Josephson vortices in scalar and vector dissipative polariton systems

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19 of May 2017, Institute for Basics Science, Korea
International Workshop *Physics of Exciton-Polaritons in Artificial Lattices*

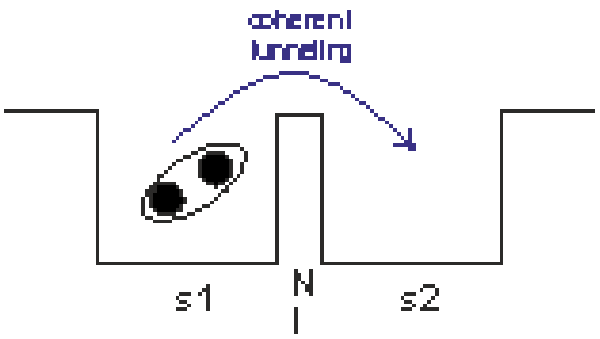
The aim of the work is to explore the analogy between coherent systems of different physical origine: superonducting systems vs polariton ones.

Abrikosov vortices - vortices in polariton condensates

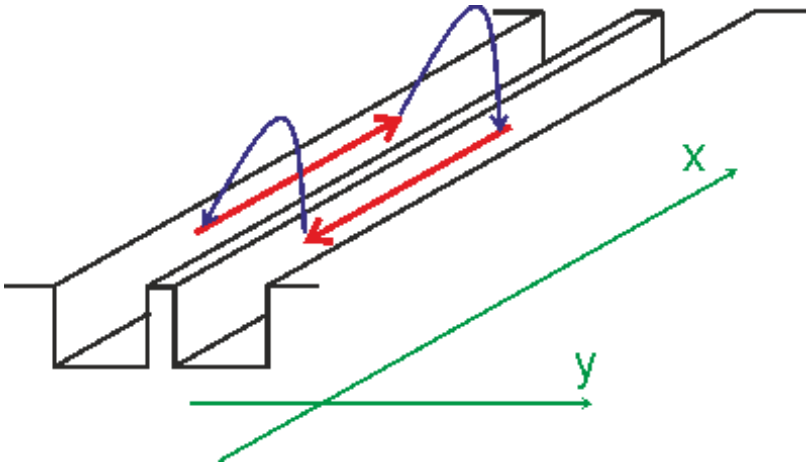
Josephson vortices - ?

Very brief introduction to Josephson effect

point Josephson junction



long Josephson junction



Outline of the talk

I. Mathematical model.
II. Scalar case.
    1. Linear geometry. Stationary Josephson effect.
    2. Annular geometry. Stationary Josephson effect.
    3. Non-stationary Josephson effect
III. Inter-polarization Josephson vortices in vector case.
    1. Linear geometry.
    2. Annular geometry.
    3. Josephson vortex as a polarization flip.
IV. Mixed vortex states: intra- and inter-polarization Josephson vortices.
V. Vortices in microstructures cavities
    1. Josephson vortices.
    2. Dark solitons.
VI. Conclusion

