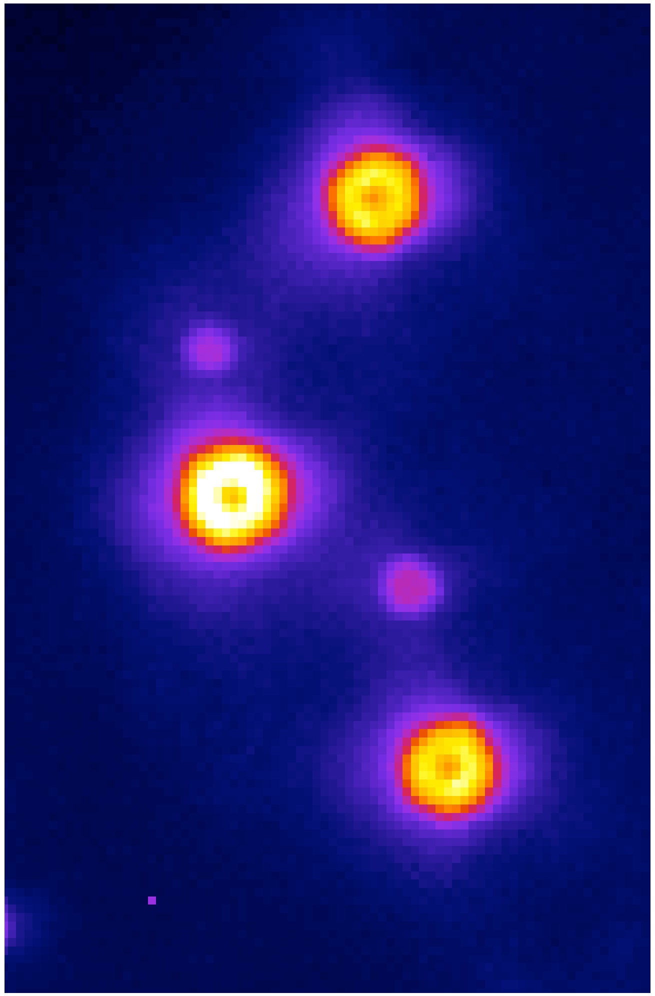
Spin Texture in a Cold Exciton Gas



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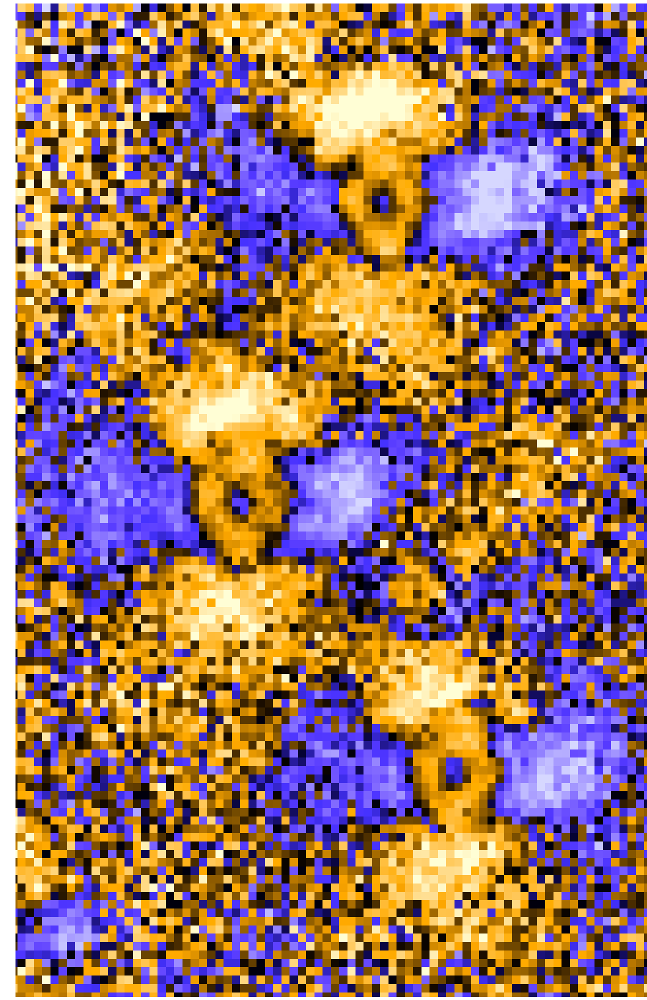
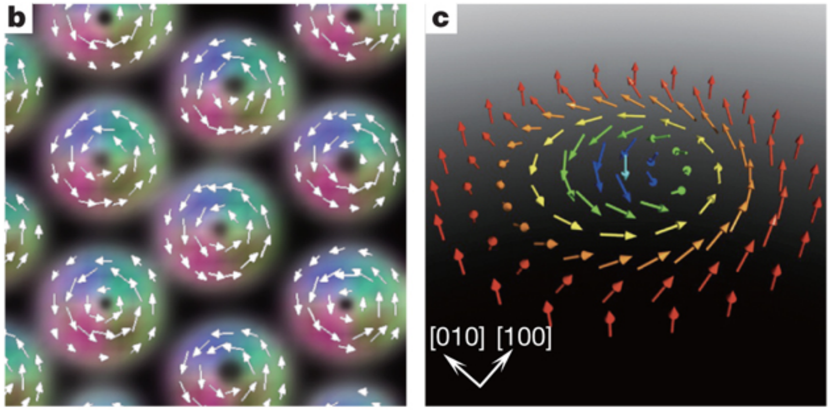


arXiv:1103.0321

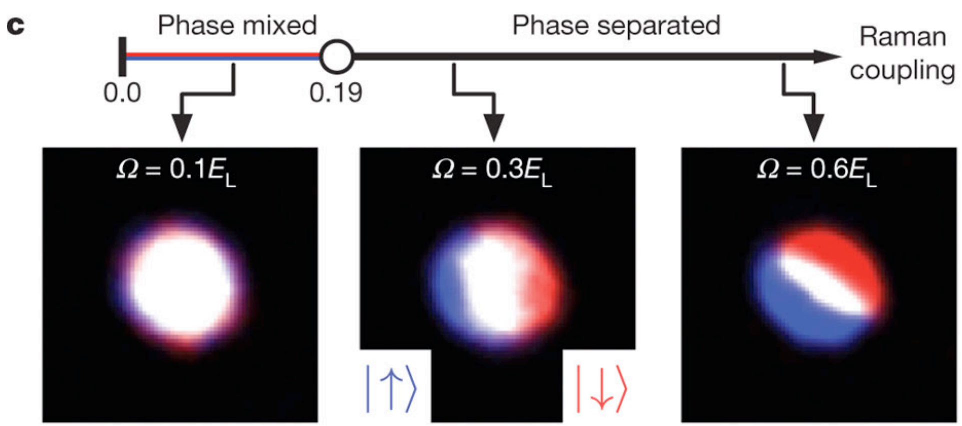
Spin textures in multi-component systems

