Collective fluctuation modes in a polariton laser

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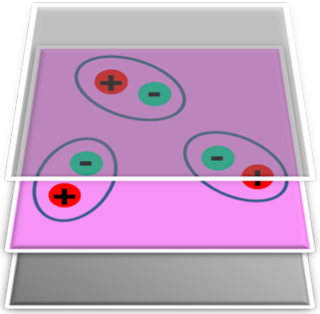
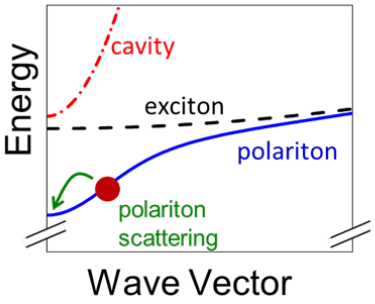
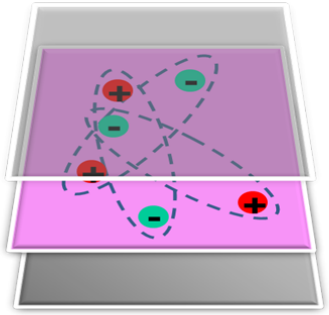
Polariton BEC





well established
(theory and experiment)

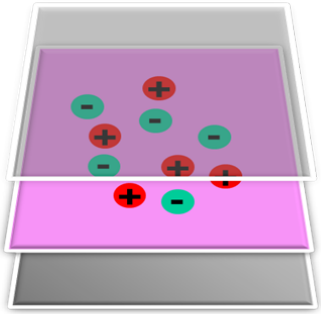
Polariton BCS

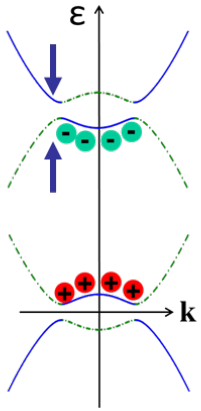


mostly theory well established

Photon Laser

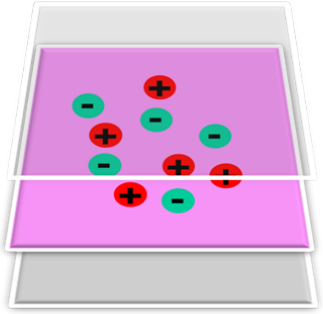
with e-h BCS (strong laser)

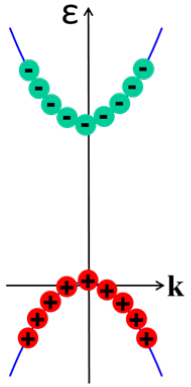




mostly theory well established

without e-h BCS (weak laser)



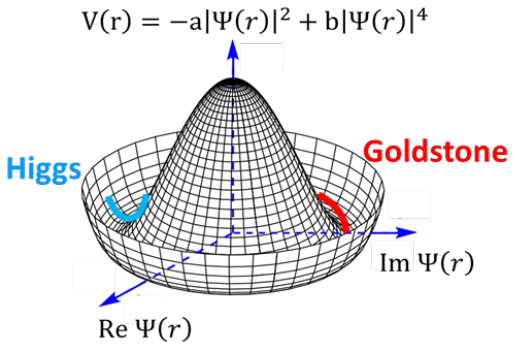


well established
(theory and experiment)

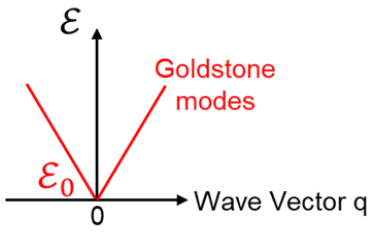
Fluctuation modes in condensates

Order parameter (condensate wave function):
phase arbitrary, but fixed by
spontaneous symmetry breaking