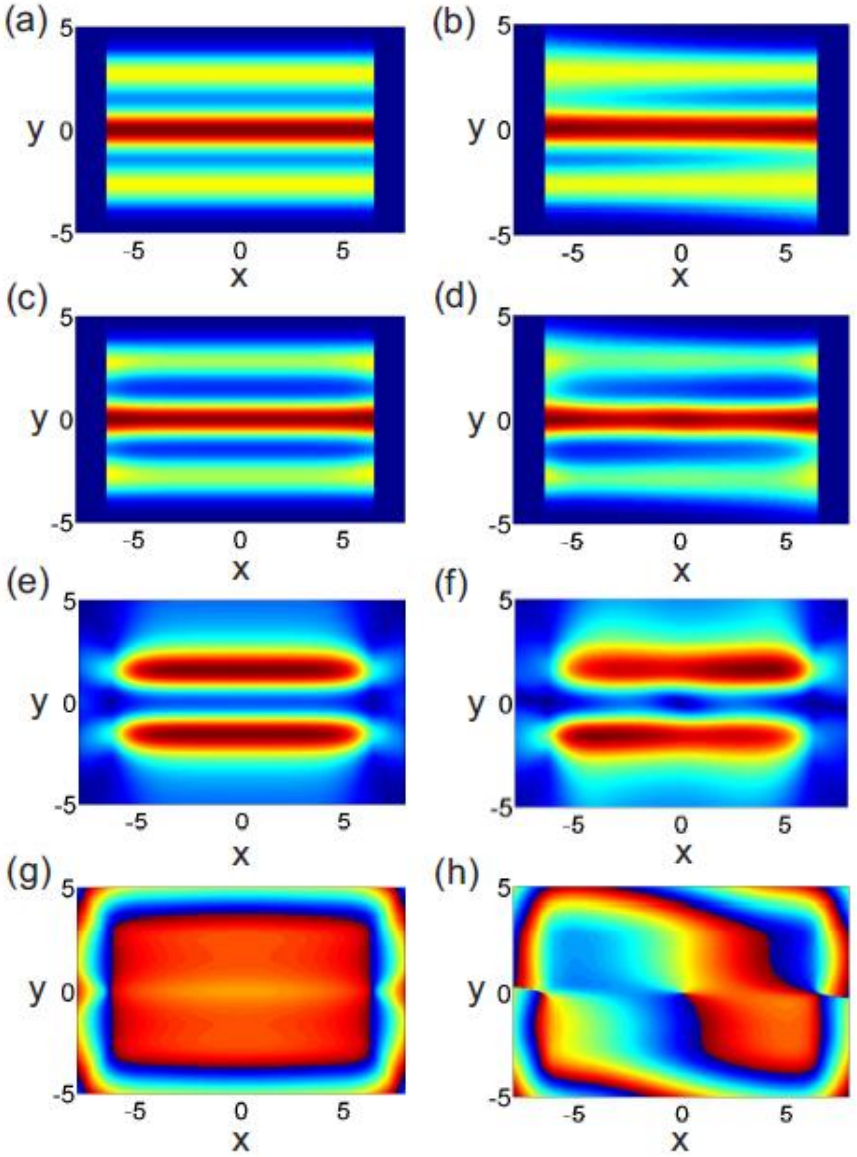
Mathematical model

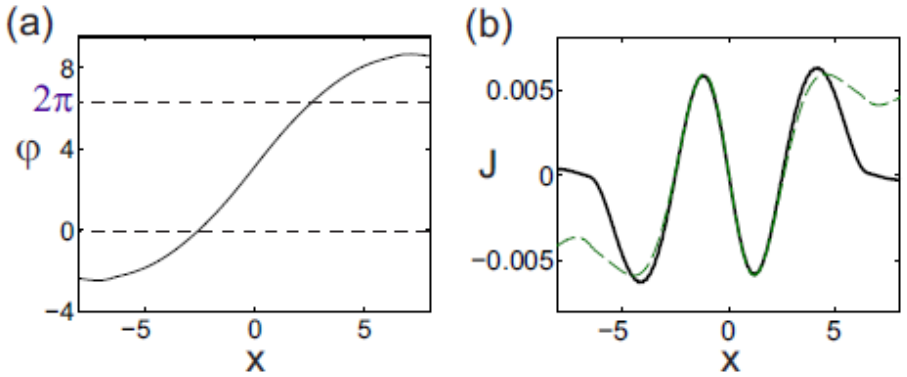
$$i\partial_t \psi_{\pm} = \left(i(n_{\pm} - \frac{1}{2}) - \frac{1}{2}\nabla^2 + |\psi_{\pm}|^2 + \alpha |\psi_{\mp}|^2 + g n_{\pm} + g_m n_{\mp} \right) \psi_{\pm} + \sigma \psi_{\mp}$$

$$\partial_t n_{\pm} = P_{\mp} - \left(i\Gamma + \beta |\psi_{\pm}|^2 \right) \cdot n_{\pm}$$

$$\alpha = -0.1 \qquad g = 3.64 \qquad \beta = 1.1 \qquad g_m = -0.364 \qquad \Gamma = 3 \qquad \sigma = 0.15$$

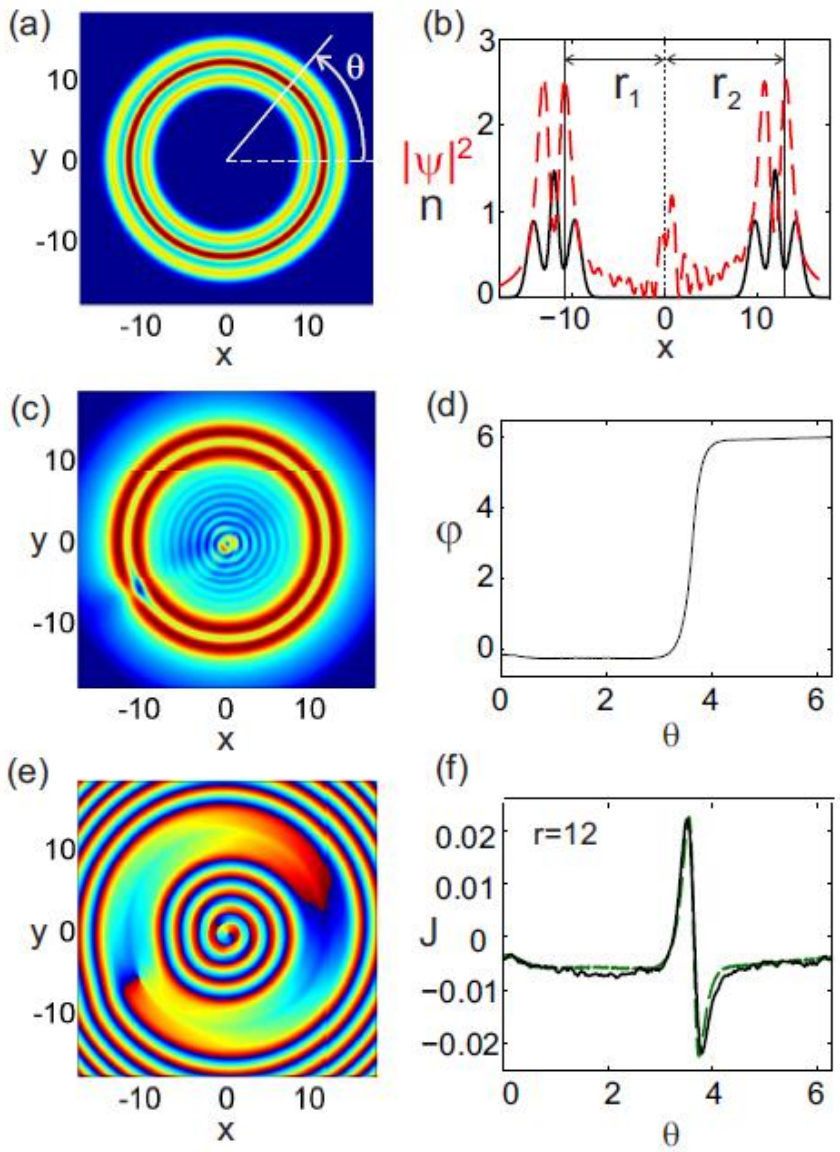
Stationary non-vortex and vortex states in linear Josephson junctions (scalar case)