- skyrmion crystals in $Fe_{0.5}Co_{0.5}Si$



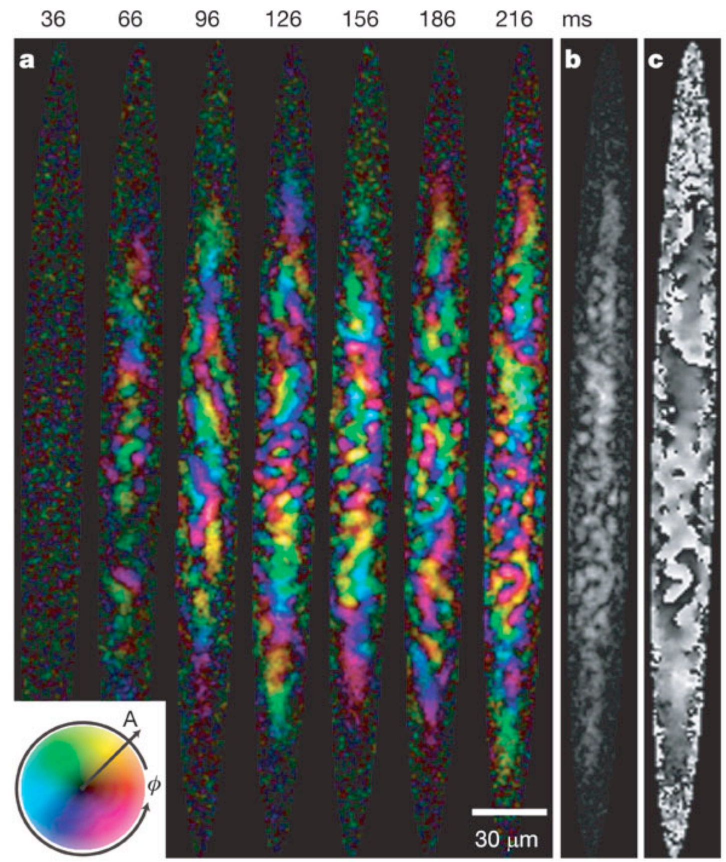
XZ Yu *et al. Nature* **465**, 901-904 (2010) doi:10.1038/nature09124

- spin-orbit coupled BEC



Y-J Lin *et al. Nature* **471**, 83-86 (2011) doi:10.1038/nature09887

- quenched ferromagnetic BEC

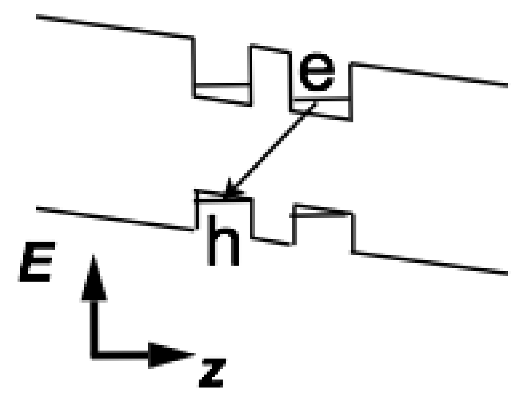


L.E. Sadler *et al. Nature* **443**, 312-315 (2006) | doi:10.1038/nature05094;

Non-homogeneous spin distribution referred to as *spin texture*

An introduction to indirect excitons

- An indirect exciton is composed of an electron and hole in separate quantum wells