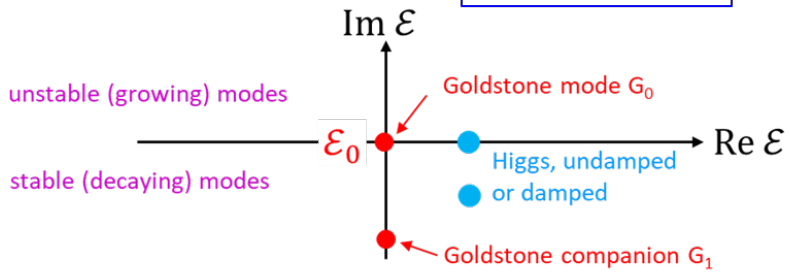
$$\Psi(\mathbf{r}) = |\Psi(\mathbf{r})|e^{i\phi}$$



Goldstone is the oscillation mode of the broken-symmetry variable (phase)*



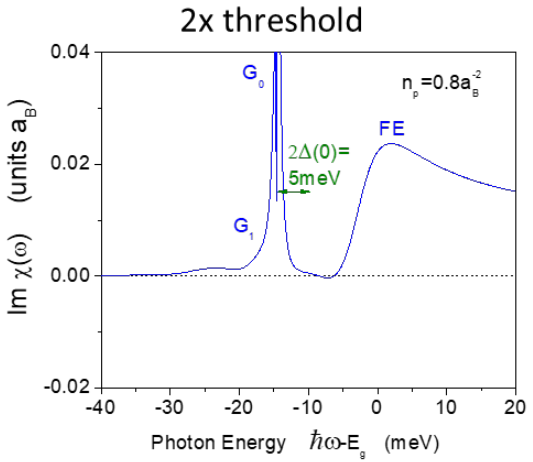
In our study q=0

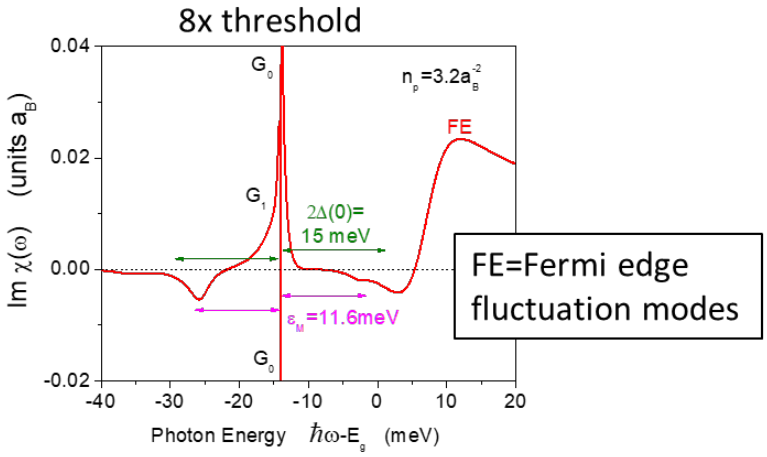


Physics of Higgs (if it exists) depends on details of system.

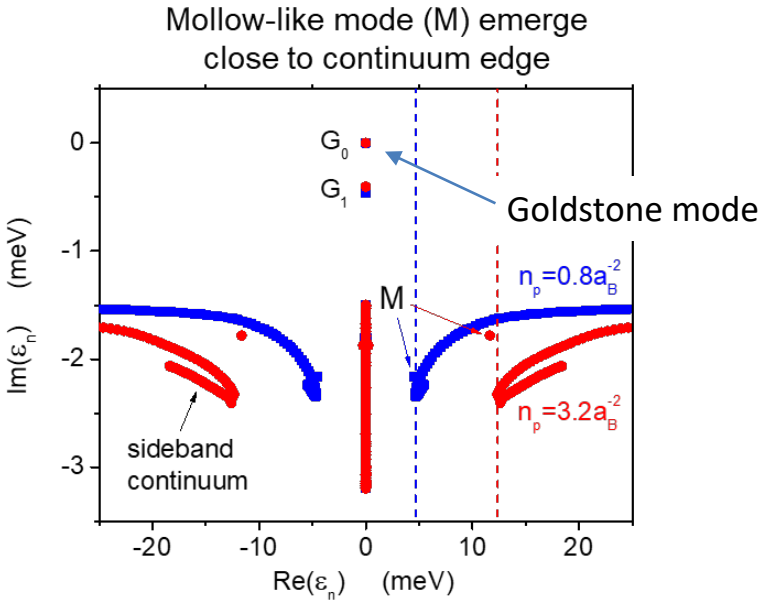
* Other terminology for phase modes in superconductors: Anderson-Bogoliubov mode, Nambu-Goldstone mode