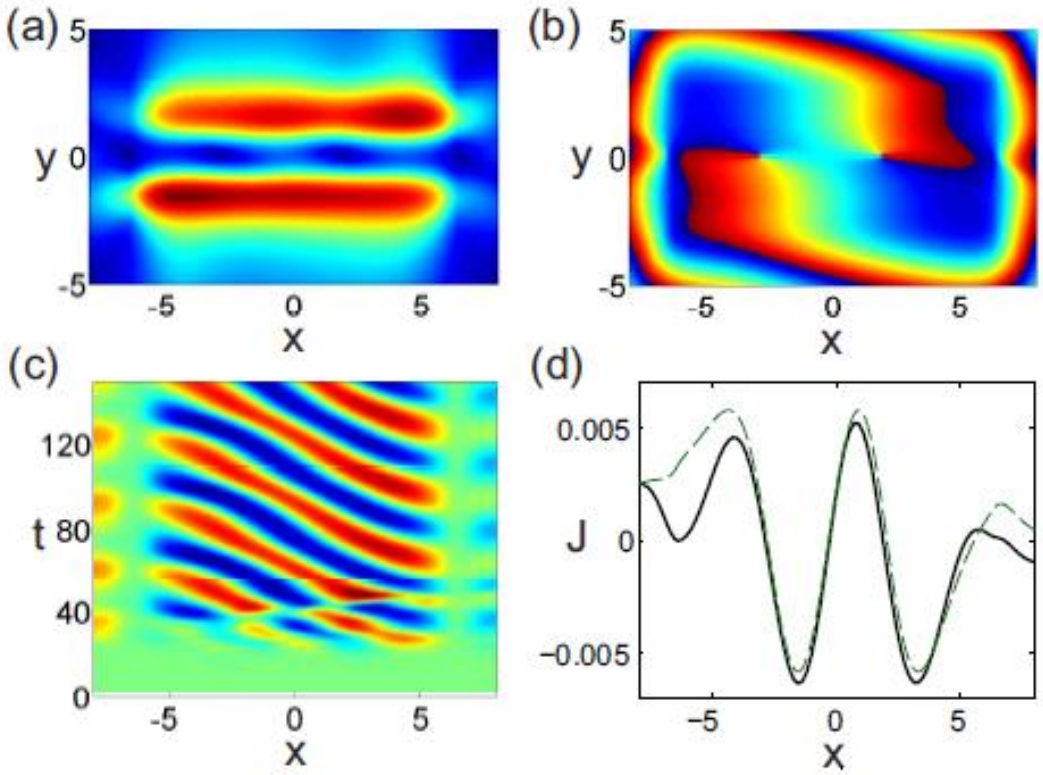
$$\varphi = \arg \frac{\psi(x,y=y_0)\cdot\psi(x,y=-y_0)^*}{|\psi(x,y=y_0)||\psi(x,y=y_0)|}$$

Annual geometry (scalar case)