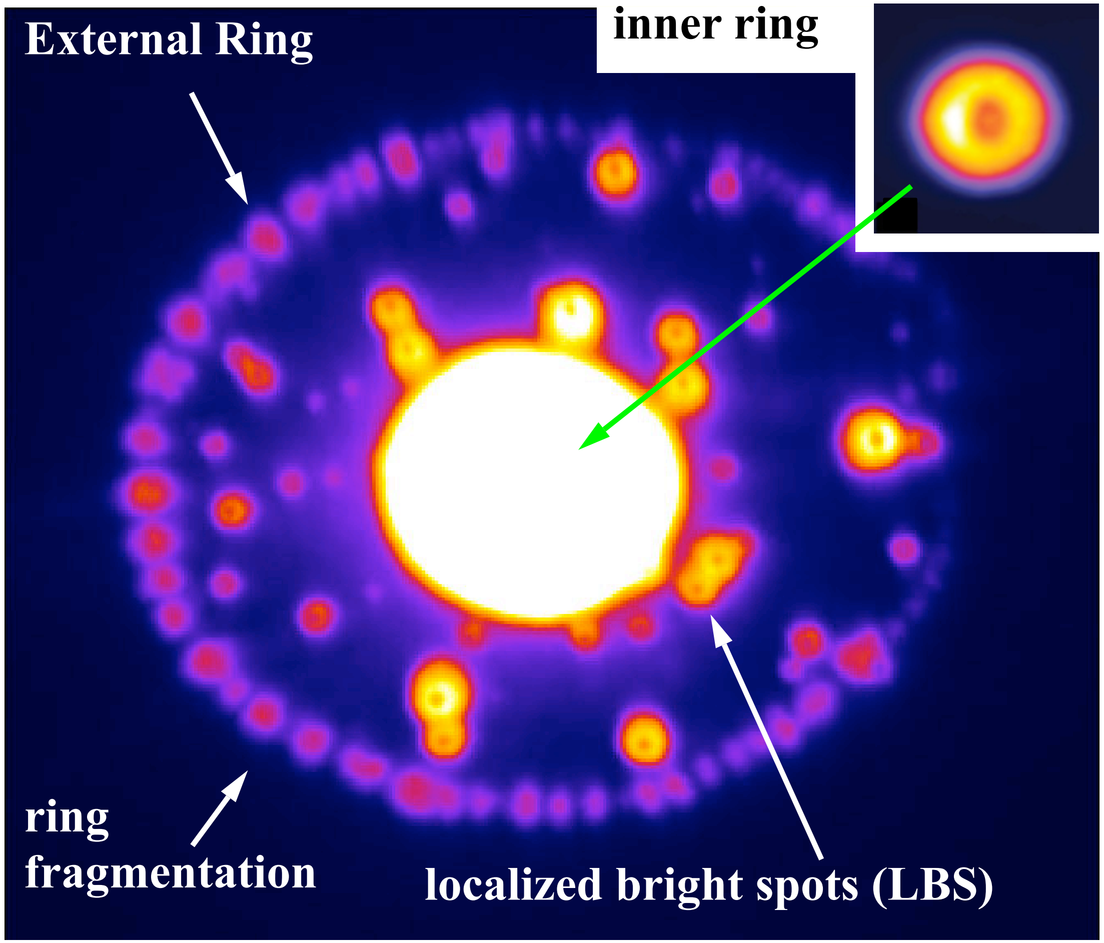
Characteristics of indirect excitons

•long lifetime •high cooling rate •bosons

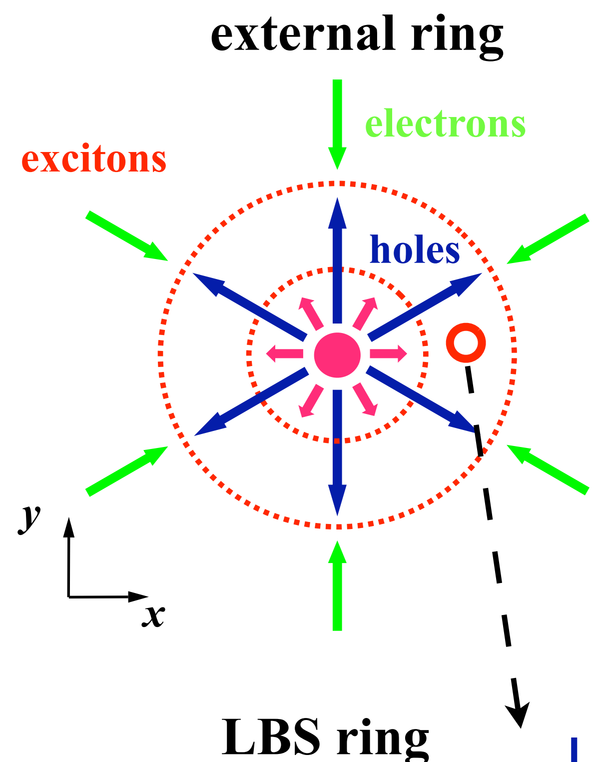
•suppression of e-h exchange → long spin relaxation lifetime

⟶ allows study of spin physics of ultracold bosons in CM materials

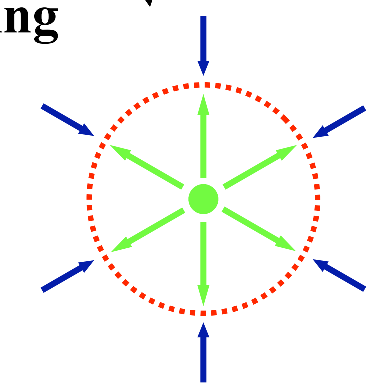
Exciton pattern formation



L.V. Butov, A.C. Gossard, & D.S. Chemla, Nature **418**, 751 (2002)

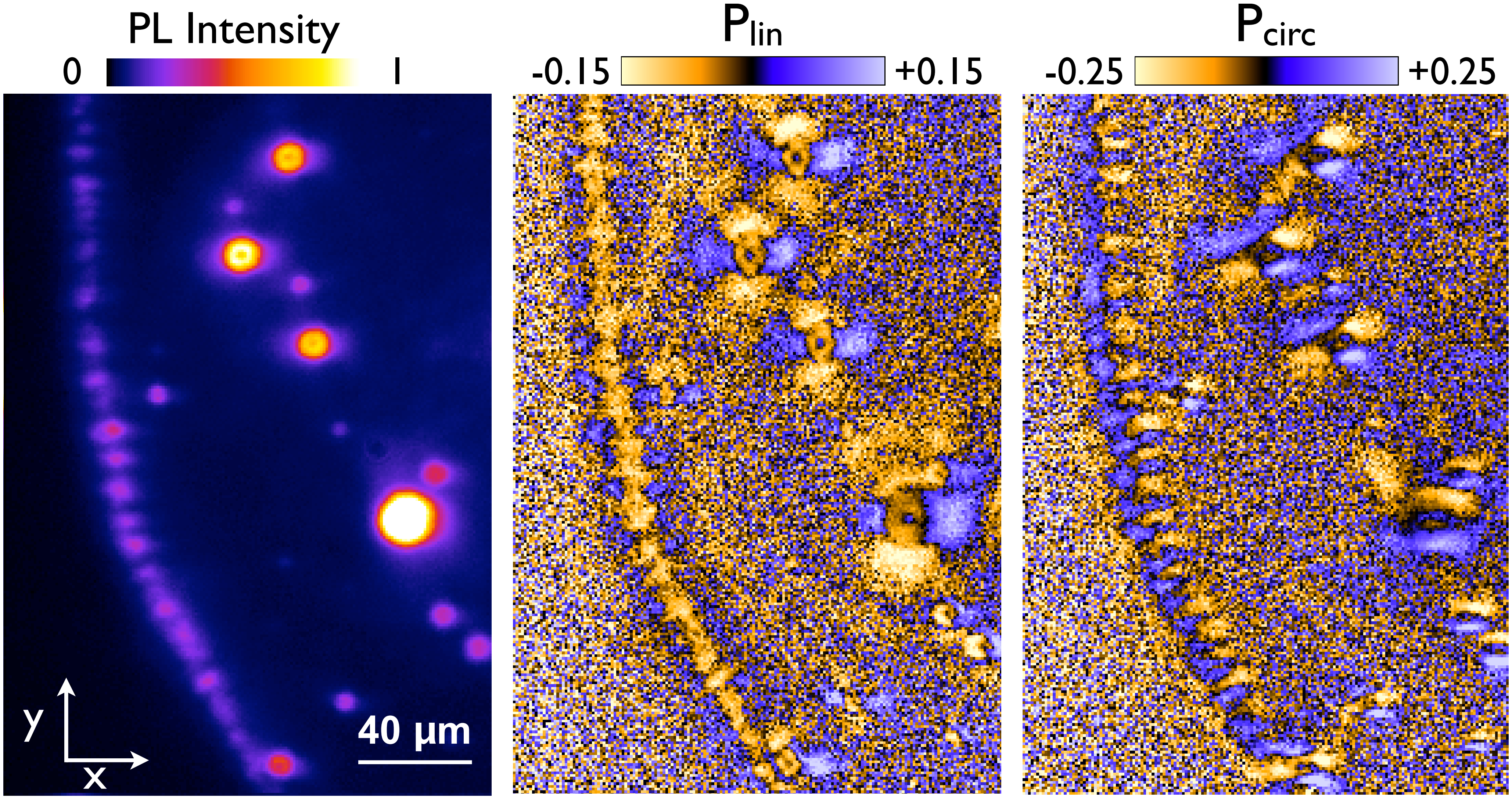


LBS ring is close to model radial source of cold excitons



Inner Ring: Yuliya Kuznetsova, Excitation energy dependence of the exciton inner ring, Session Z22, Friday 12:39