Fluctuation modes in polaritonic BCS state





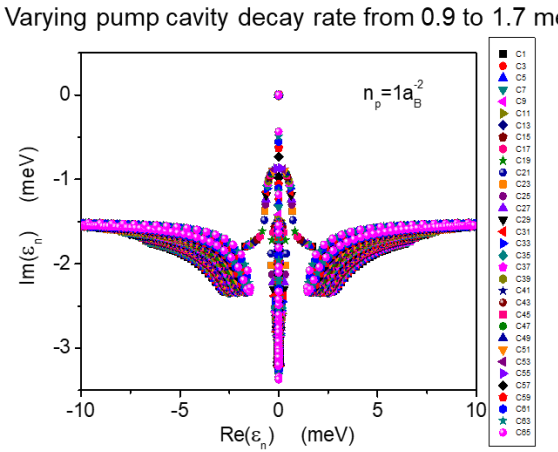
FE=Fermi edge fluctuation modes

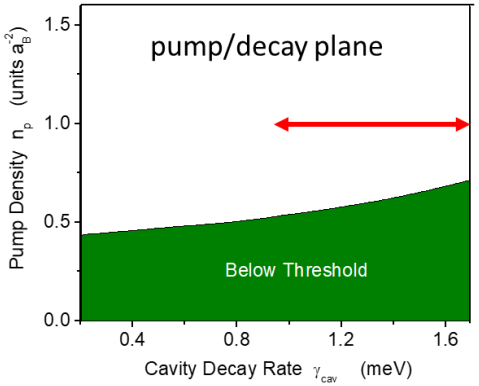


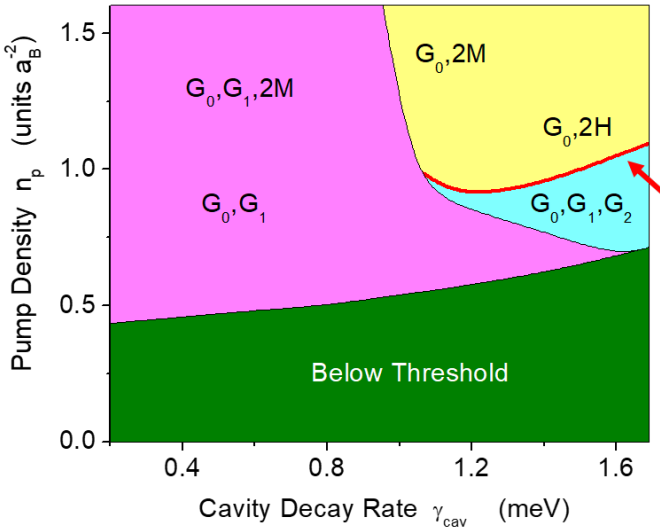
M-modes are not Higgs modes

M-mode close to onset of continuum fluctuation modes

Transformation of collective fluctuation modes in polariton BCS state







continuum of exceptional points in the pump/decay plane

[1] Binder, Kwong, Phys. Rev. B 103, 085304 (2021)

[2] Spotnitz, Kwong, Binder, Phys. Rev. B 104, 115305 (2021)