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Statistical mechanics and pressure in discrete nonlinear multimoded photonic systems

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We examine the thermodynamic behavior of discrete optical systems in the weakly nonlinear regime under thermal equilibrium conditions. Using a grand-canonical approach, we investigate the role of additional system parameters and define their conjugate variables [1]. In addition, we derive expression for the differential of the internal energy and a Gibbs-Duhem equation that relates the variations of the intensive variables. We focus our attention in the case of nonlinear discrete photonic system, such as waveguide arrays and arrays of microresonators. We study the conditions under which two-dimensional lattices can be considered as extensive. Importantly, we reveal that the introduction of size related additional system parameters leads to pertinent expressions for the electromagnetic pressure that is exerted on lattice sites [2]. In particular, the thermodynamic pressure can be directly evaluated by knowing the functional form of the coupling coefficient and the energy conveyed by the optical wave.

References

[1] N. K. Efremidis and D. N. Christodoulides, Phys. Rev. A **103**, 043517 (2021).

[2] N. K. Efremidis and D. N. Christodoulides, Thermodynamic optical pressures in tight-binding nonlinear multimode photonic systems, submitted for publication.