Polarization of emission pattern at T_{bath}=0.1K

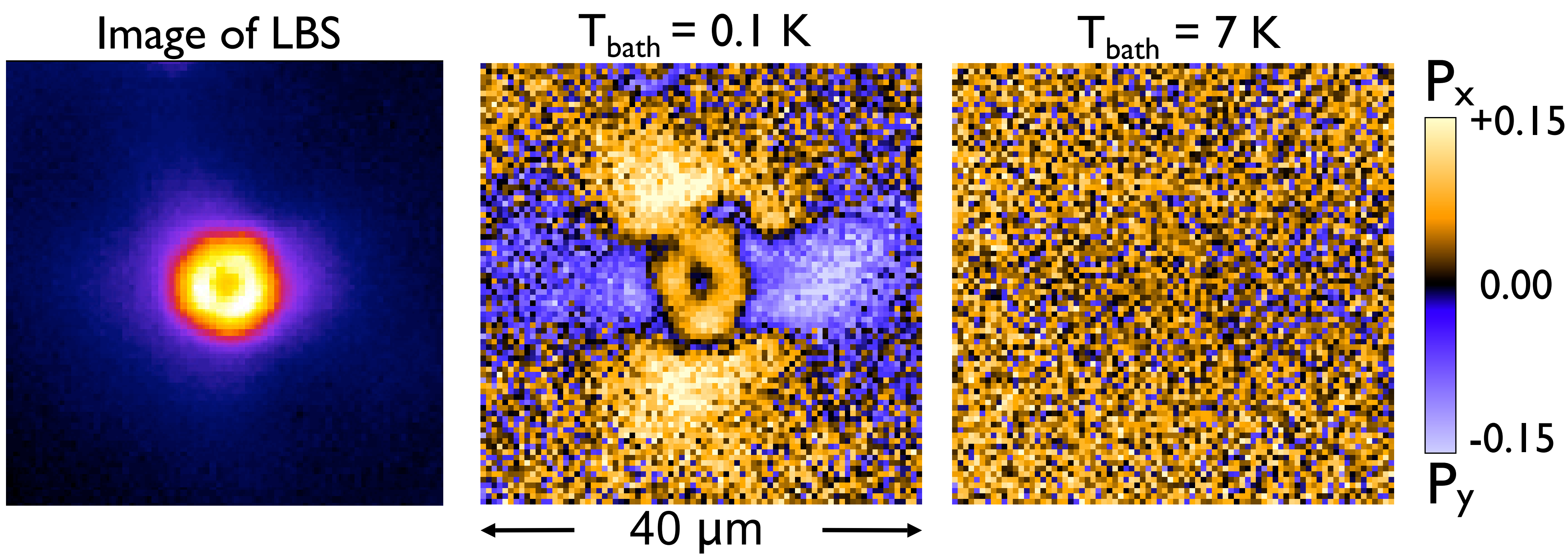


Real Space Image

Linear Polarization (in-plane spin component)

Circular Polarization (z-axis spin component)

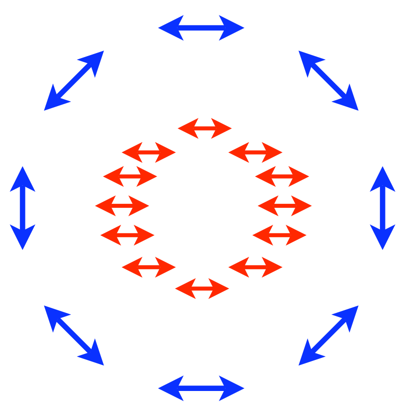
Spin Texture: Linear Polarization

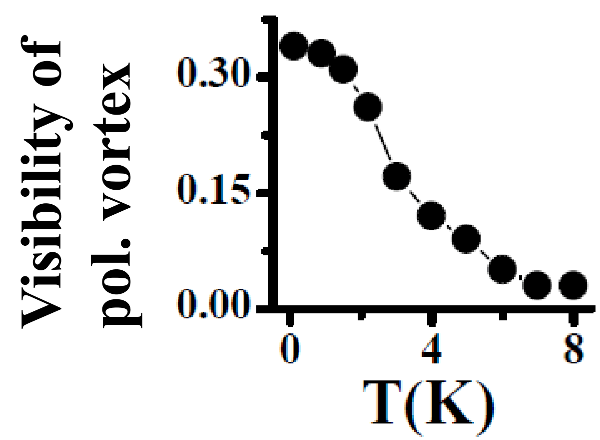


- Pattern appears with decreasing temperature

Two distinct features:

