ZnMnTe/ZnMgTe nanowires studied by magneto -photoluminescence

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- **Motivation & experimental**
- **CW measurements**
- **Polarization**
- **TR measurements**
- **summary**

Motivation

Potential of DMS nanowires: DMS + shape anistropy:

- Magnetooptical switches
- Spin filters
- ...

What characterizes the system?

- Emission polarization performance in magnetic field
- Photoexcitation decay and relaxation channels
- ...

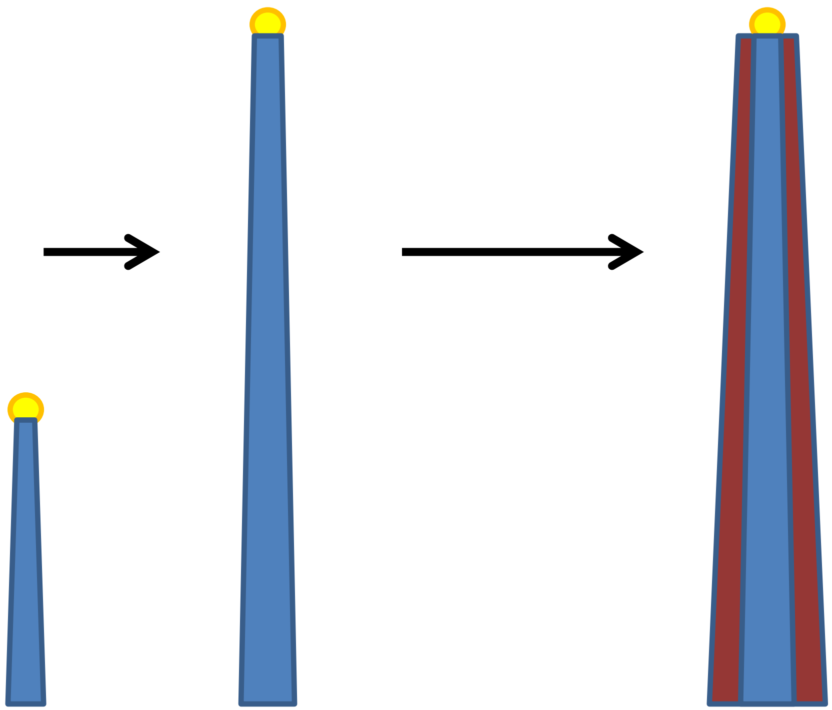
Our investigations:

- Polarization of emission
- PL dynamics in magnetic field

Samples

ZnMnTe

ZnMgTe



400 °C
60 min

200 °C
20 min

Optically active ZnMnTe/ZnMgTe core/shell nanowires (NWs):

- MBE Vapour-Liquid-Solid growth

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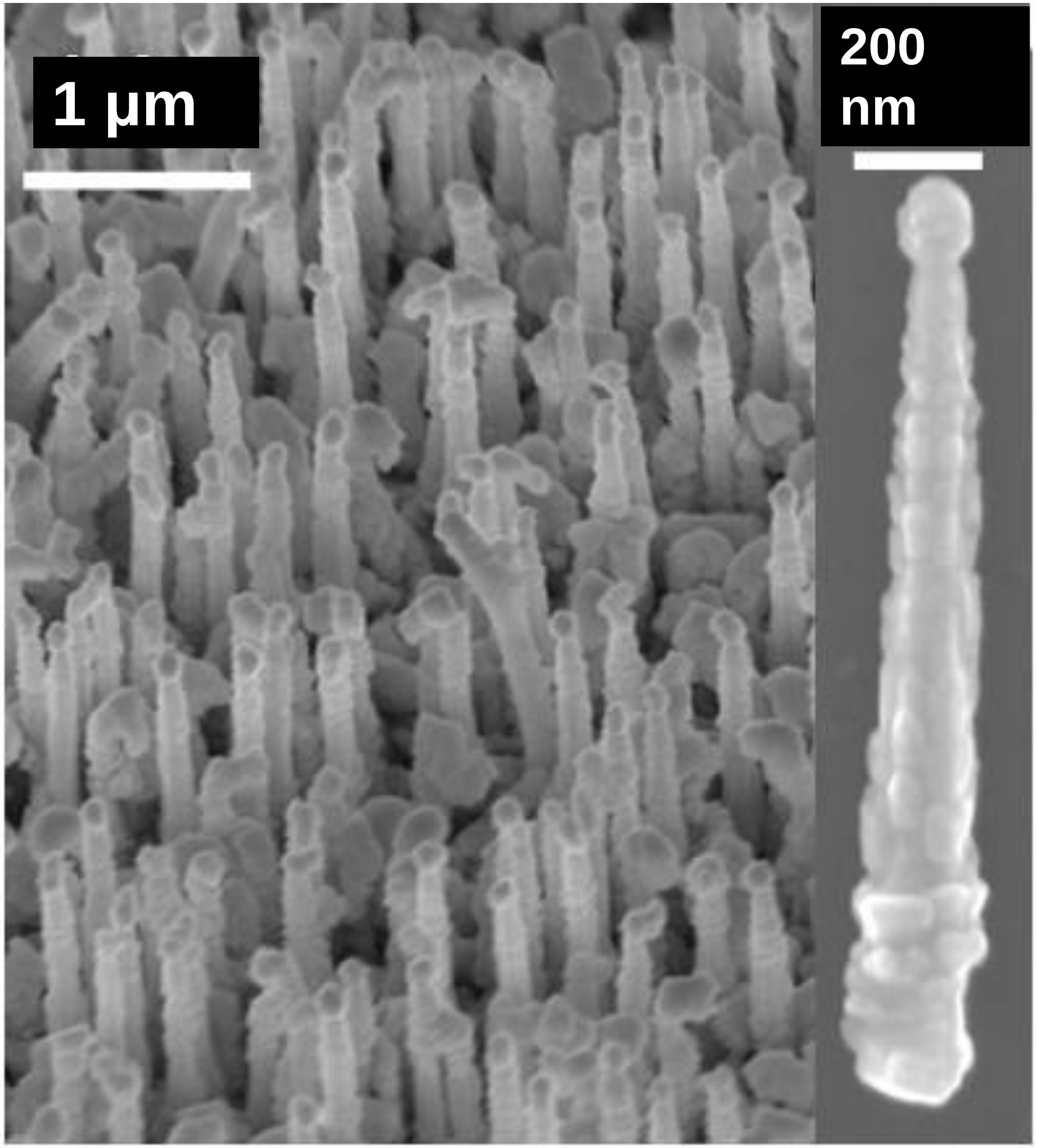
Samples



Optically active ZnMnTe/ZnMgTe core/shell nanowires (NWs):

