Chez Pierre

Presents ...

Monday, April 5, 2021

12:00pm Noon

Broadcast via Zoom

Chez Pierre Seminar

Marco Polini – University of Pisa

"Photon condensation in a spatially-varying electromagnetic field."

Theoretical work on equilibrium super-radiance (which will be here dubbed photon condensation) has an interesting and tortured history since Hepp and Lieb and Wang and Hioe independently pointed out in 1973 that (for sufficiently strong light-matter coupling) the Dicke model harbors a finite temperature second-order equilibrium phase transition between a normal phase and a photon condensate. I believe there is now consensus that photon condensation is forbidden by gauge invariance in a spatially-uniform quantum cavity field [1]. In this talk I will show that light-matter interactions in a spatially-varying quantum cavity field enable to bypass the no-go theorem of Ref. [1]. In particular, I will discuss a criterion for the occurrence of photon condensation that solely depends on the static, non-local orbital magnetic susceptibility $\chi_{\_orb}$ (q) of the electron system (ES), evaluated at the photon momentum $\hbar$q. Only three-dimensional (3D) ESs satisfying the Condon inequality $\chi_{\_orb}$ (q)>1/(4π) can harbor photon condensation. I will also discuss the experimentally relevant case of two-dimensional (2D) ESs embedded in quasi-2D cavities, where the criterion involves again $\chi_{\_orb}$ (q) but also the length of the cavity in the direction perpendicular to the 2DES. If time allows, I will a) comment on the role of spin effects (Zeeman coupling) and b) list 2DESs where the criterion is most likely to be satisfied. My conclusions on the occurrence of photon condensation are nonperturbative in the strength of electron-electron interactions and therefore apply also to strongly correlated ESs.

[1] G. M. Andolina, F. M. D. Pellegrino, V. Giovannetti, A. H. MacDonald, and M. Polini, Cavity QED of strongly correlated electron systems: A no-go theorem for photon condensation, Phys. Rev. B 100, 121109(R) (2019).

[2] G. M. Andolina, F. M. D. Pellegrino, V. Giovannetti, A. H. MacDonald, and M. Polini, Theory of photon condensation in a spatially-varying electromagnetic field, Phys. Rev. B 102, 125137 (2020).