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Researchers introduce relaxons to help describe heat flow through some crystals

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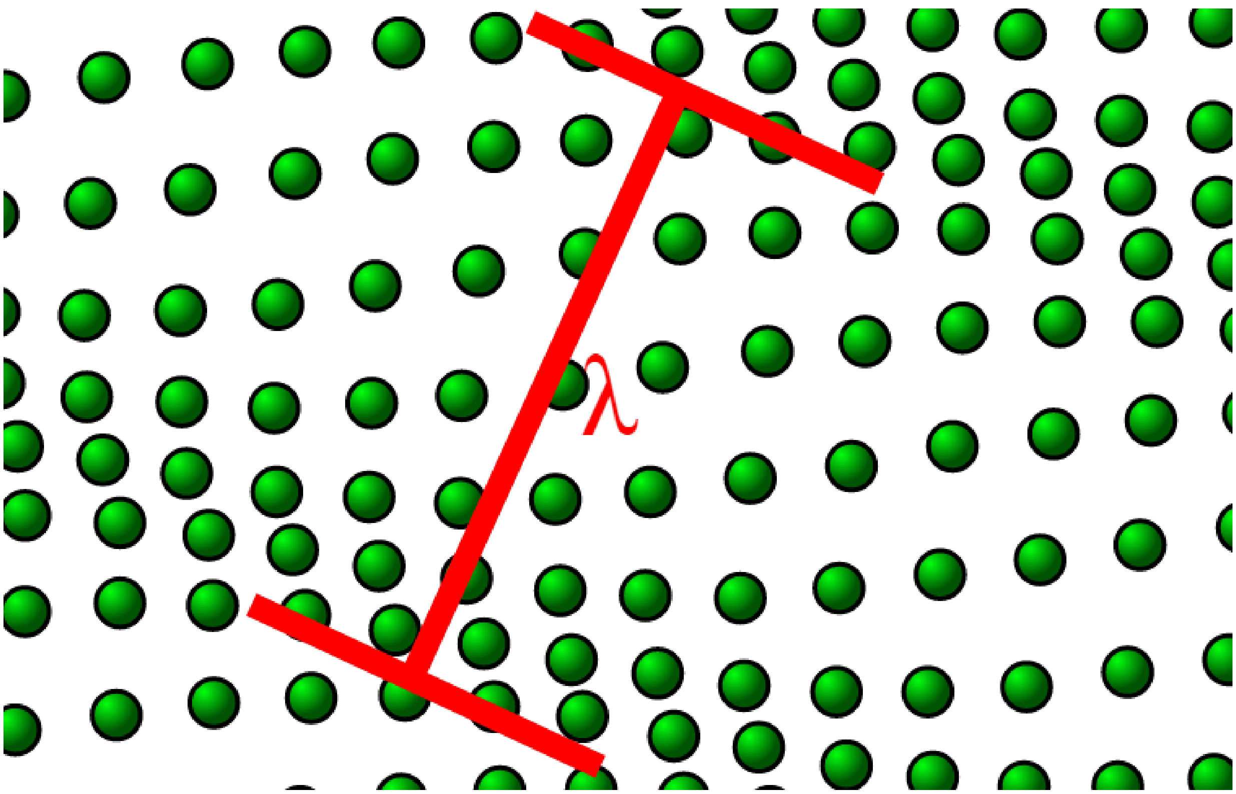

Phonon propagating through a square lattice (atom displacements greatly exaggerated). Credit: Wikipedia

A team of researchers with École Polytechnique Fédérale de Lausanne in Switzerland has introduced a new vibrational mode called a relaxon to the field of heat conduction theory to describe the way heat flows through some crystals. In their paper published in the journal *Physical Review X*, the team describes their new model and how well it worked when testing it with two particular crystals.

For many years, physicists have used phonons to assist in describing the way heat moves through crystals. Thermal conductivity occurs via two processes: scattering between phonons due to atomic vibrations and disruptions to the lattice. This method has proven to be quite accurate for predicting the way heat will be conducted through many crystals, but for some, it has not worked well at all. In this new effort, the researchers added a new vibrational mode, relaxons, to improve results for such crystals.

Relaxons, they explain, come about from coordinate frame changes that are different than for phonons—they decay to an equilibrium population over a well-defined lifetime. The researchers tested their new model by applying it to two materials: graphene and silicon. In silicon, the researchers found results within 2 percent of those conducted using the standard phonon approach, demonstrating success. With graphene, the researchers found different results—it read 8 times higher than that found using the standard phonon approach, which agreed with calculations performed prior to testing, indicating that it was a better approach. This suggests the new method offers a better means for making predictions of thermal conductivity when creating objects using graphene and perhaps other crystals. Adding relaxons is, in a sense, offering a new way to envision the means by which heat is conducted through certain types of crystals.

The addition of relaxons to the field of heat conduction, the team notes, has implications for future theoretical studies—it could be used, perhaps, in work related to the interpretation of hydrodynamic transport, offering a new means for making predictions. The new model is also likely to have an impact on experimental research as well, particularly in mean free path spectroscopy, a new field in which researchers are looking to isolate the impact of carriers with different mean free paths to conductivity.

More information: arxiv.org/abs/1603.02608