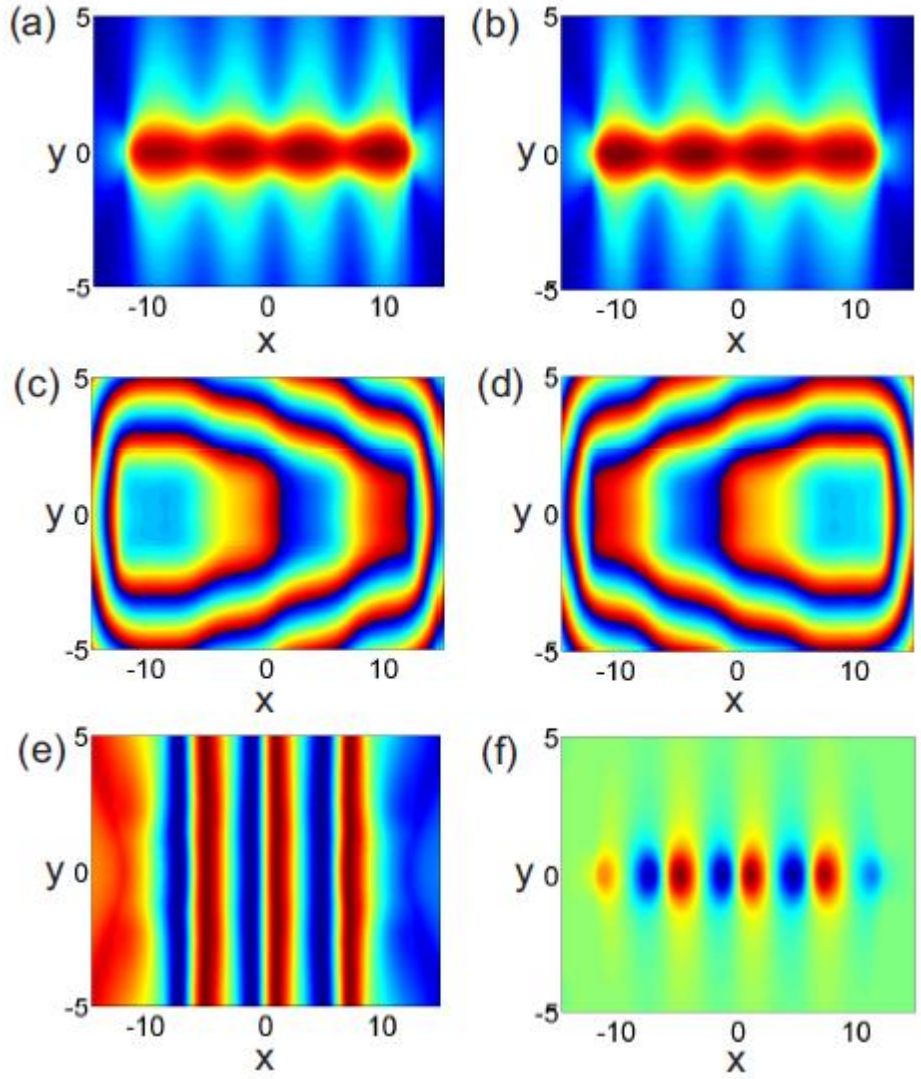


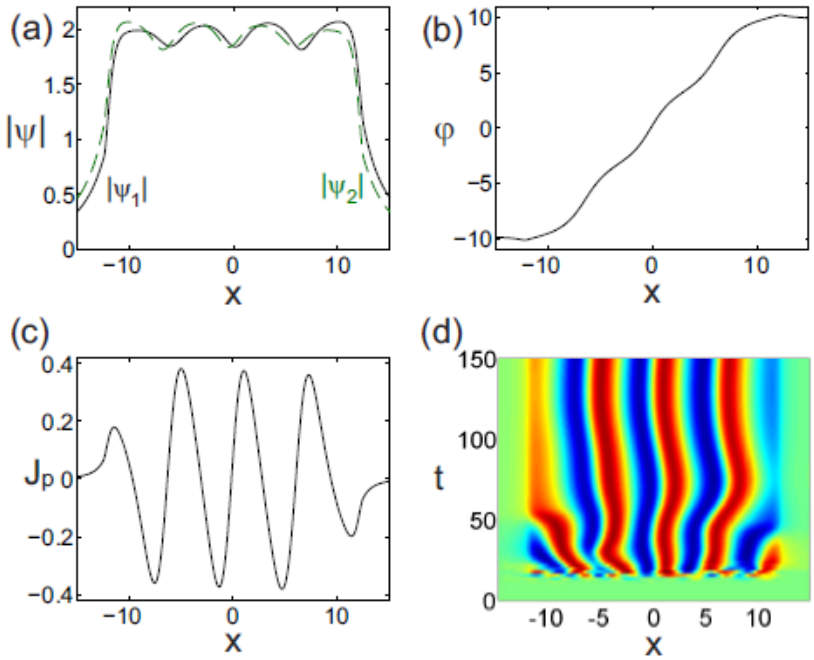
$$N_v - N_{av} = n_1 - n_2$$

Non-stationary Josephson effect

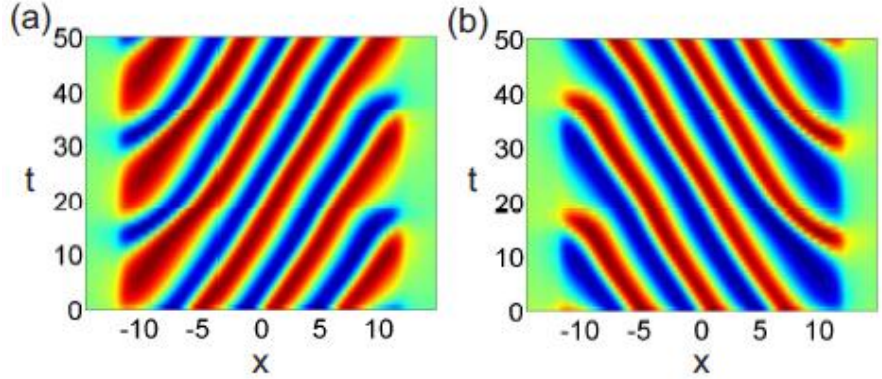


Inter-polarization Josephson vortices
linear geometry, stationary state

