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Statistical Light in Nonlinear Media as Photonic Plasma DMITRY DYLOV, JASON FLEISCHER, Princeton University, Princeton, NJ 08544, USA — We consider the nonlinear propagation of partially-spatially-incoherent light as a photonic plasma. Using wave-kinetic theory and Wigner formalism, we interpret the speckles of statistical light as quasi-particles which can interact via the nonlinearity. We analytically derive a Bohm-Gross dispersion relation for these speckles and their Langmuir-type interaction waves, and identify an effective plasma frequency, effective Debye length, etc. Experimentally, we demonstrate this mapping by studying the nonlinear propagation of diffused light in a self-focusing photorefractive crystal. Observed phenomena include modulation instability, two-stream and bump-on-tail instabilities, wave collapse and optical turbulence. By recording a hologram of the internal dynamics, we observe speckle-wave and wave-wave interactions, in both position (x) space and momentum (k) space. The results generalize ideas from plasma physics, lead to new wave dynamics in nonlinear statistical optics, and allow the experimental study of phenomena that are difficult, if not impossible, to observe in material plasma.

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