Dynamics of the matrix in DMS Type-II quantum dot systems

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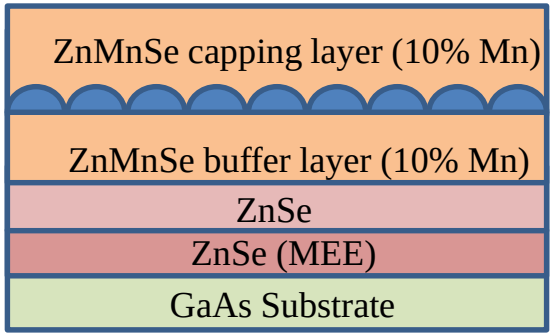
Schematic

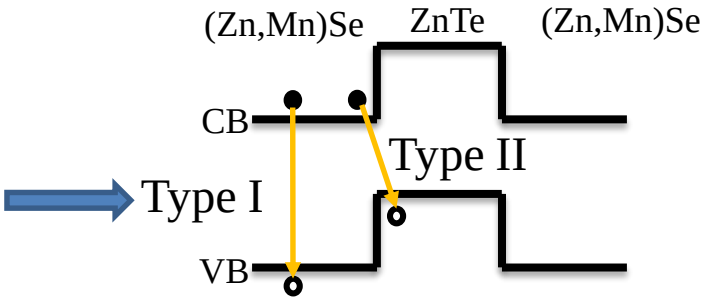
ZnTe/(Zn,Mn)Se



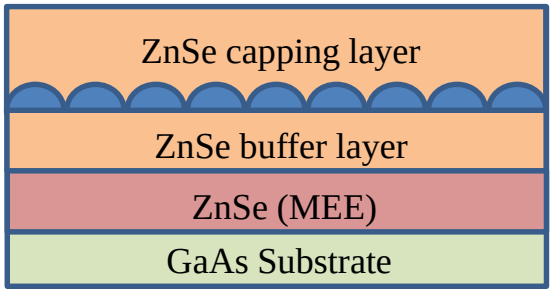
(50 nm) ZnTe QDs

(50 nm)

(50 nm)