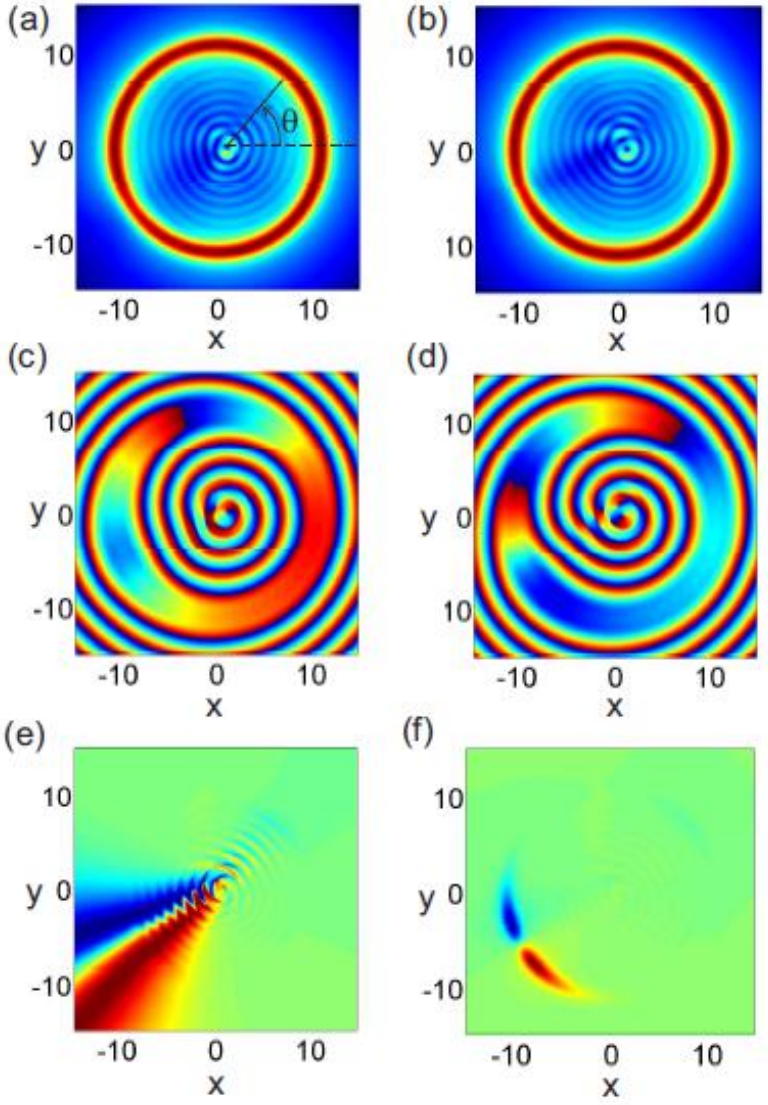


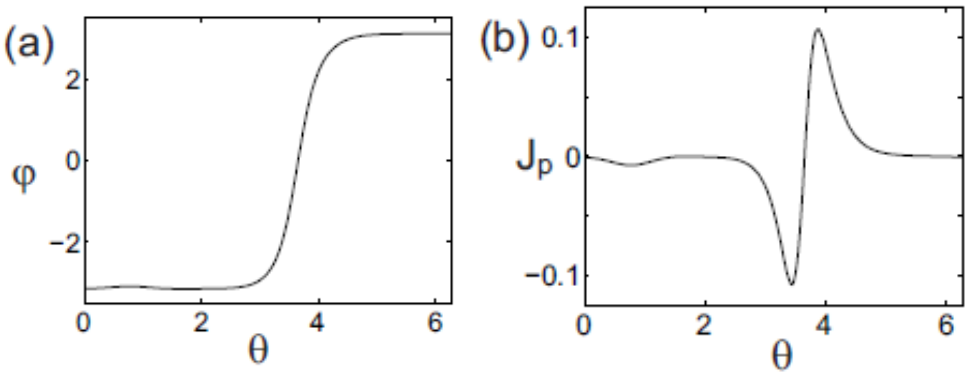


Non-stationary inter-polarization Josephson effect

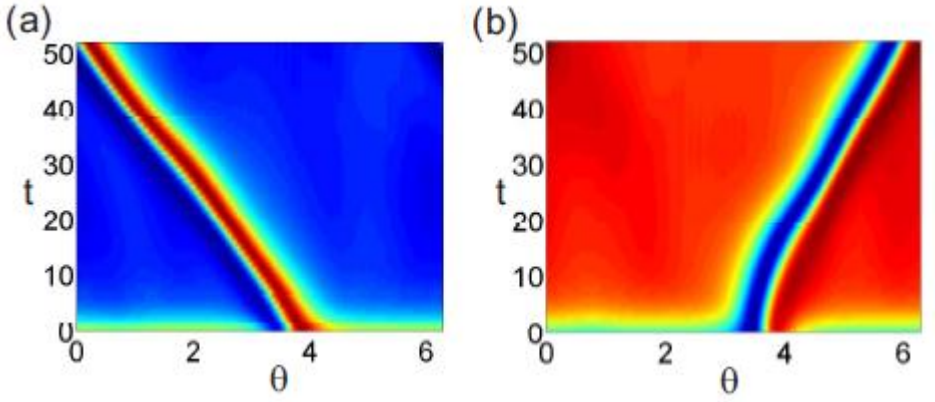


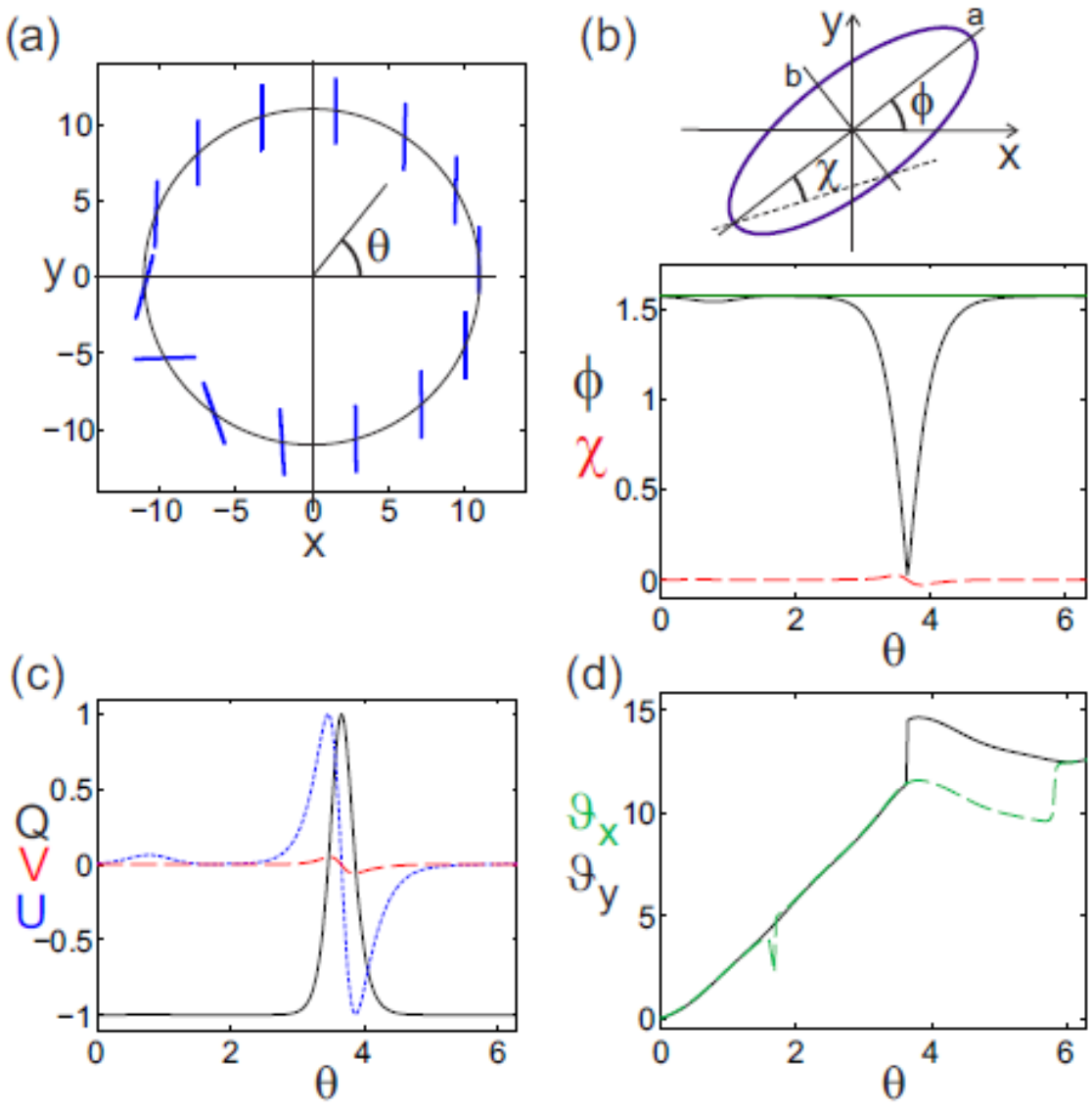
Inter-polarization Josephson vortices, annular geometry





