Temperonic Crystals: Coherence Effects of Temperature Fields in Correlated Quantum Metamaterials

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Coherent control of wave-like phenomena via metamaterials is driving a technological revolution in fields ranging from electronics, photonics, to phononics. Although temperature has been historically taken as the paradigmatic example of an incoherent field, undergoing diffusive as opposed to wave-like propagation, on short space and time scales Fourier's law fails and the possibility for temperature wave propagation sets in [1]. Building on this rationale, we propose a new class of metamaterials allowing for coherent temperature control on the ultrafast time-scale. As a model example, we propose and theoretically investigate the dispersion relation of a "Temperonic Crystal", a periodic structure made by alternating two materials sustaining heat waves on short time-scales. For instance, a Temperonic Crystal may act as a frequency filter for a temperature pulse triggered by an ultra-short laser pulse. The above concepts are then contextualized in the frame of Correlated Quantum Materials. The anisotropy inherent in high temperature superconductors make them an ideal building block to engineer metamaterials encompassing coherent control capabilities of the wave-like nature of the temperature fields occurring on ultrafast time-scales [2,3].

References:

[1] Tzou, "Macro- to Microscale Heat Transfer: the Lagging Behavior" (John Wiley & Sons, Inc., 2014)
[2] Gandolfi et al., Physica Scripta 92 (2017) 034004
[3] Giannetti et al., Advances in Physics 65, 58-238 (2016)