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Emergent Newtonian dynamics and the geometric origin of mass[1]
LUCA D'ALESSIO, Pennsylvania State University and Boston University, ANATOLI POLKOVNIKOV, Boston University — We consider an arbitrary many-body system with possibly infinitely many degrees of freedom interacting with few macroscopic parameters which are allowed to slowly change in time. These degrees of freedom can represent positions of objects in space, their angles, shape distortions, magnetization, currents and so on. By extending the Kubo linear response theory to such setups we derive the dynamics of the macroscopic d.o.f. which takes the form of the emergent Newton's second law (force is equal to the mass times acceleration) with an extra dissipative term. We find the microscopic expression for the mass tensor relating it to the non-equal time correlation functions in equilibrium. In the classical (high-temperature) limit the mass tensor is given by the product of the inverse temperature and the Fubini-Study metric tensor determining the natural distance between the eigenstates of the Hamiltonian. For free particles this result reduces to the conventional definition of mass. This finding shows that any mass, at least in the classical limit, emerges from the distortions of the Hilbert space highlighting deep connections between any motion and geometry.

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