Anderson co-localization in GaAs/AlAs superlattices

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Engineered cavities in optomechanical crystals exhibit Q-factor degradation and optomechanical coupling rate reduction due to extra-loss mechanisms and mode hybridization induced by intrinsic fabrication disorder. An alternative to further intensify efforts on improving nanofabrication techniques is to use disorder as a tool to localize light and mechanical motion by using Anderson localization. Numerical simulations of position-disordered silicon nanobeams [1] show that the average optomechanical coupling achievable is rather moderate due to low probability of co-localized photon-phonon pairs. In order to guarantee a high degree of spatial co-localization, GaAs/AlAs superlattices seem to provide the ideal platform. Longitudinal motion and light propagation in the epitaxy direction obey the exact same equations due to a somehow magical coincidence in velocities and impedances [2], therefore guaranteeing *perfect* co-localization. We assess Anderson localization of both photons and phonons in such system by using a standard transfer matrix approach and discuss the role of spatial co-localization for cavity optomechanics experiments by comparing it to other typically used superlattices (Si/Ge, $BaTiO_3/SrTiO_3$).

References

[1] P.D. García, R.Bericat-Vadell, G.Arregui, D. Navarro-Urrios, M. Colombano, F.Alzina and C.M. Sotomayor Torres, Phys. Rev. B **95**, 115129 (2017)
[2] A. Fainstein, ND. Lanzillotti-Kimura, B. Jusserand and B. Perrin. Phys. Rev. Lett. **110**, 037403 (2013)

Figures

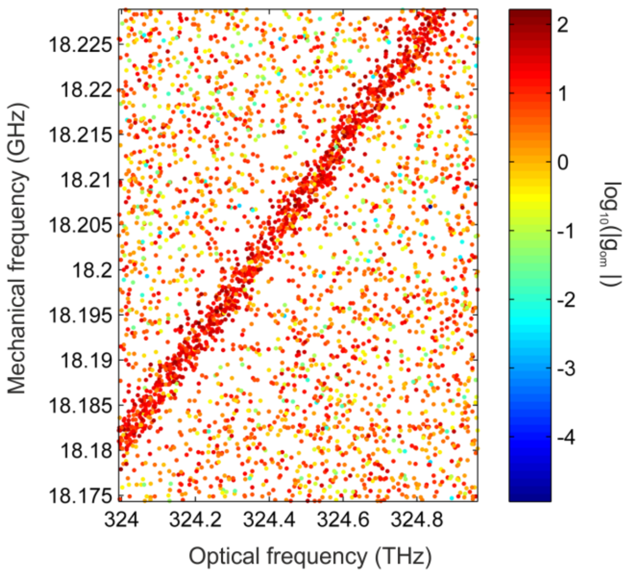

Figure 1: Vacuum optomechanical coupling rate g_{om} realizations for disordered (λ/2, λ/2) - GaAs/AlAs superlattices. The pronounced diagonal is the fingerprint of Anderson co-localization.

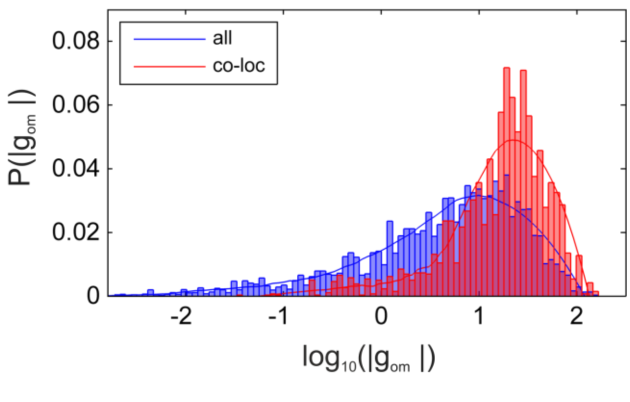

Figure 2: Probability density function of the vacuum optomechanical coupling rate g_{om} for all photon-phonon pairs (blue) and considering only co-localized pairs (red).