Exciton polaritons for reconfigurable chirality

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Optical chirality (OC), i.e. the lack of mirror symmetry in the optical response of a specimen to left- or right-circularly polarised (L/RCP) light, is encountered widely in nature, e.g. in the study of biomolecules of medicines. Sensing and control of OC is thus of major importance for applications, and numerous activities in nanophotonics are focusing on providing photonic environments that facilitate measurements [1]. Because the intrinsic optical activity of natural chiral materials is weak, ways to e.g. enhance, spectrally shift, and measure circular dichroism (CD) signals —the differential absorption under LCP or RCP illumination— are highly in demand.

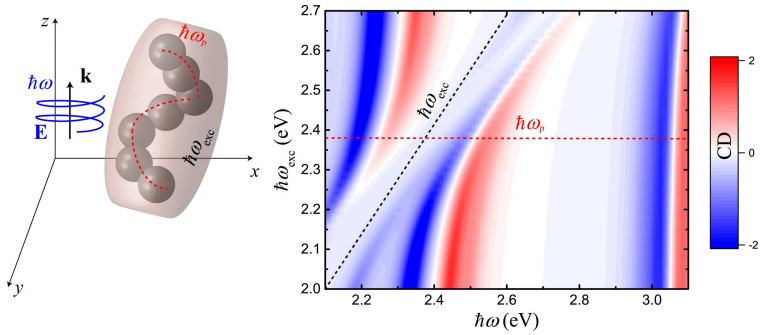

Figure 1: A metallic nanosphere helix that supports a collective plasmonic mode at energy $\hbar\omega_{\rm p}$, embedded in an excitonic matrix characterised by a transition at $\hbar\omega_{\rm exc}$. The entire system is illuminated by circularly polarised light of energy $\hbar\omega$. When the detuning between the two energies is small, the modes interact strongly, leading to an anticrossing in the optical spectra, including those for CD.

Here we suggest a means to manipulate and configure OC via strong coupling of the optical resonances of the sample with the excitons of an encapsulating or supporting medium [2]. We first show analytically, through the simple example of a chiral sphere coated with an excitonic layer, that strong coupling allows the emergence of two tuneable bands of strong CD signals (in place of the sole otherwise anticipated), whose energy depends on the excitonic material. This response is then verified with numerical calculations for a helix of metallic nanospheres embedded in an excitonic (itself achiral) matrix, as shown in Fig. 1. Strong coupling enables therefore post-fabrication flexibility for detecting CD signals and manipulating OC [3].

References

[1] Warning et al., ACS Nano **15**, 15538 (2021).

[2] Tserkezis et al., Rep. Prog. Phys. **83**, 082401 (2020).

[3] Stamatopoulou et al., Nanoscale, *submitted*.

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