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The talk is divided in two different part which corresponding to my research interest.

Let focus on the first part Exciton-Polariton in Artifical Lattice.
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First ,exciton-polariton or for short polariton is a quasiparticle as a consequence of strong coupling between the cavity photon and excitoon.

In principle, we can regard the polarion is a superposition of light and matter party of wavefunction.

Describe the picture, light is localized in the cavity, exciton is in the quantum well.

In the style of second quantization, the system can be describe by the follow Hamiltonian.

The typical eigenspectrum is the following. In exciton-polariton physics, we useually consider the lower branch.

The advantanges are the following:
Comparing the exciton BEC
Comparing to caivty photonics

The following properties of polariton are mainly dependend on the fraction of photon component or exciton component inside of polariton. One can easily change this properties by change the detuning.

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The detuning is defined as follow, the energy deference between the cavity phtonon and exciton.

Here we plot dispersion the position, 0 and negative detuning case for the polariton.

The lower panel corresponding to the LP Hopfield cofficents.

Due to the combination of light and matte the typical effective mass can be orders of magnitude smaller that the exlectron. This give a relative large de Broglie wave length.
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This properties allow us to manipulted the exciton polariton condensation in some micro scale potentials.

In 0D ,1 D and 2D.

To manipulate the potential one can spatially carve the microcavity in different shape. Lieb in 1D Hony cone lattic Bentz circle.

Alternatively by apply extra metallic layers on the top of caveity as show in figure.

In the talk, we will give different results by consider the exciton-polariton in different artifical lattice the topic incluid.

To descripe the dynamics of the polariton system, the numerical method we used is the driven-disspipative Gross-Pitaevskii equation.

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The Gross–Pitaevskii equation (GPE, named after Gross and Pitaevskii) describes the ground state of a quantum system of identical bosons using the Hartree–Fock approximation.

In exciton-polariotn physics we are more interested in lower branch of system, so we use the following equation to describe the dynamics of the system.

Due to the decay of the cavity photon. Introduce the decay term \lambda term.

To describe the gain of the system, we have to independent pumping sources.

The first is the coherent pumping, which describe the pump coherently add to the system.

The incoherent pumping.

Later we will use the following equations to study the dynamics of the exciton-poilariton system.

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The first example we will consider is the multivally system.

Where we consider the cavity photon and exciton are separeately manipulated by two period potentials.

The eigenwave function of the groud state for k=0 and k=pi/2 state.

Stimuilate scattering and stochastic scattering term to describe the phono-polariton interaction.

And the corresponding result..

We further to consider the 2D case. With the TE-TM spliting term, we have the following result.

Diferent valley have different polarization.

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In this section we consider the complex terms in the generalized GP equation in polariton condensation.

V(x) and alpha beta.

Pi and 0 state condensation

We furtuer checnk the intermittency feature of the system by consider the dependence between the

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Next we talk about the flat band condensation in the exciton-polariton system.