Bounding the resources for thermalizing many-body localized systems

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Characterizing the precise conditions under which physical systems thermalize is one of the long-standing questions for understanding quantum thermodynamics. Recently, many-body localization (MBL) has been identified as a mechanism that robustly hinders thermalization and hence promises insights into general thermalization conditions. In this work, we provide lower and upper bounds on the size of the heat bath required to thermalize a system in a MBL phase. Specifically, we find a simple, yet physical, collision model of interaction between the sites of a MBL spin lattice system and a heat bath which leads to thermalization of the sites. For this model we are then able, by employing recent tools from quantum information theory known as the *convex split lemma*, to derive quantitative bounds on the size of the heat bath required to thermalize a given region of the spin lattice. Furthermore, we numerically compute the scaling of the size of the thermal bath as a function of the number of lattice sites, and we show that this size increases as the MBL phase gets stronger. Thus, our results provide quantitative insights into the robustness of the MBL phase against thermal noise, and help to clarify the connection between this phase and the thermalization process.