- MBE Vapour-Liquid-Solid growth
- Core/shell ~70/35 nm
- x_{Mn} up to 4 %

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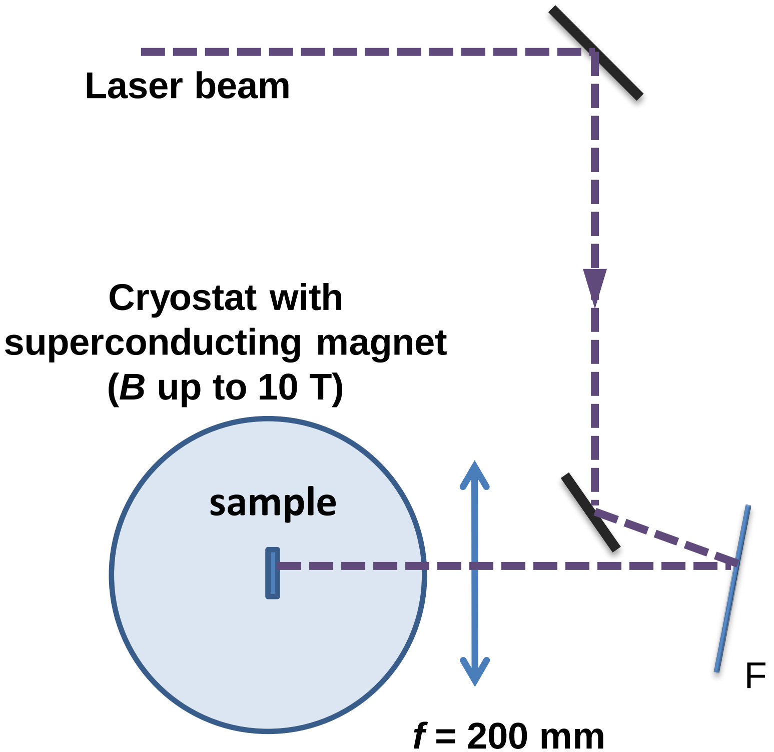
Experimental Setup



- **Excitation: 442 nm (cw) and 410 nm (pulsed) lasers, focused to *d* = 3 µm**
- **Magnetic field up to 10 T, temperature of 2 K**

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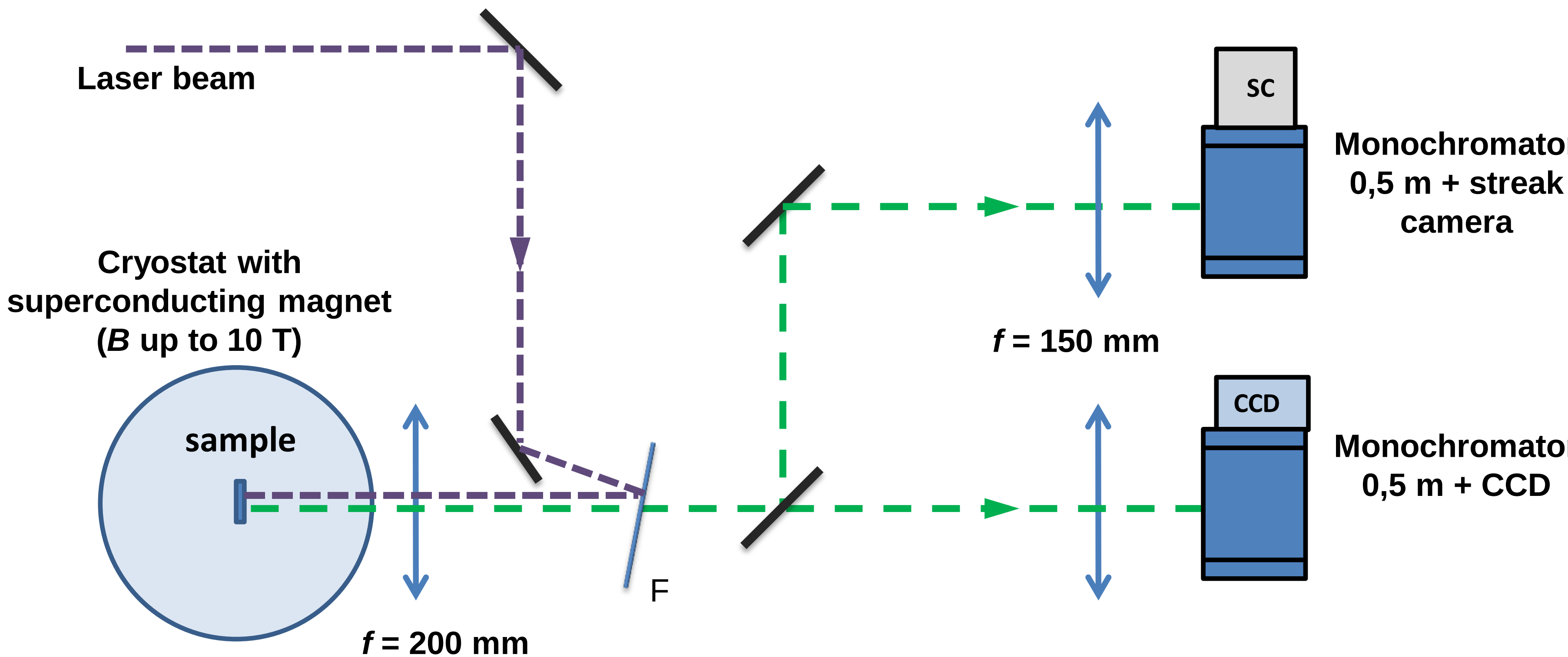
Experimental Setup



- Excitation: 442 nm (cw) and 410 nm (pulsed) lasers, focused to d = 3 μm
- Magnetic field up to 10 T, temperature of 2 K
- Detection: CCD or a streak camera

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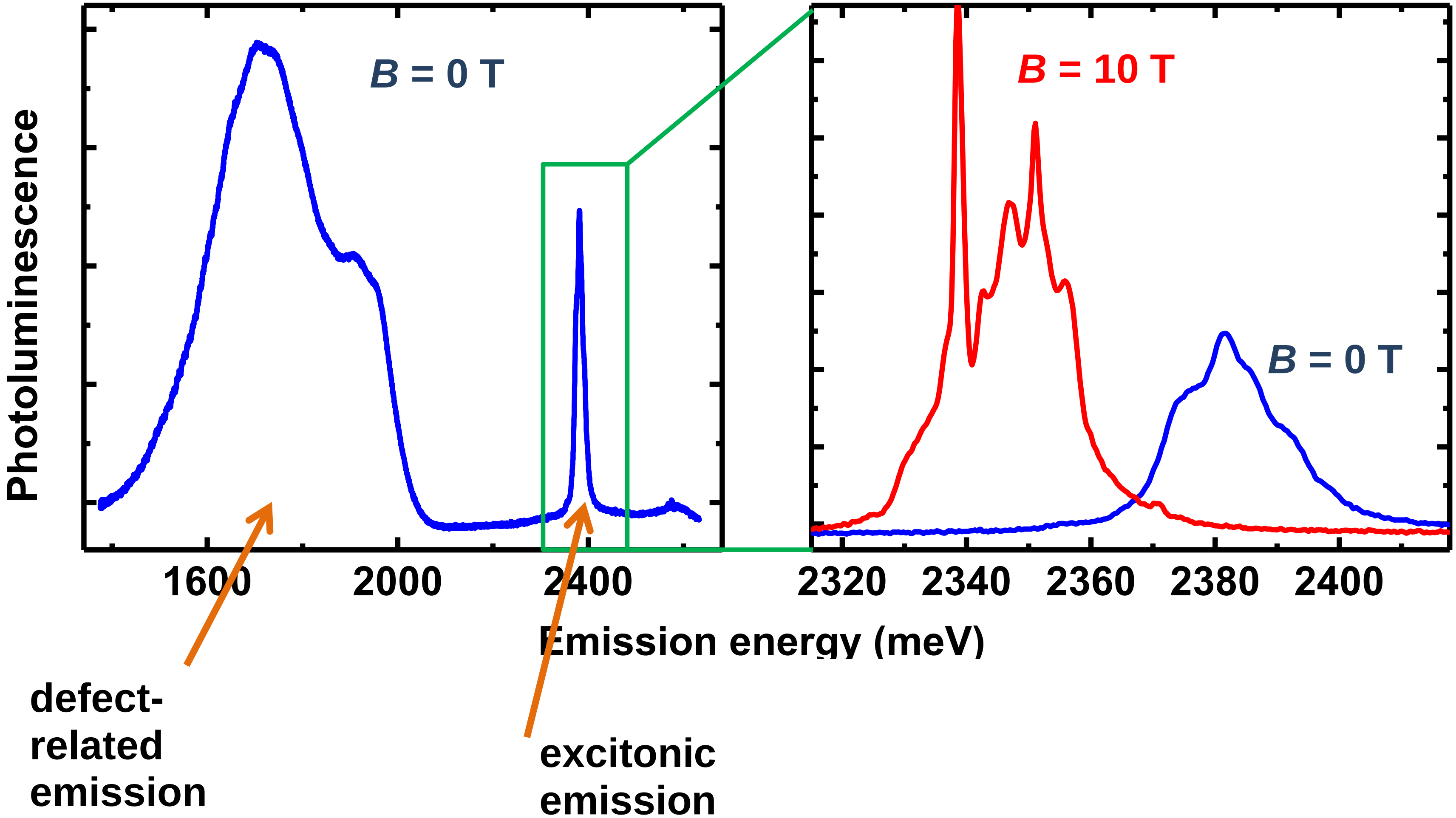
Luminescence: Following the single NW



