Poster Presentation

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Optical conductivity of the R-Cd quasicrystals and approximants

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Recently, a new family of R-Cd binary icosahedral quasicrystals has been discovered [1]. Using optical reflectance spectroscopy, we have examined the quasicrystal $GdCd_{7.98}$ and the approximants $GdCd_6$ and YCd_6. To explain the unique behaviour of electrons in a quasiperiodic lattice Mayou [2] created a model of electron transport due to anomalous diffusion of wave packets scattering from the quasiperiodic lattice. We have determined the optical conductivity of the above-mentioned materials from 7.5 meV to 5.5 eV and have used Mayou's model of optical conductivity for approximants and quasicrystals, $\sigma_1 \propto \mathrm{Re}[\ (1/(\gamma-i\omega))^{(2\beta-1)}\ ]$, to describe the low frequency behaviour. Despite the concern of Mayou of not being able to differentiate experimentally between normal metallic conductivity of ballistic electrons, $\beta=1$, and sub-ballistic conductivity, $1/2<\beta<1$, we clearly see $\beta\approx3/4$ in the intraband peak of the icosahedral approximants, which has not been observed before. Before this work, the only unambiguously Drude-like peak seen in any quasicrystal or their approximant occurred in the decagonal approximant γ-brass, which was fit with exactly $\beta=1$ [3]. However, unlike the approximants in our study, this sample of γ-brass was admittedly not a good approximant to a quasicrystal with its small lattice constant. In the $GdCd_{7.98}$ quasicrystal, we observe low frequency behaviour that lacks a Drude peak but is not nearly perfectly linear as seen by others. In this case, the low frequency behaviour is qualitatively similar to the diffusive regime, $0<\beta<1/2$, that is often seen. However, it is not adequately modelled by Mayou's generalized Drude model. With these results, unlike in previous optical conductivity studies, we have a striking difference in the low frequency conductivity that suggests that there is a difference in the physics of the optical conductivity of periodic and quasiperiodic lattices that needs to be explored.

[1] *A.I. Goldman et al., Nature Materials, 2013, 12, 714-718.,* ***[2]*** *D. Mayou, Phys. Rev. Lett., 2000, 85, 1290.,* ***[3]*** *Demange et al., Phys. Rev. B., 2002, 65, 144205.*

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