Non-stationary Josephson effect




(a)
θ
y
x
(b)
y
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b
ϕ
χ
x
ϕ
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θ
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(d)
ϑx
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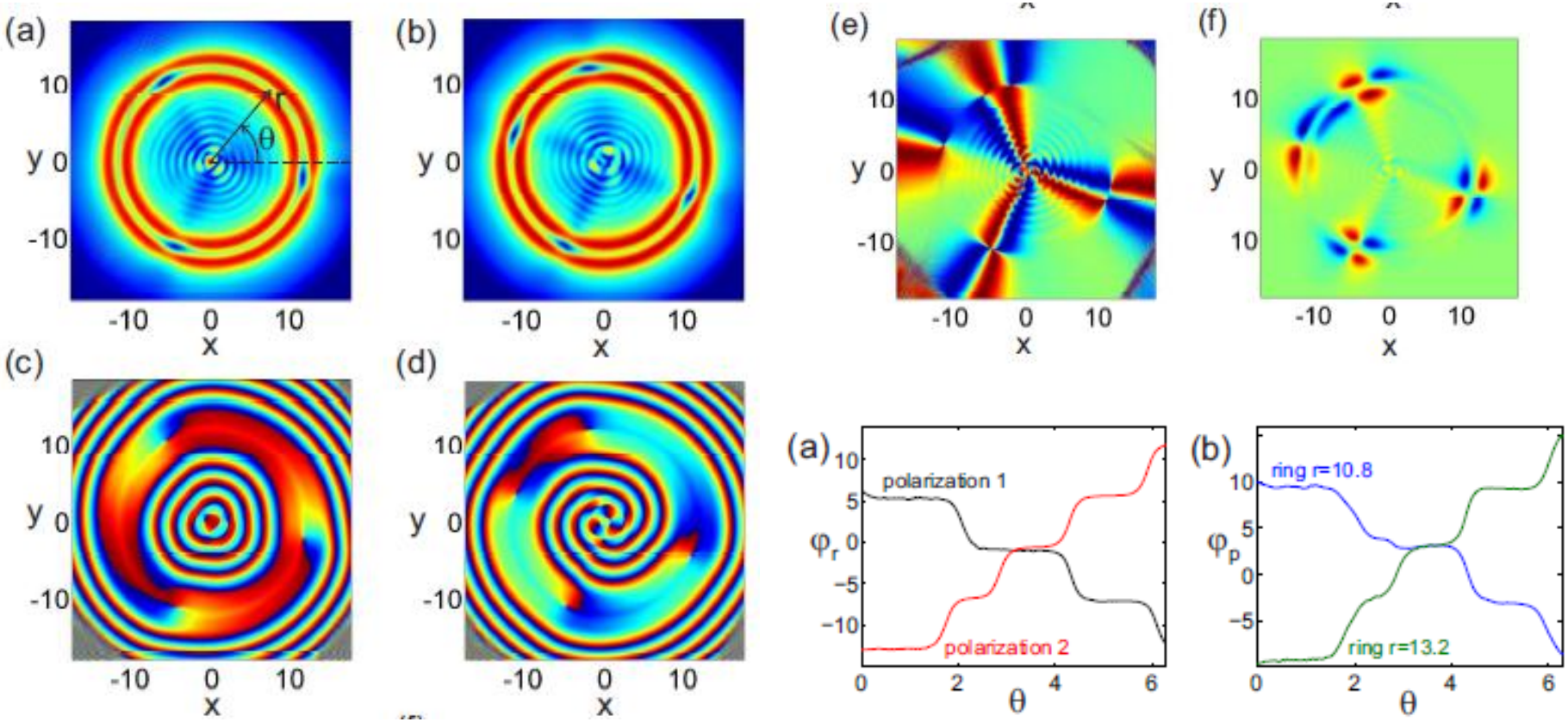
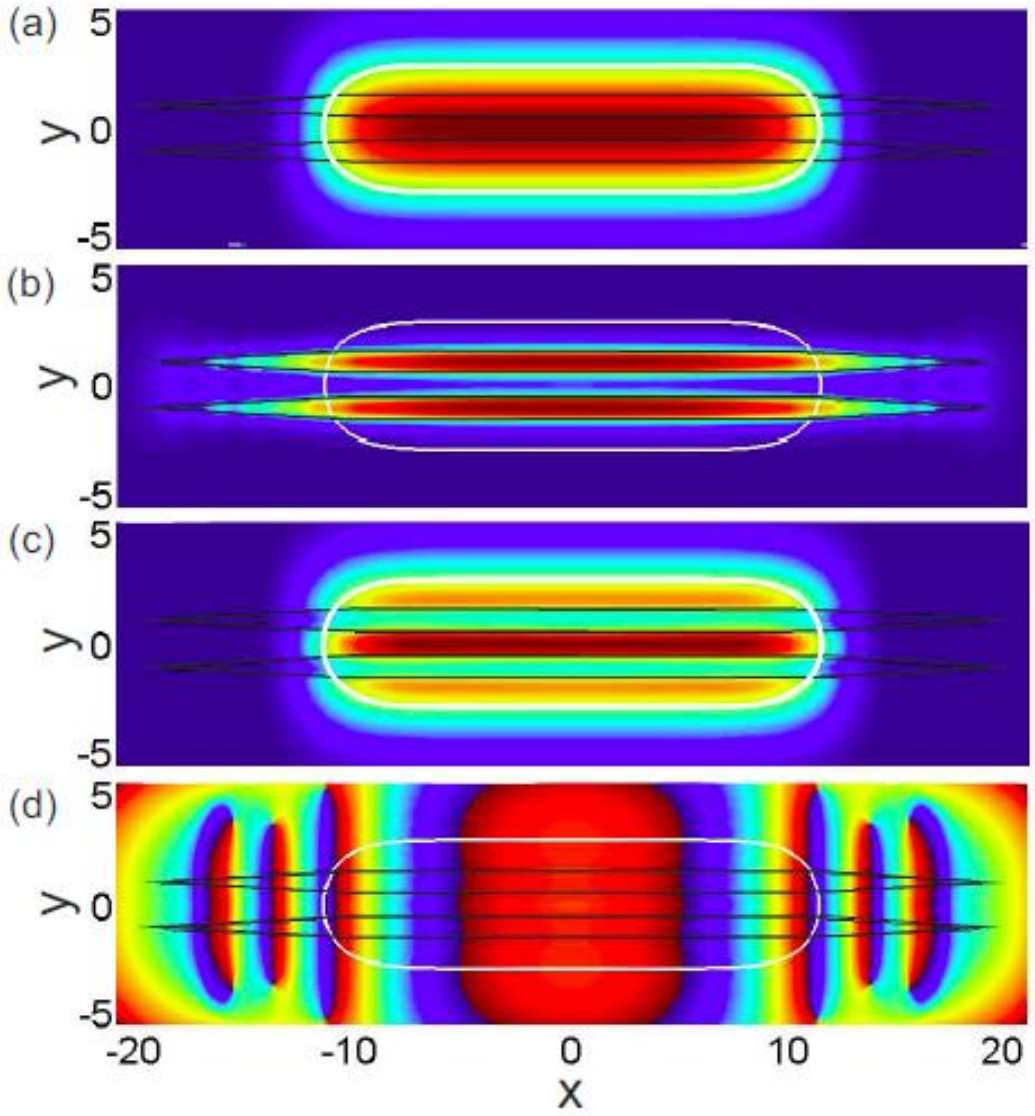
θ

