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Measuring the dynamic structure factor of a dissipative quantum many-body system TOBIAS DONNER, RENATE LANDIG, RAFAEL MOTTL, LORENZ HRUBY, Institute for Quantum Electronics, ETH Zurich, FERDINAND BRENNECKE, University of Bonn, TILMAN ESSLINGER, Institute for Quantum Electronics, ETH Zurich — A Bose-Einstein condensate whose motional degrees of freedom are coupled to a high-finesse optical cavity via a transverse pump beam constitutes a dissipative quantum many-body system with long range interactions. These interactions can induce a structural phase transition from a flat to a density-modulated state. The transverse pump field simultaneously represents a probe of the atomic density via cavity-enhanced Bragg scattering. By spectrally analysing the light field leaking out of the cavity, we measure non-destructively the dynamic structure factor of the fluctuating atomic density while the system undergoes the phase transition. An observed asymmetry in the dynamic structure factor is attributed to the coupling to dissipative baths. Critical exponents for both sides of the phase transition can be extracted from the data. We further discuss our progress in adding strong short-range interactions to this system, in order to explore Bose-Hubbard physics with cavity-mediated long-range interactions and self-organization in lower dimensions.

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