Linewidth of single NW emission ~ 2 - 5 meV

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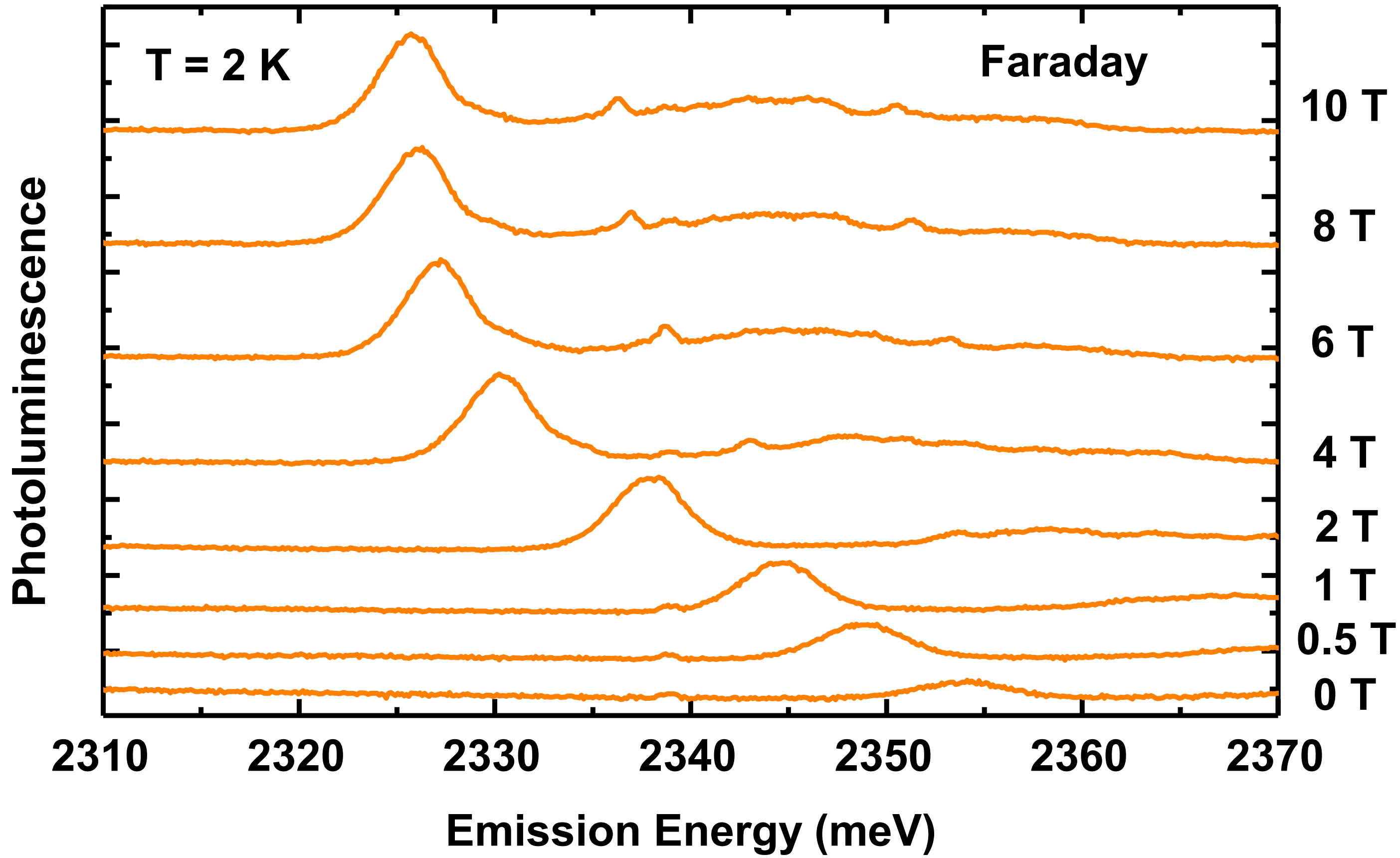
Emission in Magnetic Field



NW excitonic transition in magnetic field:

- Energy: redshift due to the Zeeman splitting
- PL intensity: increase up to 5x
- Linewidth: decrease (down to 60 %)