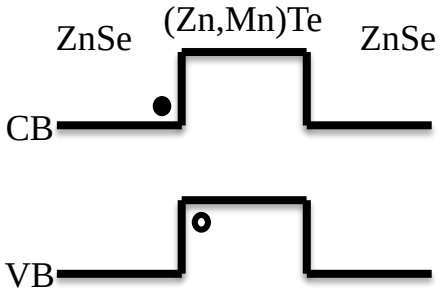


(Zn,Mn)Te/ZnSe

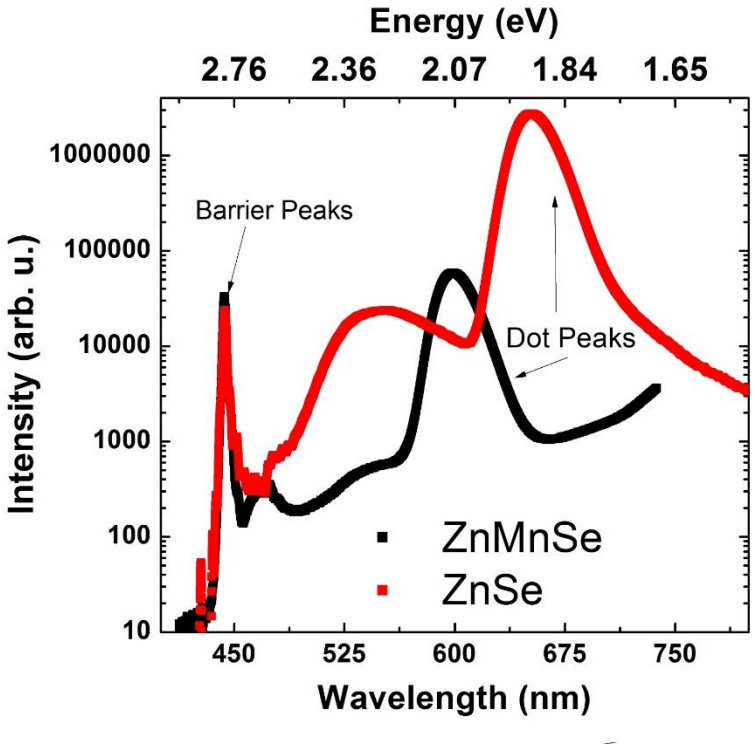


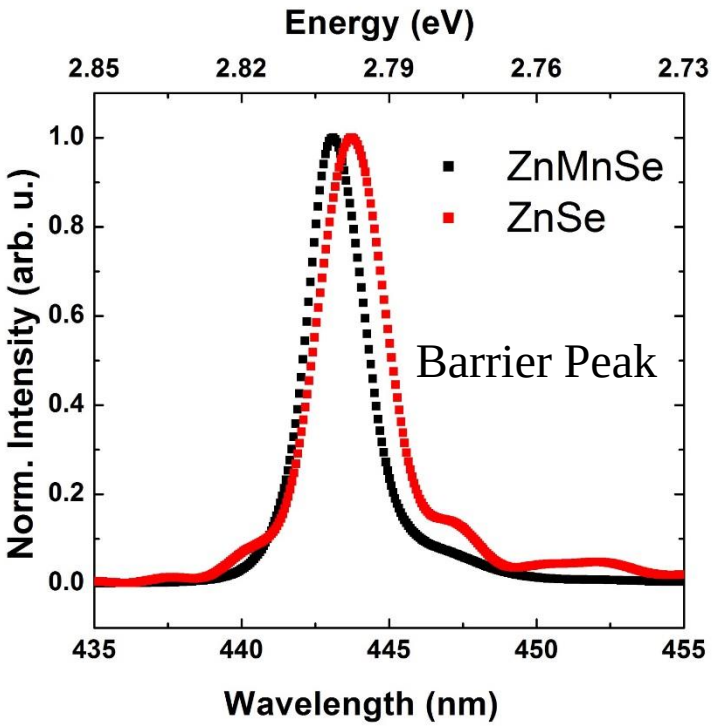
(50 nm) ZnMnTe QDs (5% Mn)

(50 nm)



