Environmental noise found to enhance the transport of energy across a line of ions

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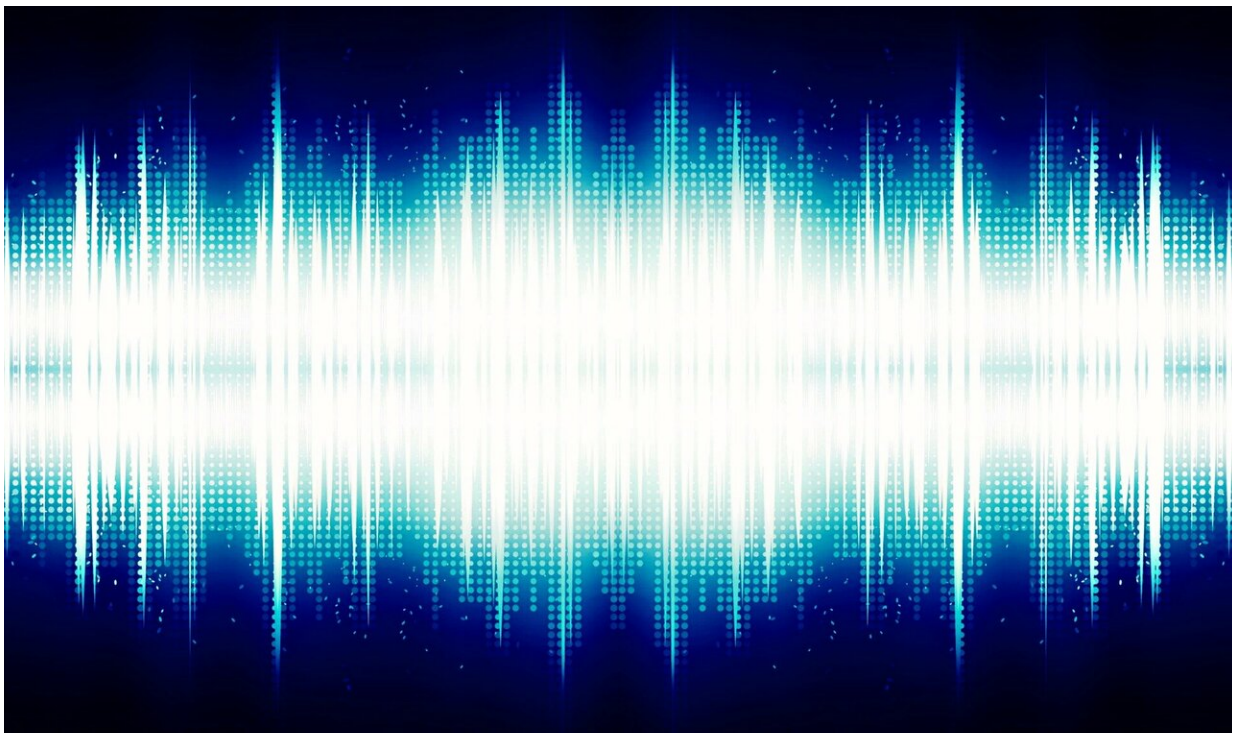

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A team of researchers affiliated with several institutions in Austria and Germany has shown that introducing environmental noise to a line of ions can lead to enhanced transport of energy across them. In their paper published in *Physical Review Letters*, the researchers describe their experiments and why they believe their findings will be helpful to other researchers.

Prior research has shown that when electrons move through conductive material, the means by which they do so can be described by quantum mechanics equations. But in the real world, such movement can be hindered by interference due to noise in the environment, leading to suppression of the transport energy. Prior research has also shown that electricity moving through a material can be described as a wave—if such waves remain in step, they are described as being coherent. But such waves can be disturbed by noise or defects in an atomic lattice, leading to suppression of flow. Such suppression at a given location is known as an Anderson localization. In this new effort, the researchers have shown that Anderson localizations can be overcome through the use of environmental noise.

The work consisted of isolating 10 calcium ions and holding them in space as a joined line—a one-dimensional crystal. Lasers were used to switch the ions between states, and energy was introduced to the ion line using laser pulses. This setup allowed them to watch as energy moved along the line of ions from one end to the other. Anderson localizations were introduced by firing individual lasers at each of the ions—the energy from the lasers resulted in ions with different intensities. With a degree of disorder in place, the team then created noise by randomly changing the intensity of the beams fired at the individual ions. This resulted in frequency wobble. And it was that wobble that the team found allowed the movement of energy between the ions to overcome the Anderson localizations.

The researchers note that there was a limit on the system—too much noise, and energy transport once again slowed due to the quantum Zeno effect. They claim that their system could prove useful to other researchers because it allows for studying quantum effects in an artificially engineered quantum system.

More information: Christine Maier et al. Environment-Assisted Quantum Transport in a 10-qubit Network, *Physical Review Letters* (2019). DOI: 10.1103/PhysRevLett.122.050501

arXiv:1809.07680v1 arxiv.org/abs/1809.07680

Abstract
The way in which energy is transported through an interacting system governs fundamental properties in many areas of physics, chemistry, and biology. Remarkably, environmental noise can enhance the transport, an effect known as environment-assisted quantum transport (ENAQT). In this paper, we study ENAQT in a network of coupled spins subject to engineered static disorder and temporally varying dephasing noise. The interacting spin network is realized in a chain of trapped atomic ions and energy transport is represented by the transfer of electronic excitation between ions. With increasing noise strength, we observe a crossover from coherent dynamics and Anderson localization to ENAQT and finally a suppression of transport due to the quantum Zeno effect. We found that in the regime where ENAQT is most effective the transport is mainly diffusive, displaying coherences only at very short times. Further, we show that dephasing characterized by non-Markovian noise can maintain coherences longer than white noise dephasing, with a strong influence of the spectral structure on the transport effciency. Our approach represents a controlled and scalable way to investigate quantum transport in many-body networks under static disorder and dynamic noise.