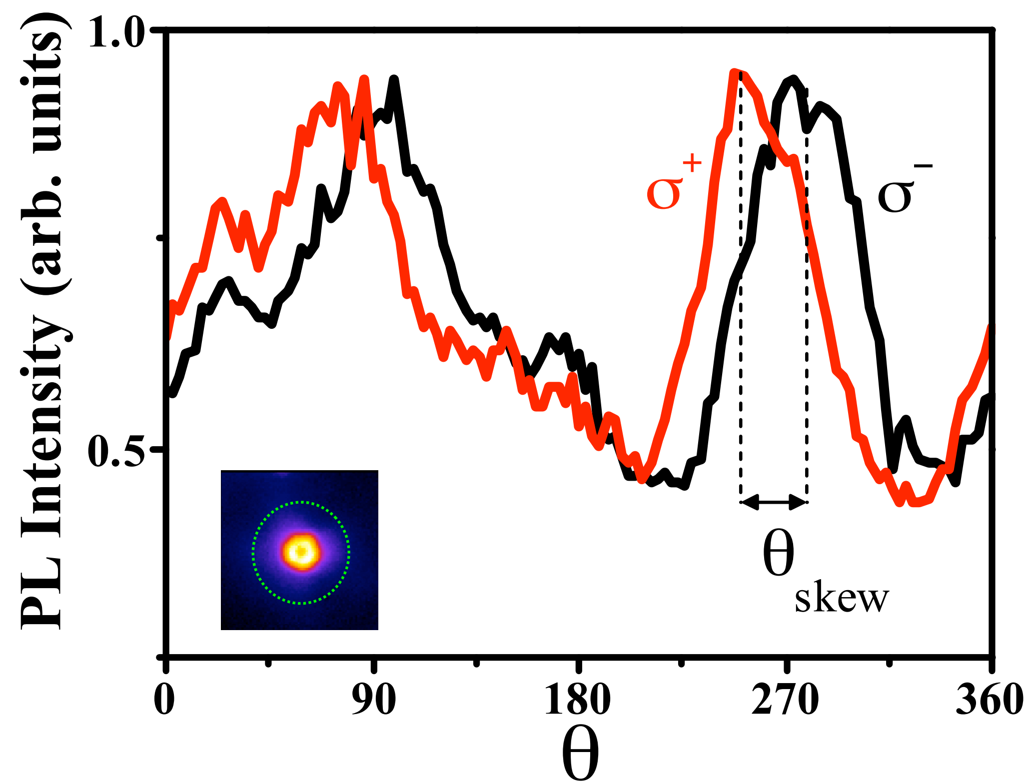
- polarization ring
- polarization vortex