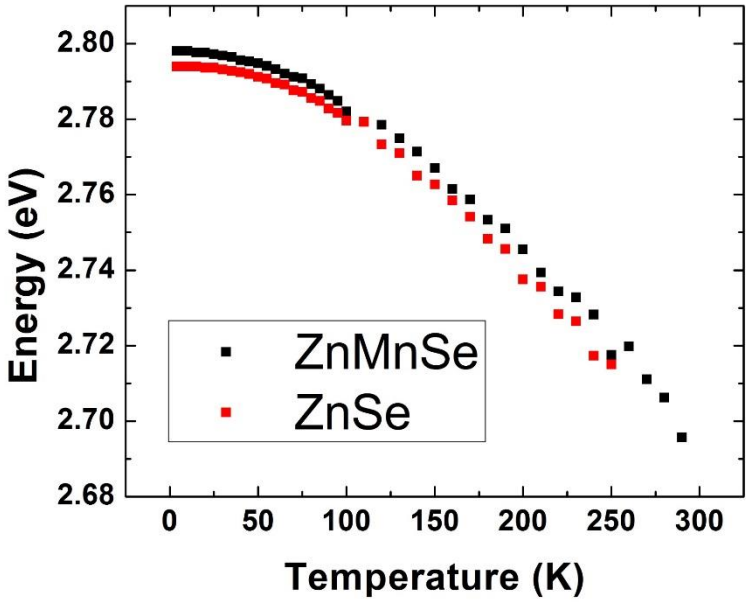
Photoluminescence at 4K

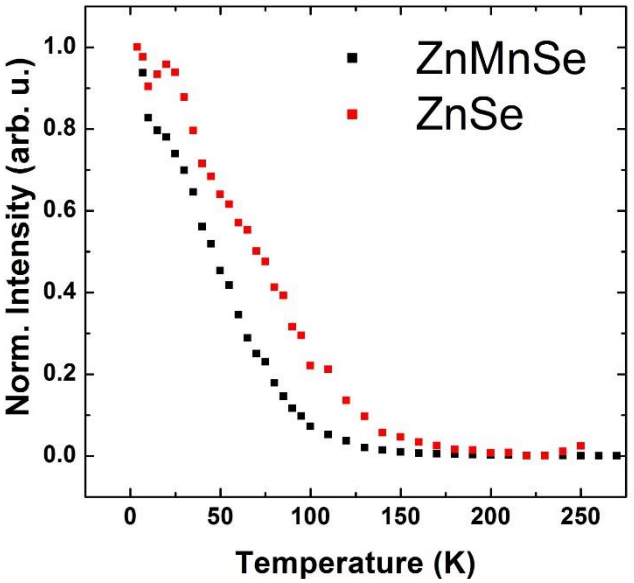




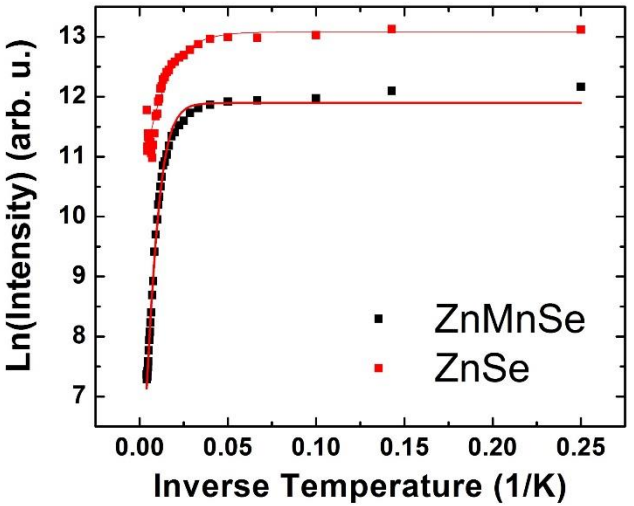
- B. Barman *et al.*, Physical Review B **92**, 035430 (2015).
- I. R. Sellers *et al.*, Physical Review B **82**, 195320 (2010).
- I. R. Sellers, V. R. Whiteside, A. O. Govorov, W. C. Fan, W. C. Chou, I. Khan, A. Petrou, and B. D. McCombe, Physical Review B **77**, 241302 (2008).

Temperature Dependence



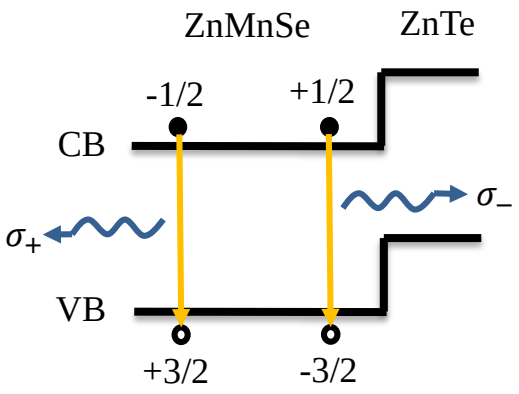


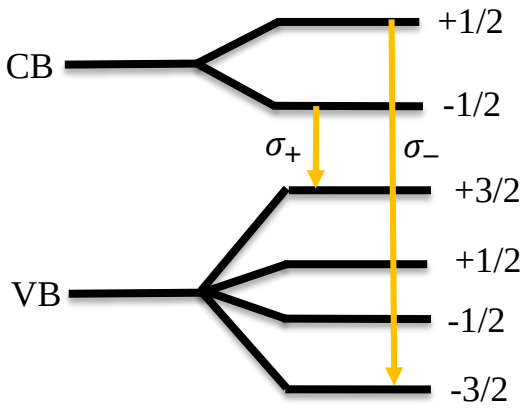
- The barrier region in both samples exhibits classic Varshni behavior due to temperature.
- Both samples also exhibit fast quenching of the photoluminescence (PL) after 25K