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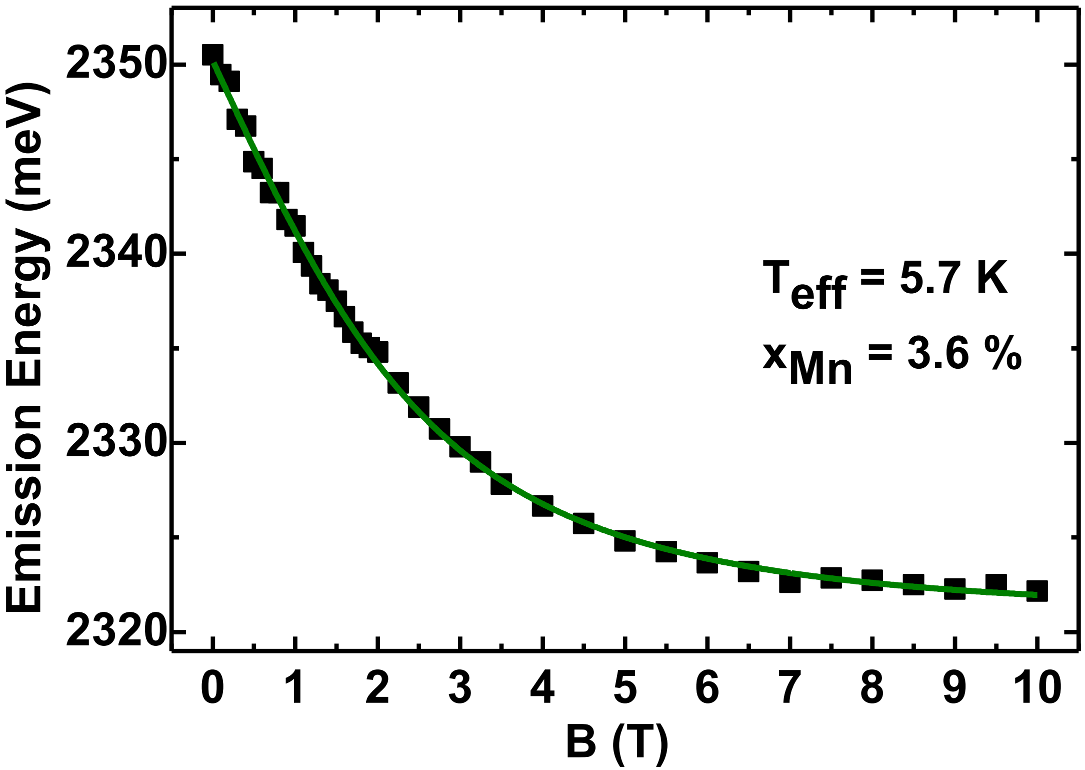
Emission in Magnetic Field



- Zeeman splitting

$$\Delta E(B) = E_s B_S\left(\frac{g_{\mathrm{Mn}}\mu_B B}{kT_{\mathrm{eff}}}\right)$$

$$E_s = \frac{1}{2}(N_0\alpha - N_0\beta)x_{\mathrm{Mn}}S_0$$

- fit yields E_S = 56 meV
- => x_{Mn} = 3.6 %

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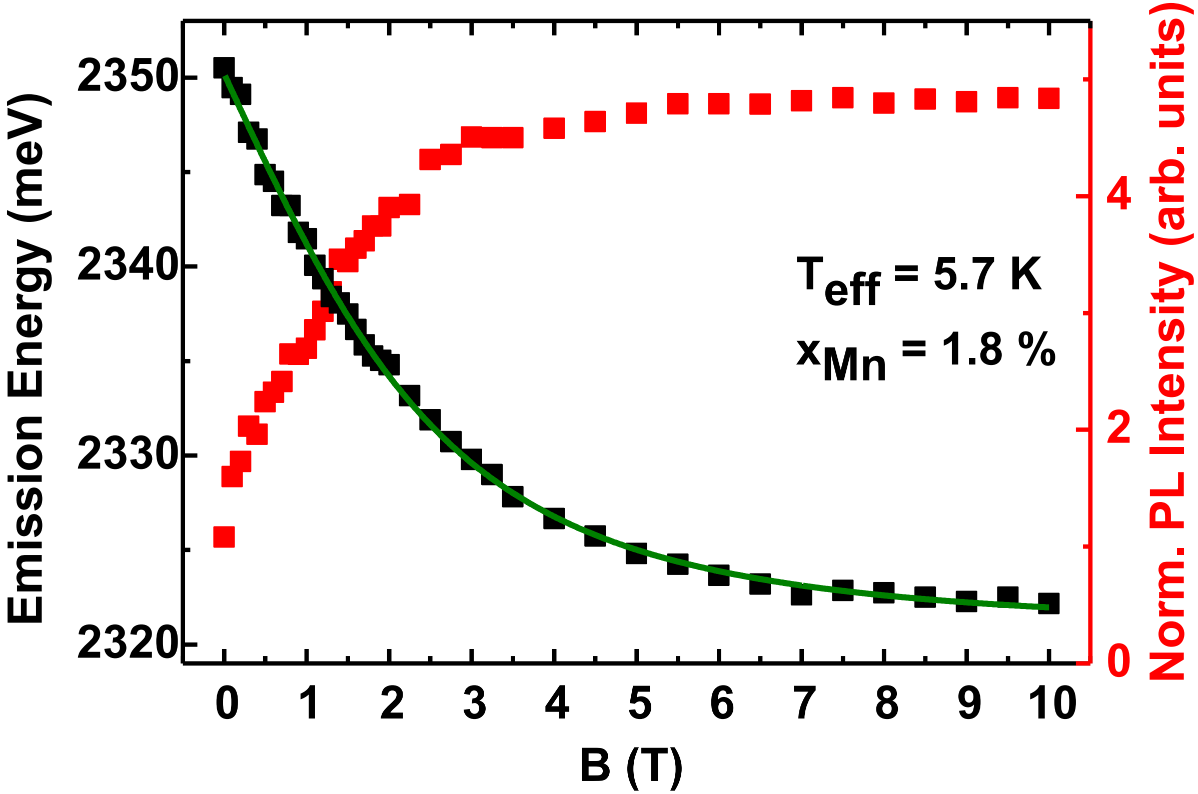
Emission in Magnetic Field



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PL Intensity enhancement:

- Brillouin – like dependence
- saturation at about *B* = 3 T

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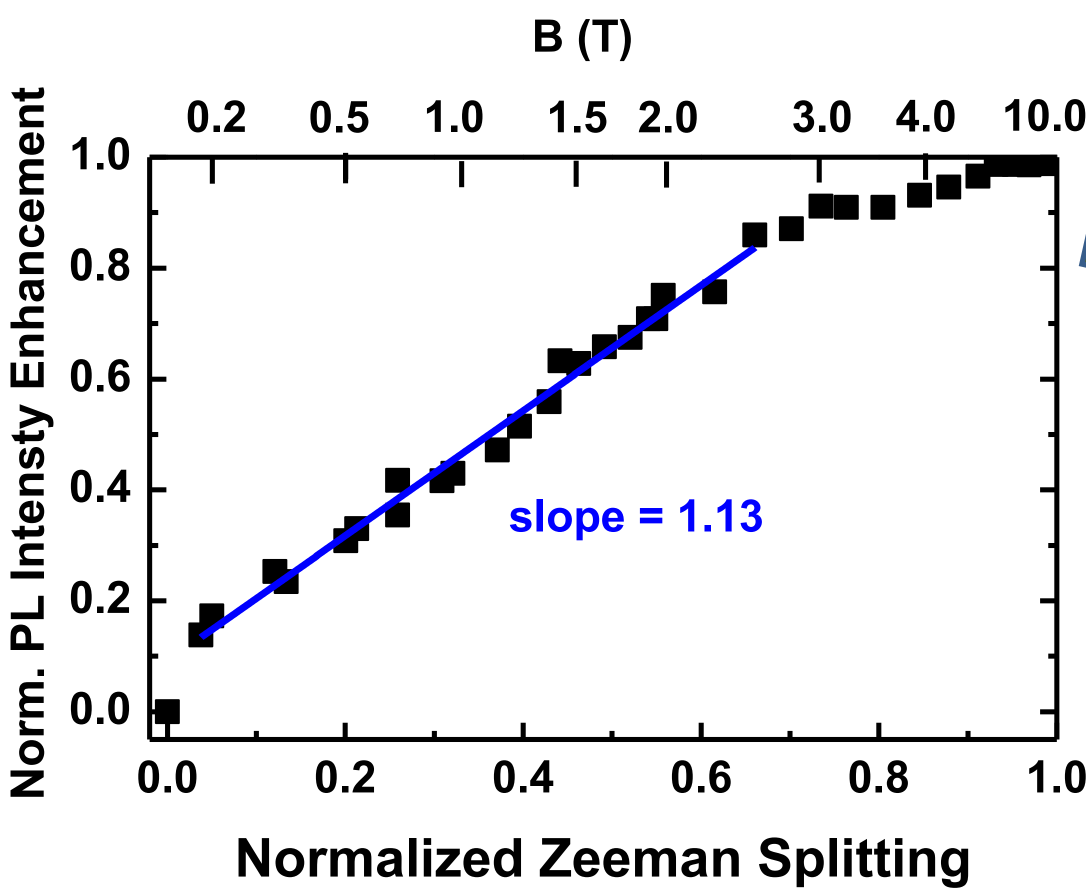
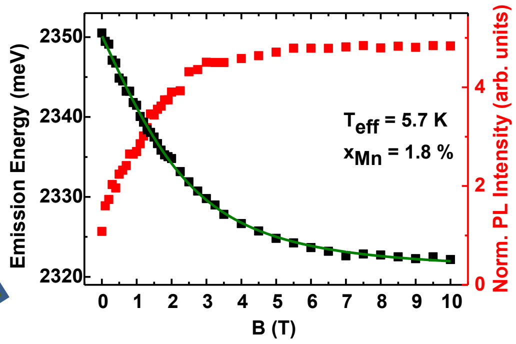
Emission in Magnetic Field





