Spectroscopic probes of quantum many-body correlations in polariton microcavities

Levinsen, Jesper[1,2,*], Francesca Maria Marchetti[3], Jonathan Keeling[4], Parish, Meera[1,2]

[1]*School of Physics and Astronomy, Monash University, Clayton Campus, Australia*
[2] *ARC CoE FLEET*
[3] *Universidad Autonoma de Madrid, Spain*
[4]*University of St Andrews, St Andrews, United Kingdom*
**e-mail: jesper.levinsen@monash.edu*

We theoretically investigate the many-body states of exciton-polaritons that can be observed by pump-probe spectroscopy. Here, a weak-probe “spin-down” polariton is introduced into a coherent state of “spin-up” polaritons created by a strong pump. We show that the spin-down impurities become dressed by excitations of the spin-up medium, and form new polaronic quasiparticles that feature two-point and three-point many-body quantum correlations, which, in the low density regime, arise from coupling to the vacuum biexciton and triexciton states respectively. In particular, we find that these correlations generate additional branches and avoided crossings in the spin-down optical transmission spectrum that have a characteristic dependence on the spin-up polariton density. Our results thus demonstrate a way to directly observe correlated many-body states in an exciton-polariton system that go beyond classical mean-field theories.

References

[1] Levinsen, Marchetti, Keeling, Parish, Spectroscopic probes of quantum many-body correlations in polariton microcavities, arXiv:1806.10835