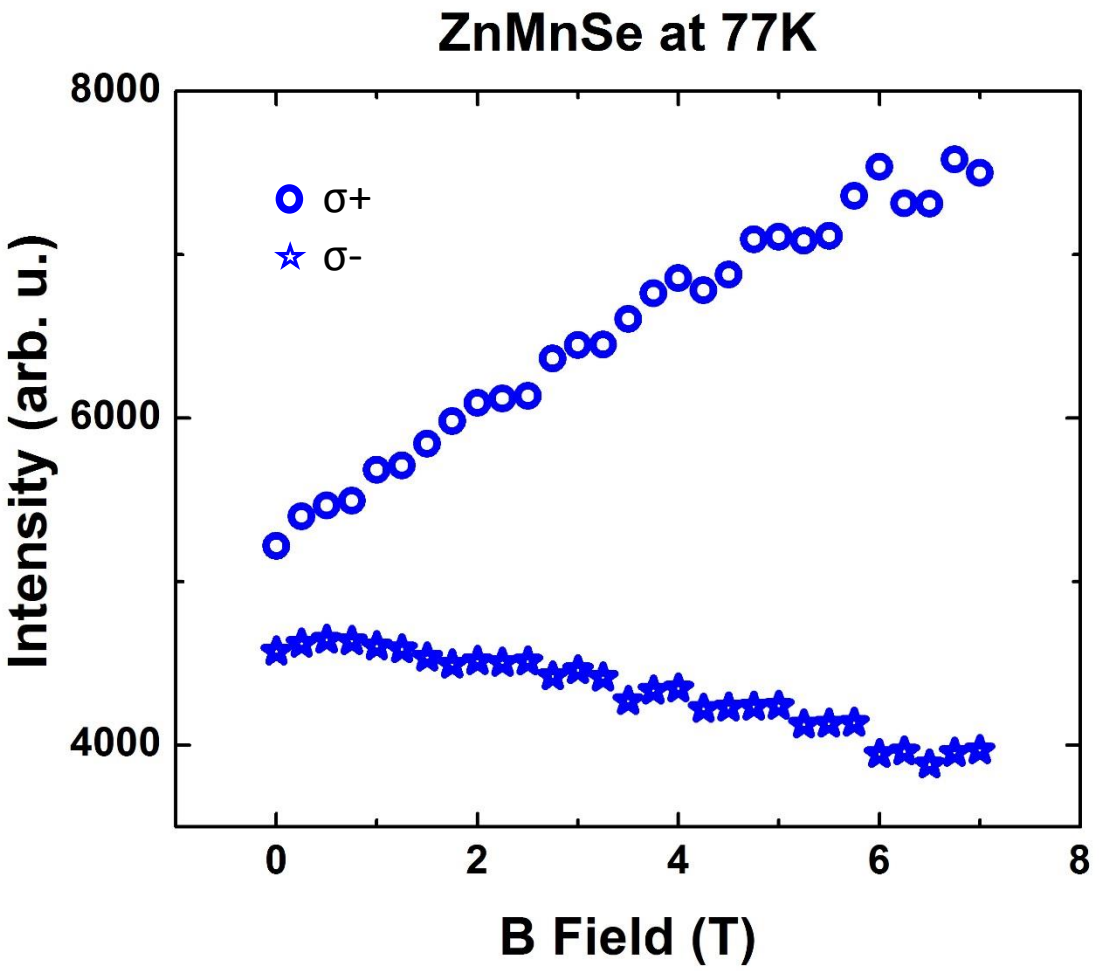


ZnMnSe E_A = 17 meV
ZnSe E_A = 14 meV

Intensity vs Field

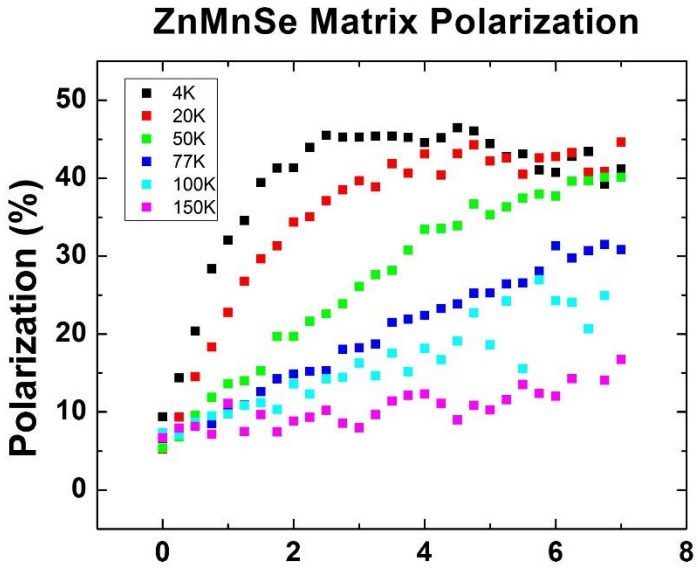