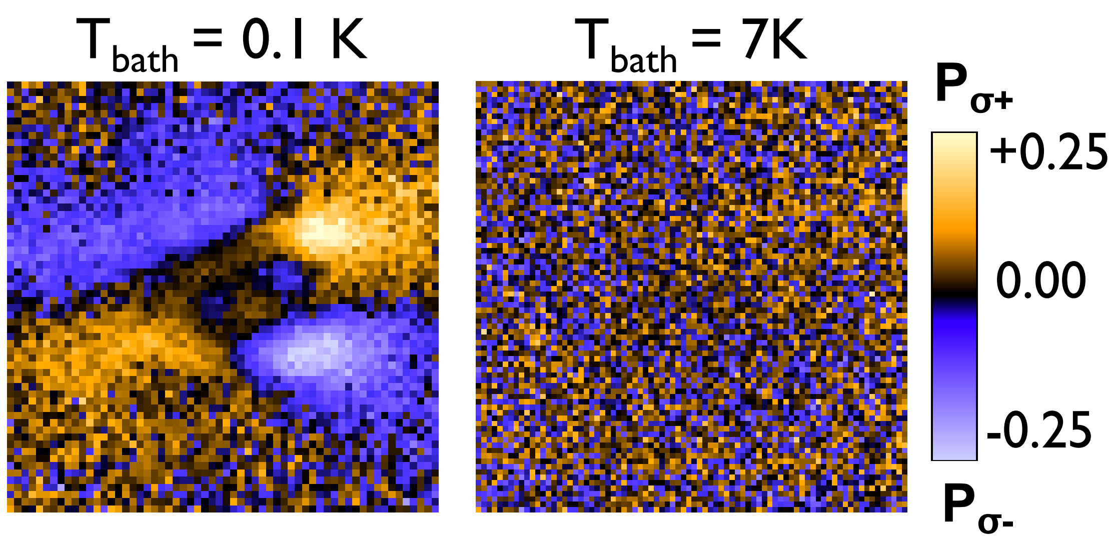


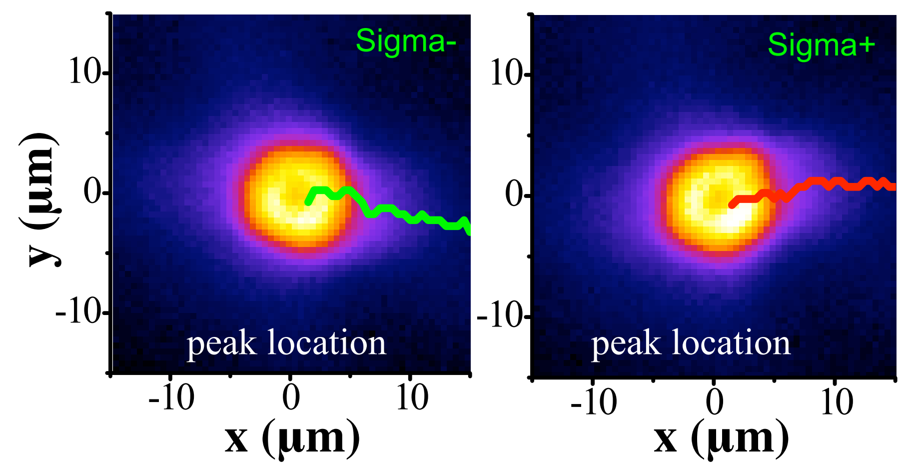


Spin Texture: Circular Polarization

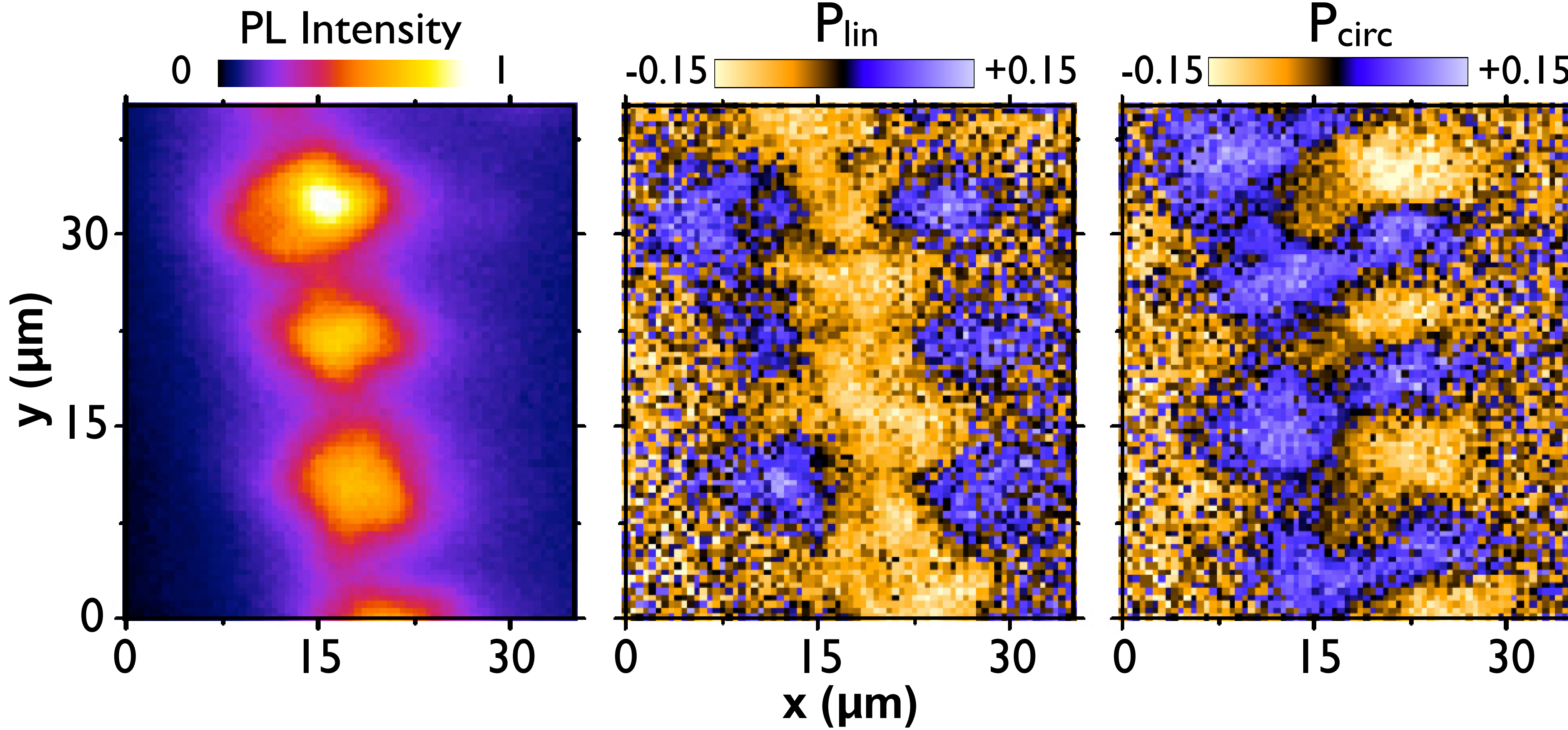
- flux of excitons from LBS is anisotropic
- spin-dependent skew of exciton flux
- corresponding four-leaf pattern of circular polarization





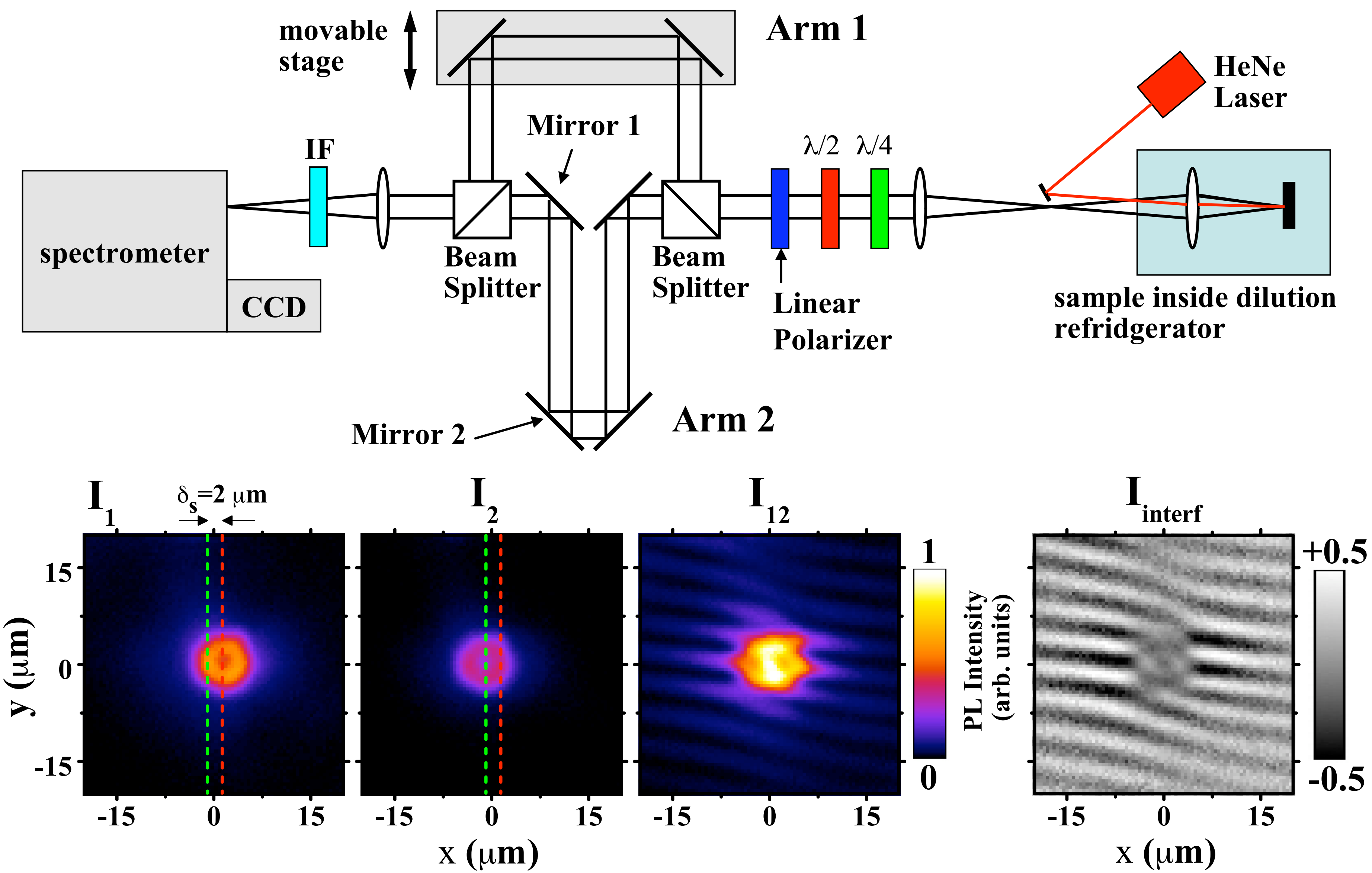


Spin Texture: External Ring



- at low T, Macroscopically Ordered Exciton State (MOES) emerges in external ring
- periodic array of MOES beads → periodic spin texture
- spin texture not related to any local defect structure