PL Intensity enhancement:

gradual quenching of non radiative, spin – dependent recombination channel related to Mn ions

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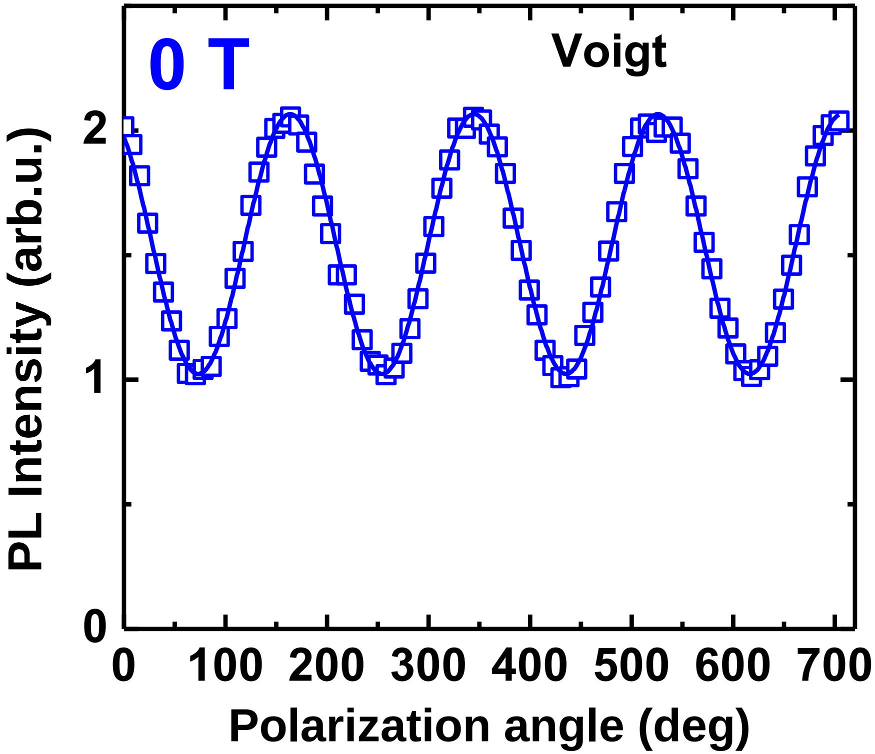
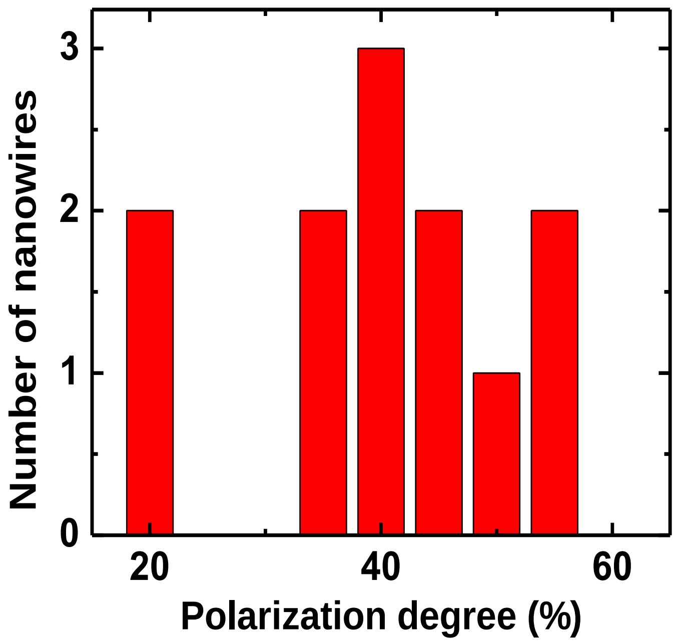
Linear Polarization Degree



$$\mathrm{LPD} = \frac{I_{MAX} - I_{MIN}}{I_{MAX} + I_{MIN}}$$



Our NWs: High degree of LPD (av. 40 % at 0 T)

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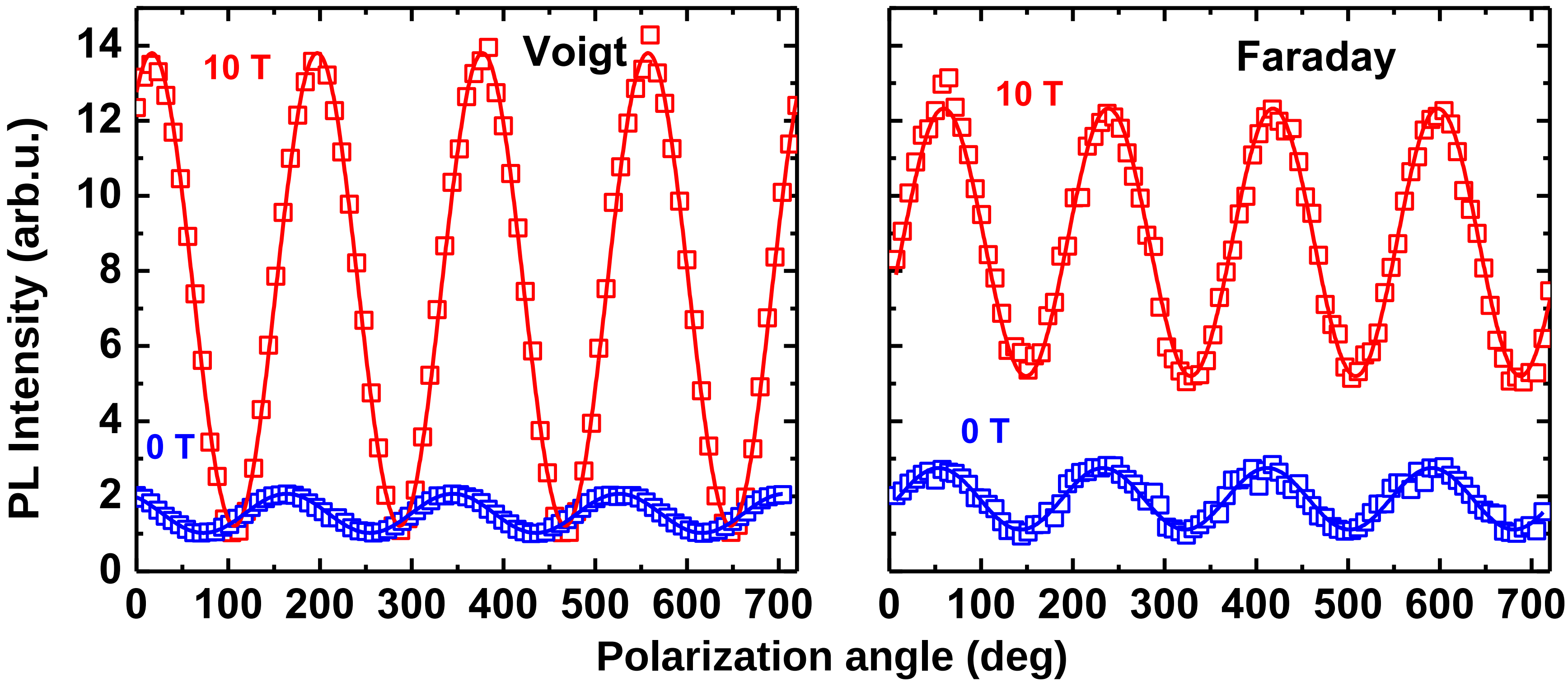
Polarization in magnetic field