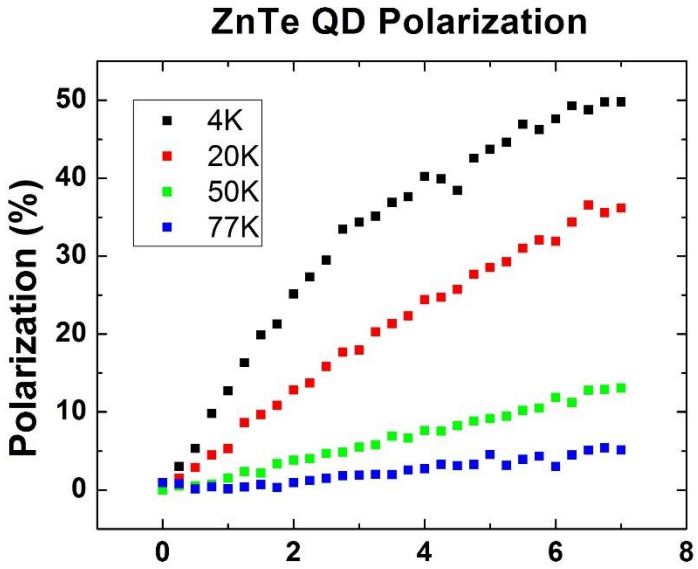




Polarization is calculated using Peak Height – $P = \frac{|\sigma_+ - \sigma_-|}{\sigma_+ + \sigma_-} \times 100$