Shift-Interferometry with M-Z interferometer

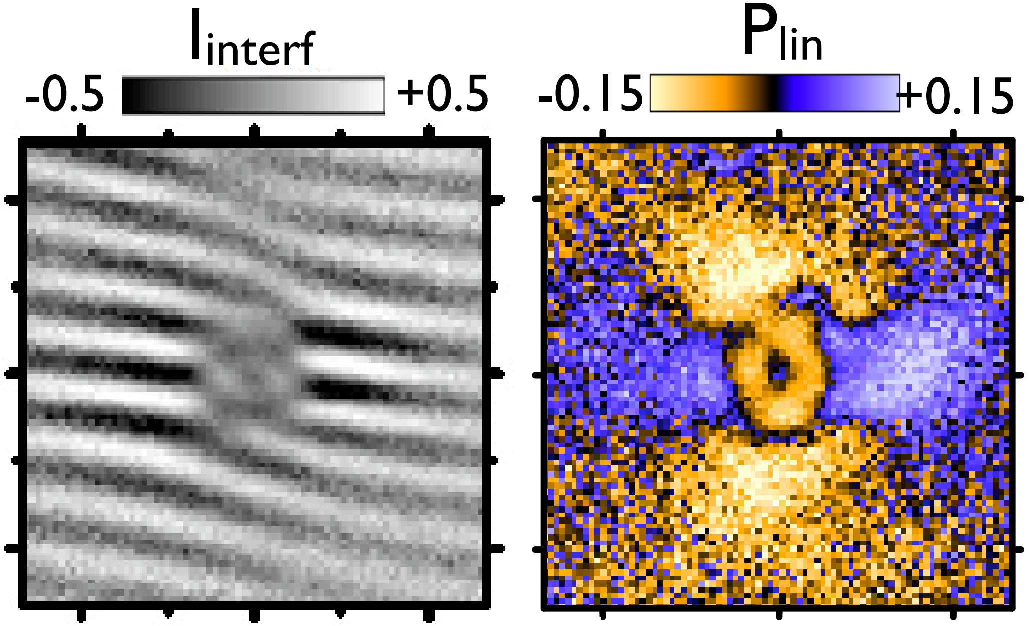


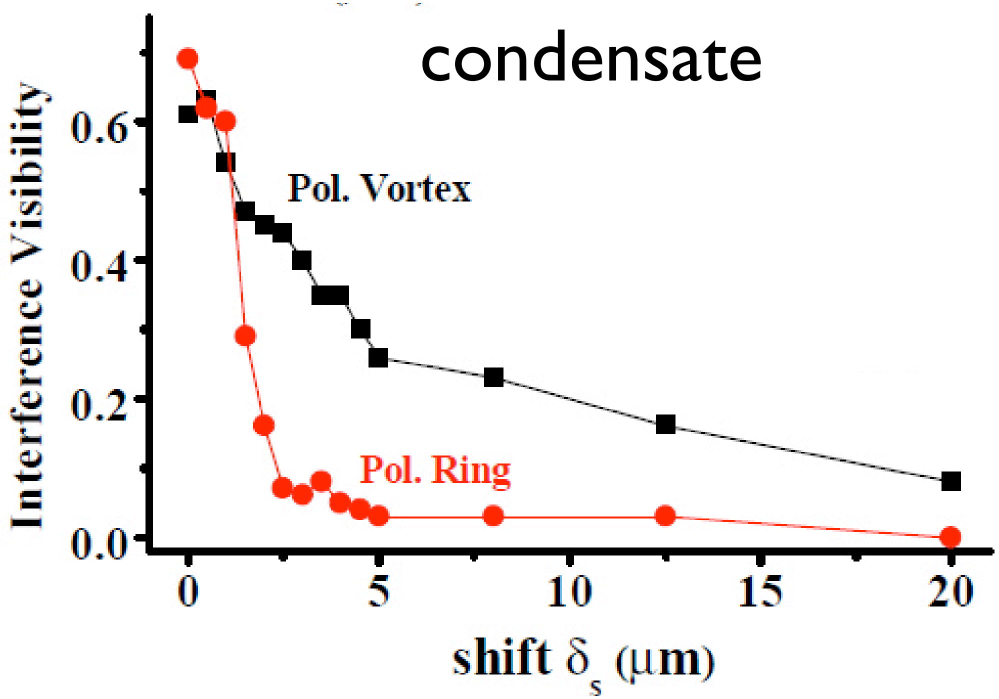
Coherence Measurements

- extended coherence with coherence length $\xi \approx 8$ µm in the pol. vortex
- $\lambda_{db} \approx 0.5$ µm at 0.1K

