Thermoelectric clathrates: From phonons to correlations

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Thermoelectric materials can convert temperature gradients into electrical power and are thus of interest for applications in waste heat recovery. The ideal thermoelectric combines a high electrical conductivity and thermopower with a low thermal conductivity. Intermetallic type-I clathrates show extremely low lattice thermal conductivities which appears to be related to the interaction of guest-atom derived rattling modes and acoustic phonons [1,2]. Recently, we have succeeded to incorporate cerium as guest atom into a Si-based clathrate [3]. In many simpler intermetallic compounds this rare-earth element is known to lead, via the Kondo interaction, to strong correlation phenomena including the occurrence of giant thermopower values at low temperatures. Indeed, we observe a 50% enhancement of the thermopower compared with a rare-earth-free reference material. Importantly, this enhancement occurs at high temperatures and we suggest that a rattling enhanced Kondo interaction underlies this effect.

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We acknowledge financial support from the Austrian Science Fund (TRP 176-N22 and I623-N16) and the European Research Council (ERC Advanced Grant No 227378).