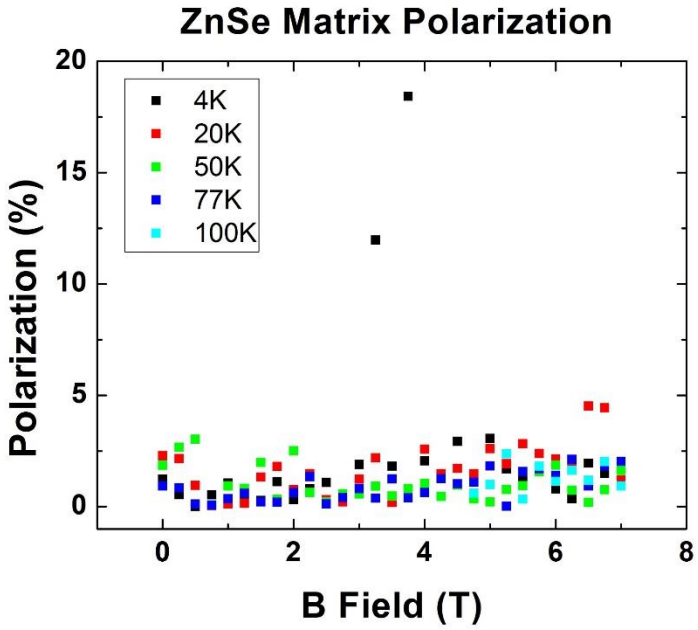
Polarization

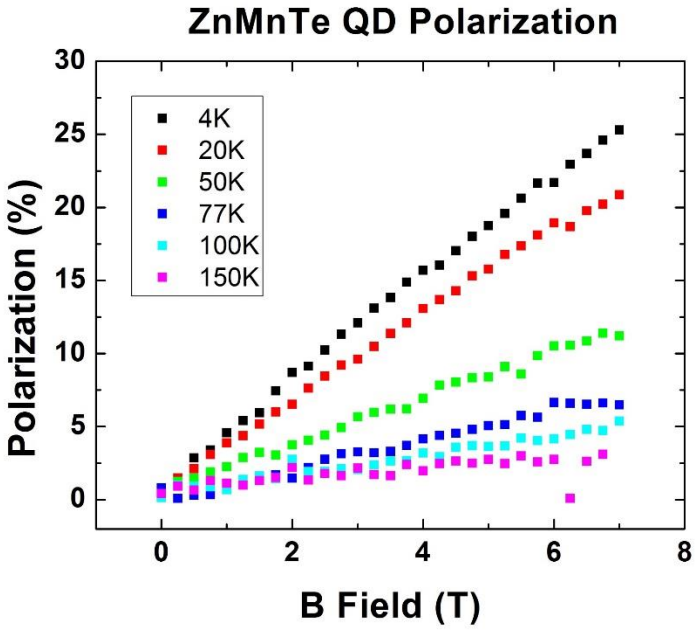




10% Mn

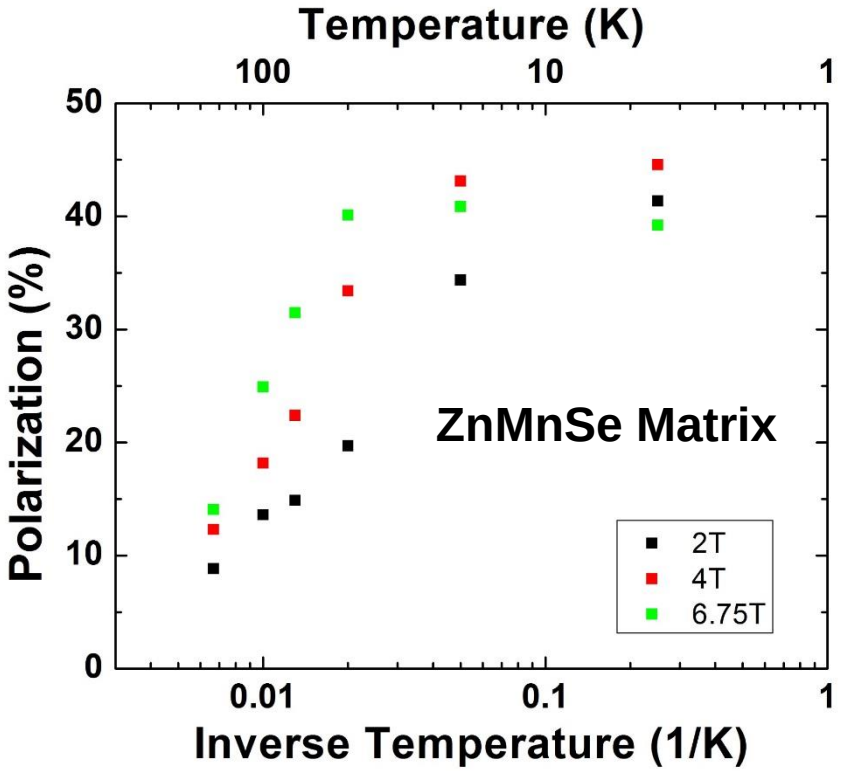
B. Barman *et al.*, Physical Review B **92**, 035430 (2015).