Linear Polarization Degree

polarization direction

Voigt: altered by magnetic field

Faraday: negligible impact of magnetic field

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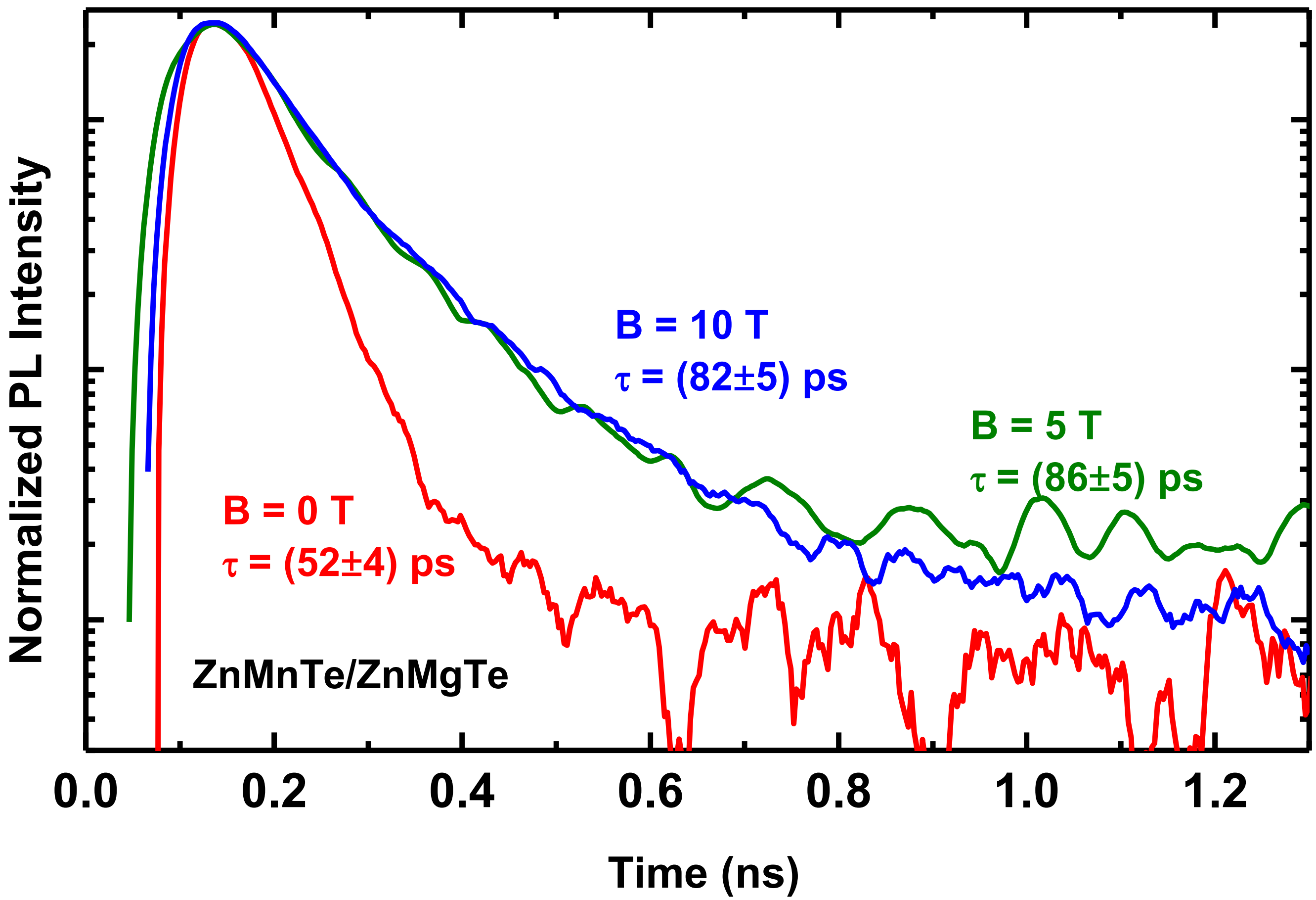
Time resolved study of Photoluminescence



- **ZnMnTe sample: Magnetic field induced exciton lifetime increase (up to 60% in 10 T)**
- **Saturation at *B* = 3 - 4 T**

