respect, we derive new equations of state and show that both the 'internal energy' and optical power always flow in accord to the second law of thermodynamics. The laws governing isentropic processes are derived and the prospect for realizing Carnot-like cycles is presented. In addition to shedding light on fundamental issues, this work may pave the way towards a new generation of high-power multimode optical structures and could have ramifications in other disciplines, such as Bose–Einstein condensates and optomechanics.



A schematic of a graded-index multimode fiber system indicating the onset of thermalization, manifested as beam self-cleaning during propagation.

References

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