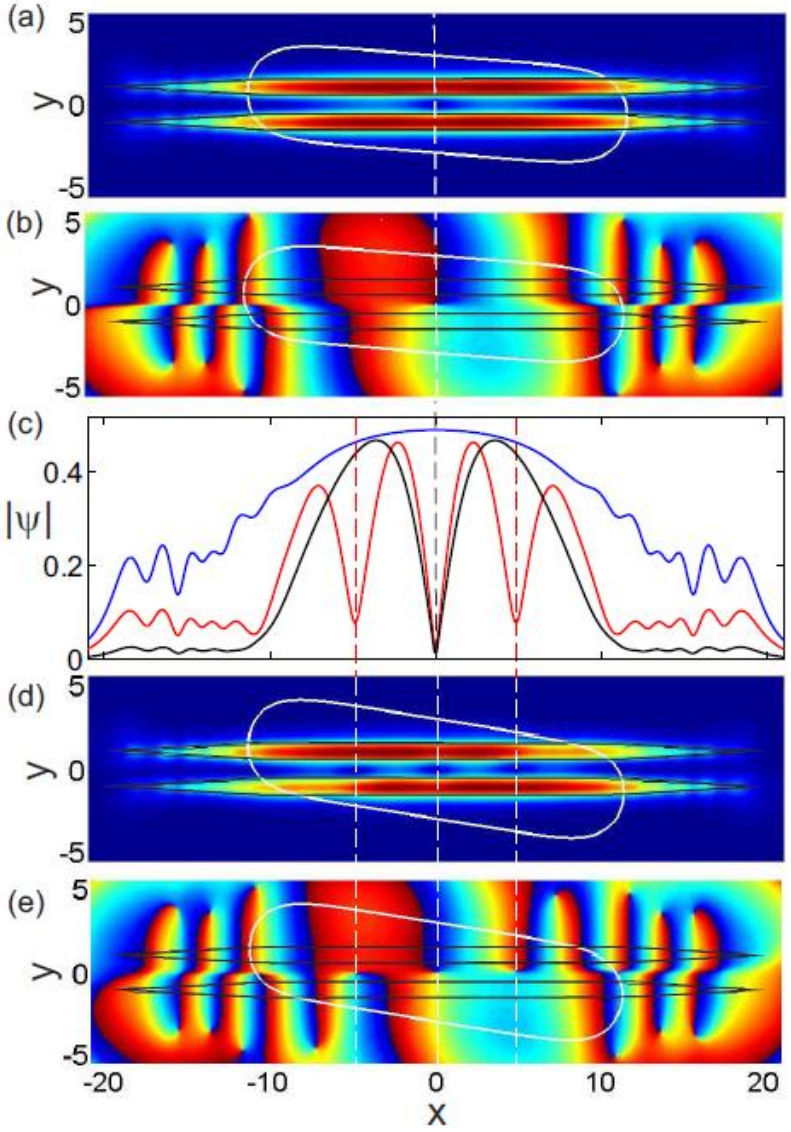
Coexisting Inter- and intra-polarization Josephson vortices, annular geometry