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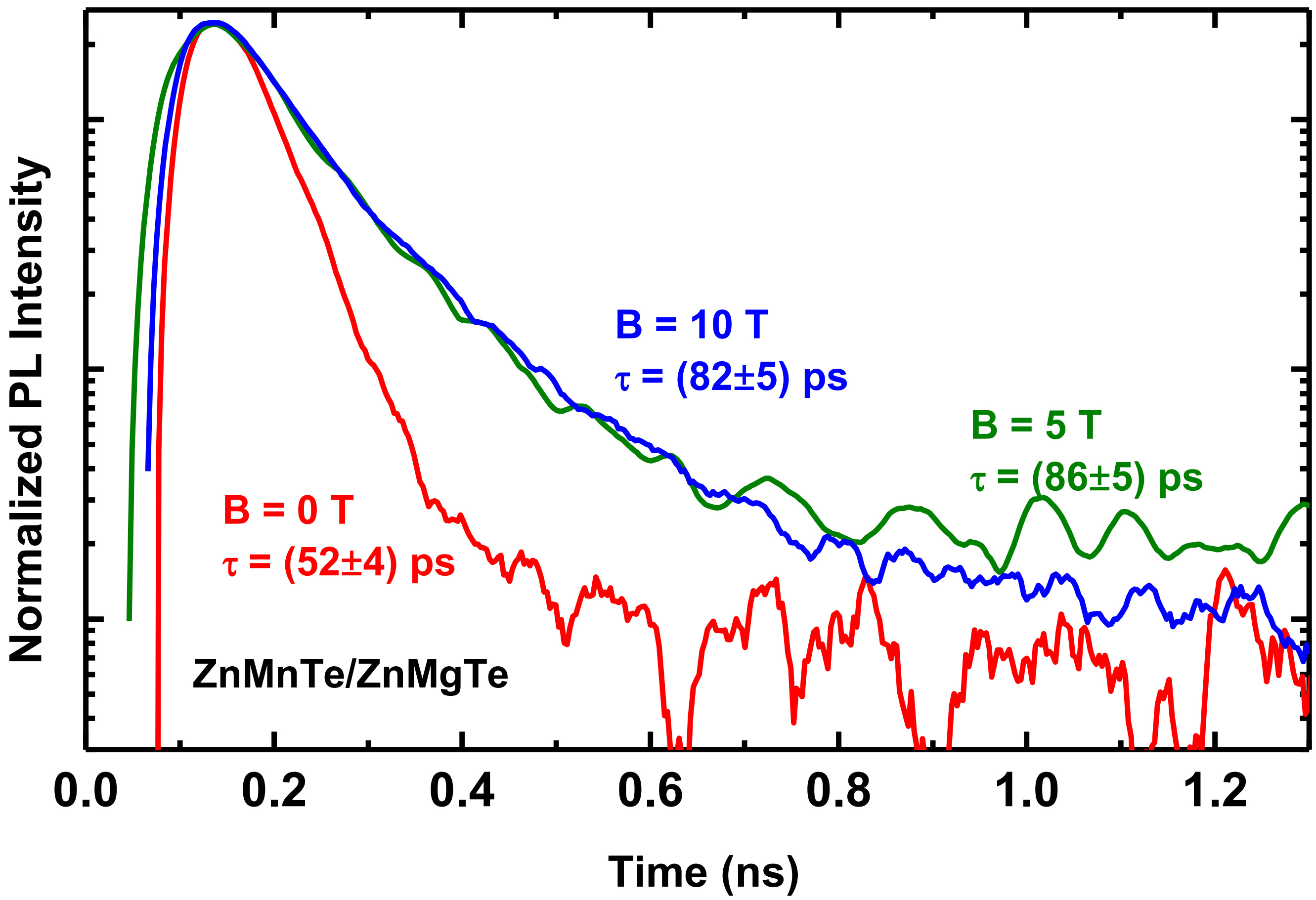
Time resolved study of Photoluminescence



- Non-radiative processes inhibited
- consistency with cw measurements.

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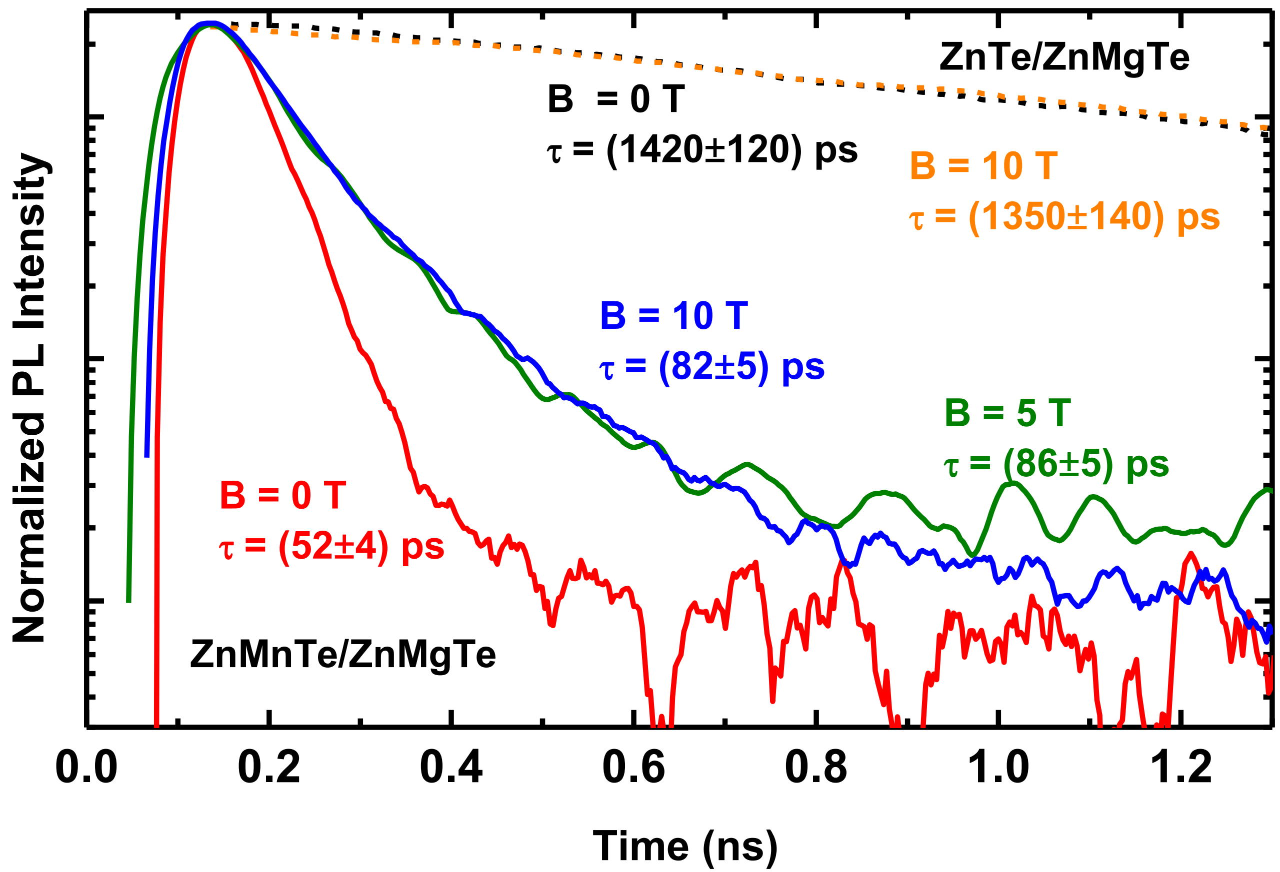
Time resolved study of Photoluminescence



ZnTe sample:

- **excitonic lifetime independent of the magnetic field**
- **Decay time – order of magnitude longer.**

