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Fluctuation spectra underlie the behaviour of non-equilibrium systems ALPHA LEE, DOMINIC VELLA, University of Oxford, JOHN WETTLAUFER, Yale University — A diverse set of important physical phenomena, ranging from hydrodynamic turbulence to the collective behaviour of bacteria, are intrinsically far from equilibrium. Despite their ubiquity, there are few general theoretical results that describe these non-equilibrium steady states. Here we argue that a generic signature of non-equilibrium systems is nontrivial fluctuation spectra. Based on this observation, we derive a general relation for the force exerted by a non-equilibrium system on two embedded walls. We find that for a narrow, unimodal spectrum, the force depends solely on the width and the position of the peak in the fluctuation spectrum, and will, in general, oscillate between repulsion and attraction. We demonstrate the generality of our framework by examining two apparently disparate examples. In the first we study the spectrum of wind-water interactions on the ocean surface to reveal force oscillations underlying the Maritime Casimir effect. In the second, we demonstrate quantitative agreement with force generation in recent simulations of active Brownian particles. A key implication of our work is that important non-equilibrium interactions are encoded in the fluctuation spectrum. In this sense the noise becomes the signal.

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