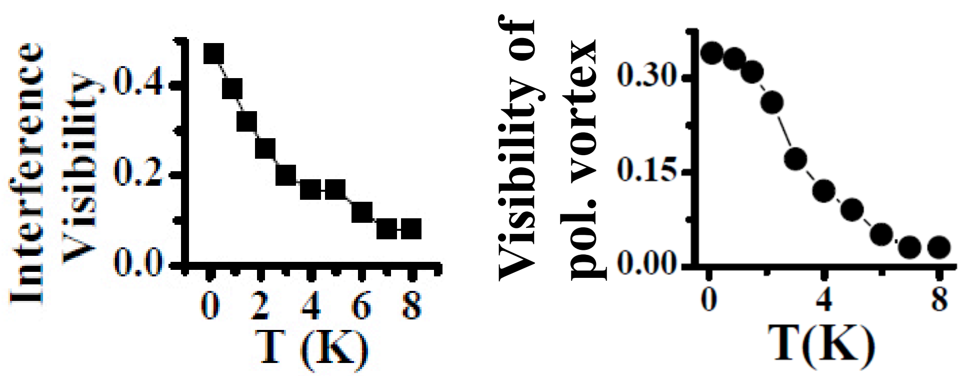
$\xi >> \xi_{classical}$

→characteristic of a condensate





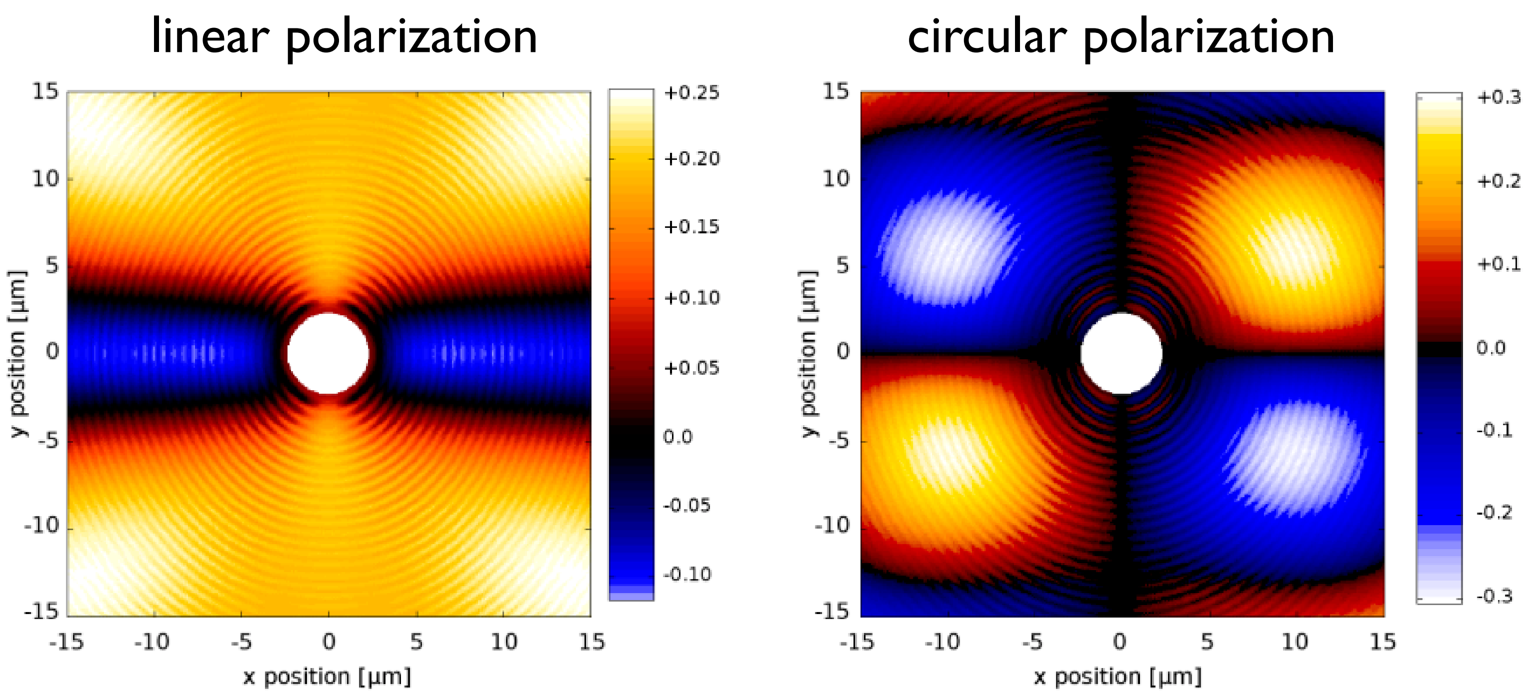
- extended coherence and pol. vortex emerge at low T



Model of exciton spin texture

- based on ballistic exciton transport and precession of spins of electrons and holes
- precession of electrons and holes due to spin-orbit interaction combined with splitting of linearly polarized states

described by Dresselhaus Hamiltonian



Qualitative reproduction of observed phenomena:

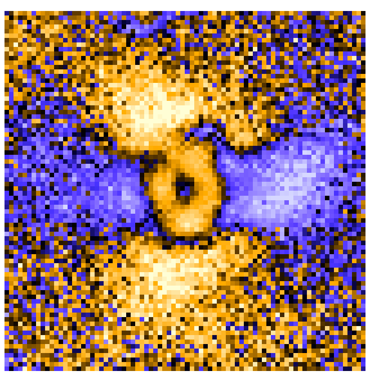
- vortex of linear polarization
- four leaf pattern of circular polarization

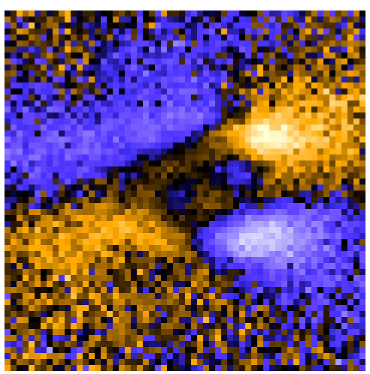
Conclusions

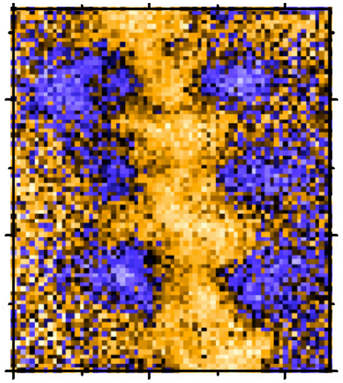
observation of an exciton spin texture:

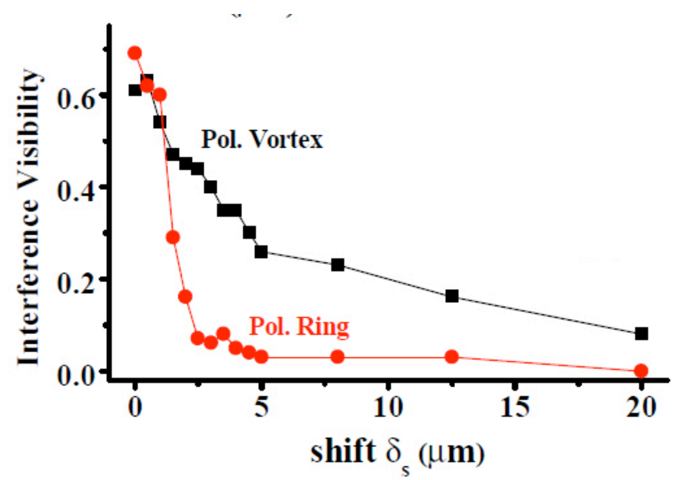
- vortex of linear polarization
- four-leaf pattern of circular polarization
- ring of linear polarization
- periodic spin texture

- extended coherence $\xi >> \xi_{classical}$ in polarization vortex









arXiv:1103.0321