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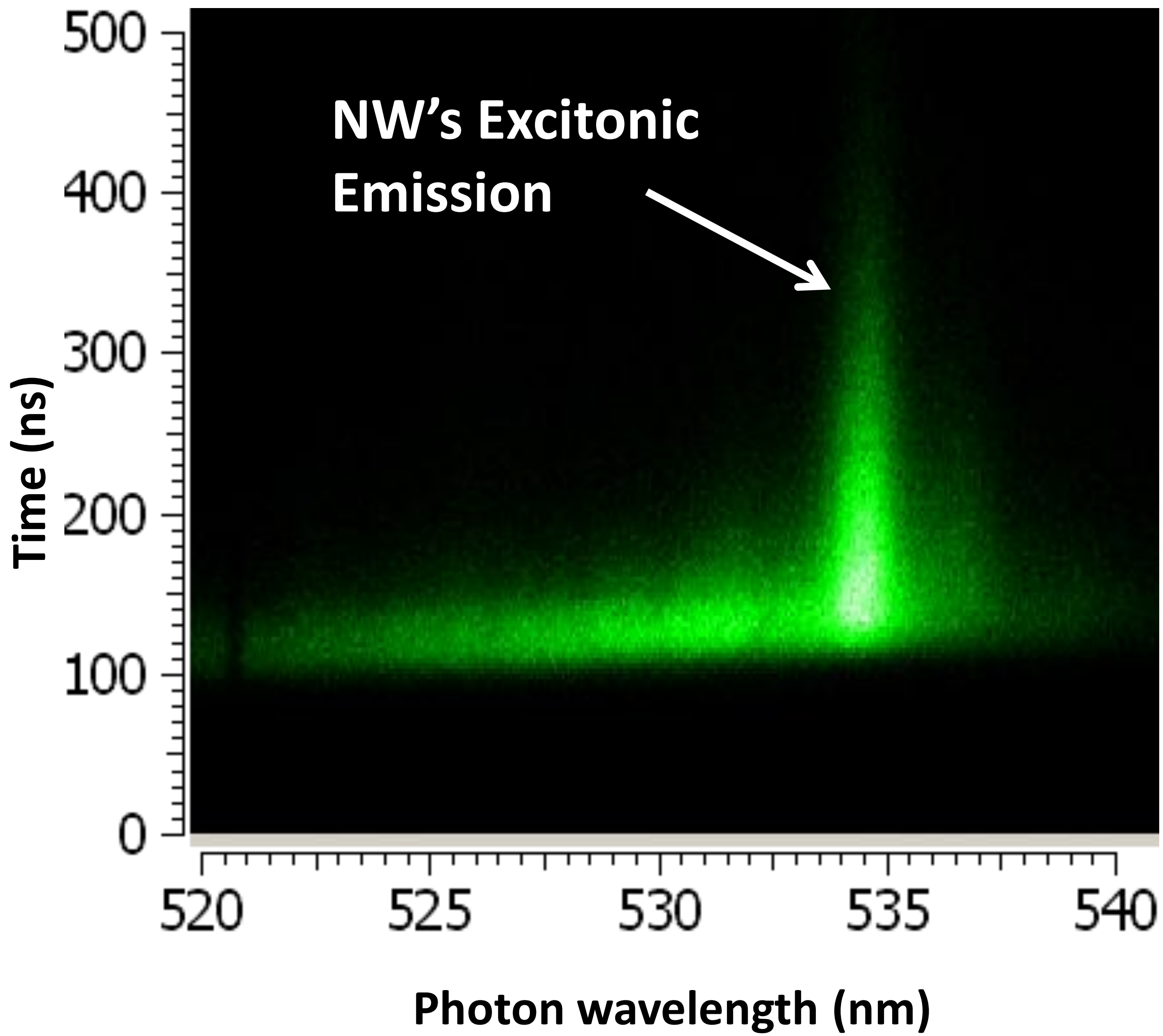
Summary

- Polarization and emission dynamics of optically active magnetic ZnMnTe/ZnMgTe nanowires determined
- High degree of linear polarization due to anisotropic geometry of nanowire
- Polarization of emission affected by magnetic field in Voigt configuration
- cw and TR measurements: Spin dependent, non-radiative channel of photocreated carriers recombination quenched by magnetic field

Time resolved study of Photoluminescence



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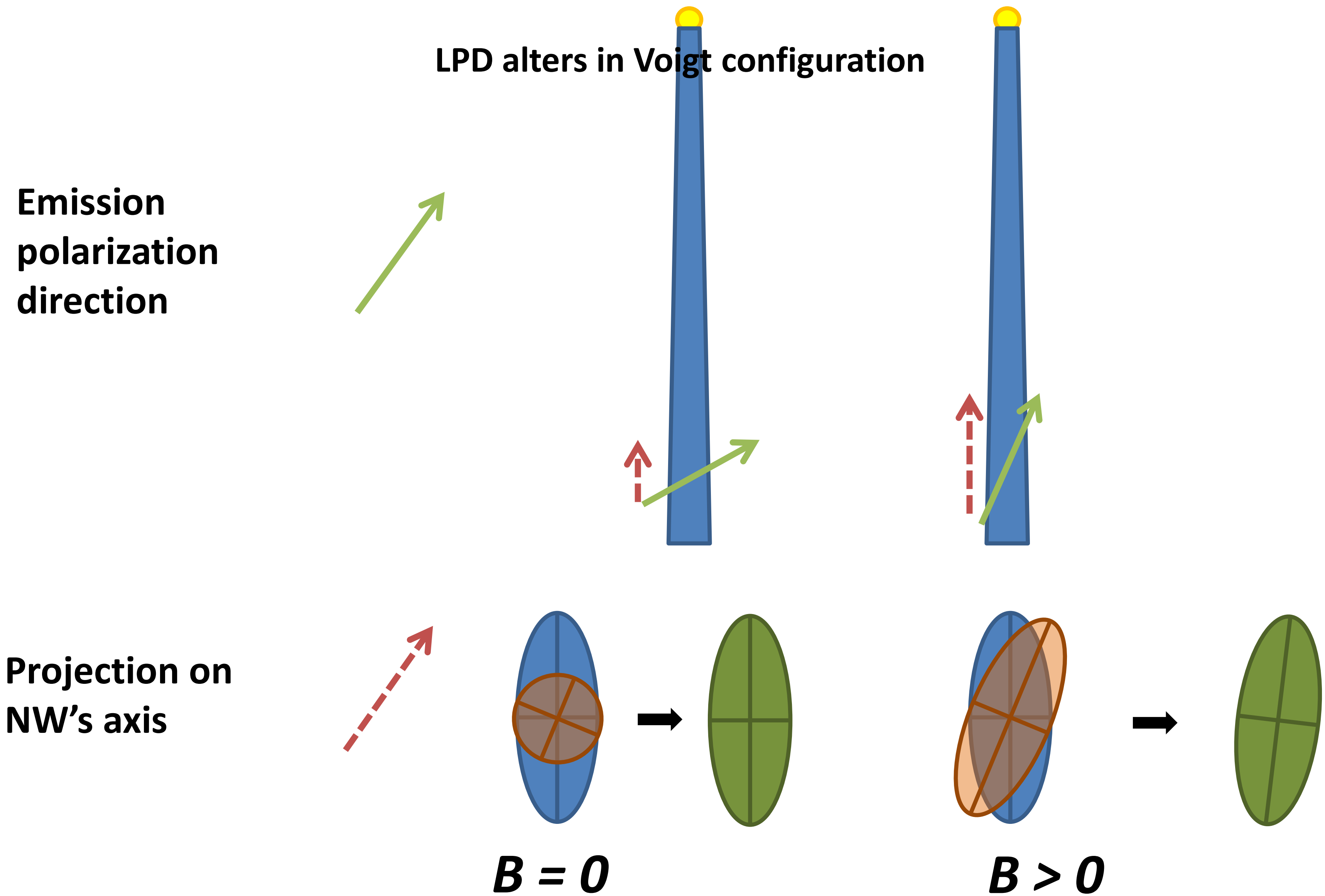
Emission dynamics in magnetic field



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