Superradiant emission from electronic excitations in semiconductor quantum structures

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Light-matter interaction, usually considered only as a weak probe, becomes the dominant energy relaxation mechanism for *collective excitations* in a two-dimensional electron gas. Indeed, when the concentration is sufficiently high, electrons respond to the solicitation of photons as a whole, with an absorption spectrum presenting a unique resonance at a completely different energy with respect to that of the electronic transitions.[1] This optical resonance corresponds to a many-body excitation of the system that ties together all the dipoles, thus presenting a phenomenal interaction with light.[2] This results in a spontaneous emission rate of the collective excitation depending on the electronic density, a phenomenon known as *superradiance*.[3]

By conducting thermal emission experiments, we have observed a strong dependence of the linewidth as a function of the emission direction and electronic density. Due to superrandiance phenomena, spontaneous emission lifetimes shorter than 100 fs has been deduced for collective excitations in 2-dimensional electron gas.[4] These excitations have radiative decays more than six orders of magnitude faster than the spontaneous emission lifetime of a single particle at the same wavelength. This extremely fast radiative decay has important consequences on the characteristics of the incandescent emission that we have modelled by solving quantum Langevin equations, including coupling of the collective excitations with electronic and photonic baths.[5]

References

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