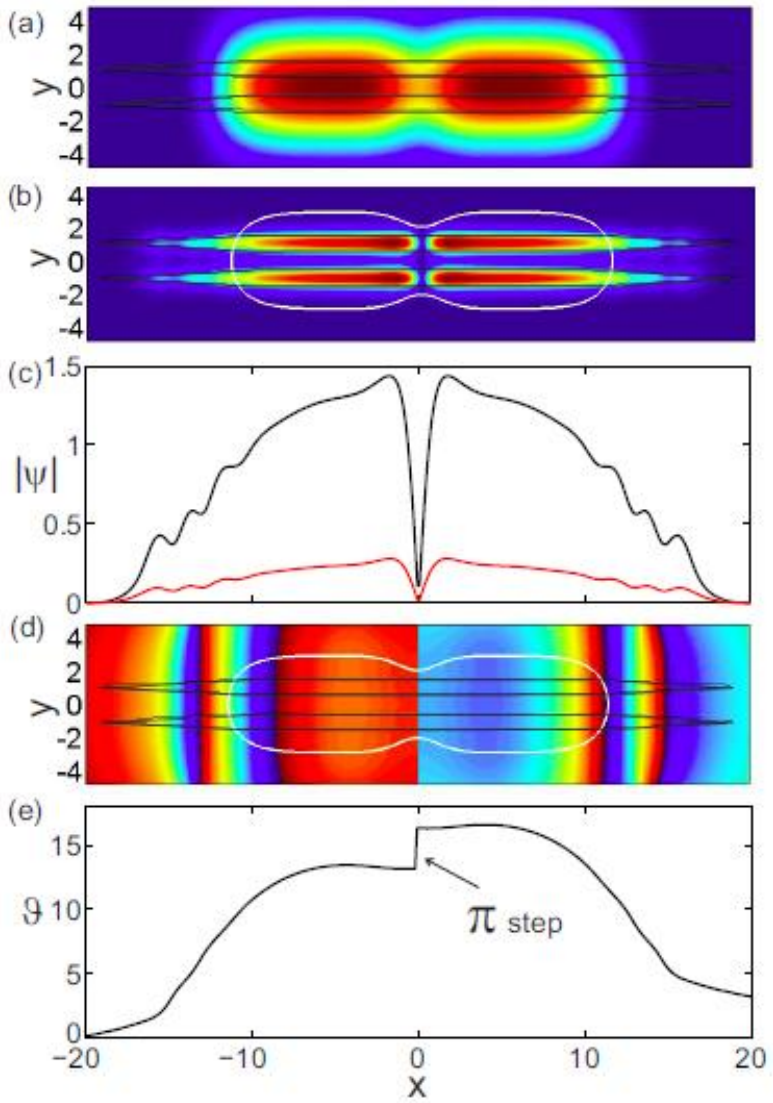
Polariton condensate in potential wells



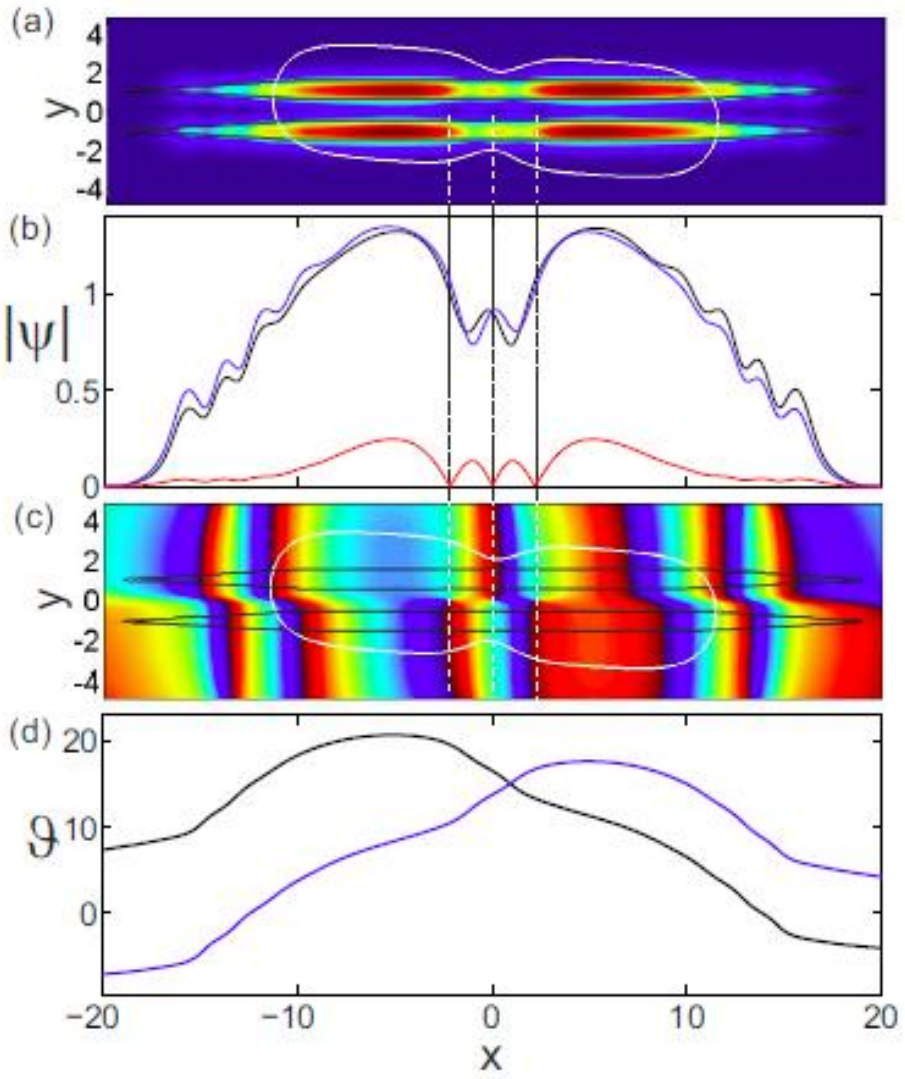
Josephson vortex state



Dark soliton state



Destruction of dark soliton state and the formation of Josephson vortex state



Conclusion

1. The formation of Josephson vortices in polariton systems with incoherent pump is studied theoretically.

2. It is shown that inter-polarization Josephson vortices can be considered as localized flips of the polarization.

3. Mixed states of intra- and inter-polarization vortices are found.

Thank you for your attention!