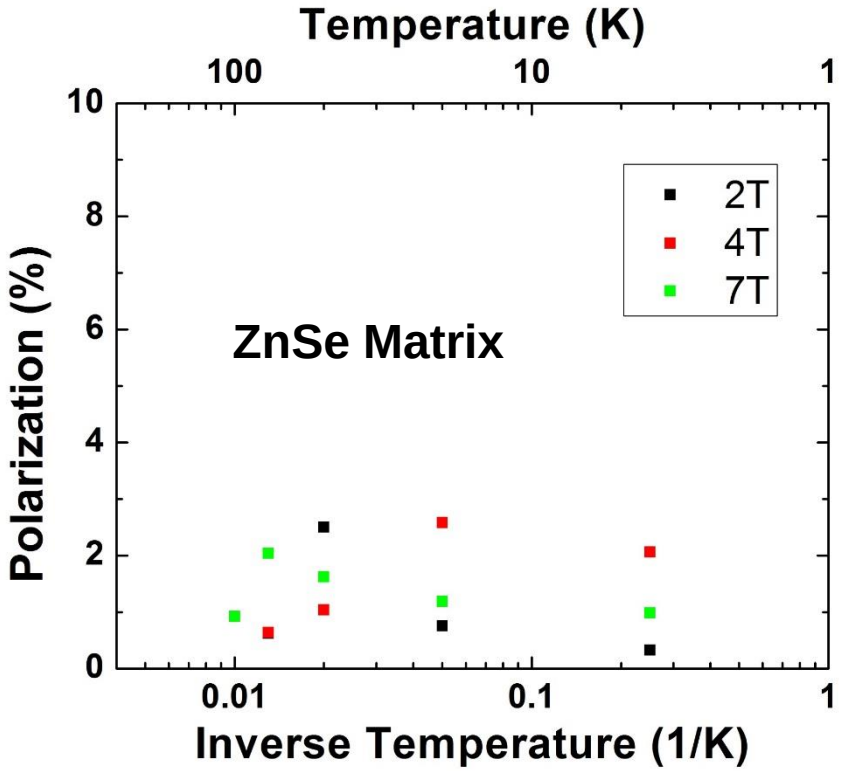




5% Mn

Temperature Dependent Polarization

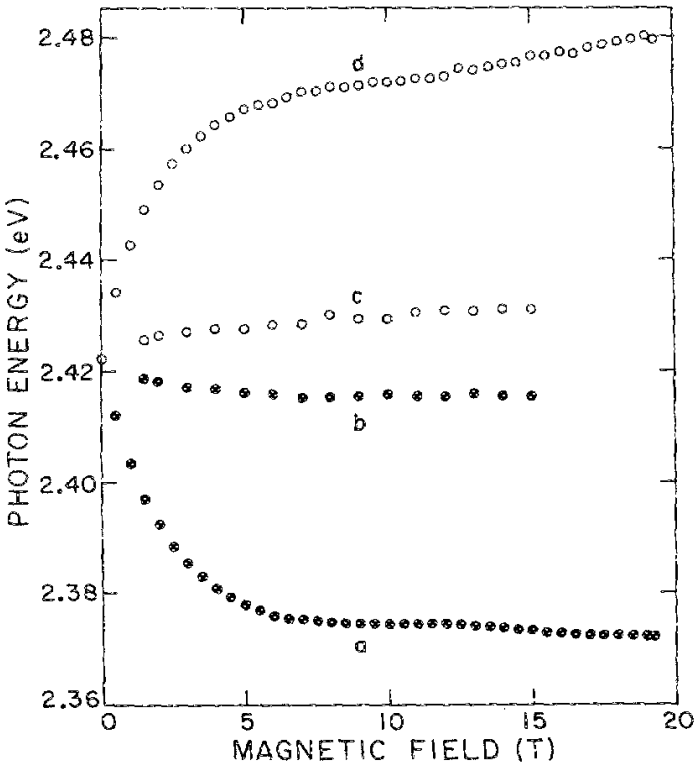




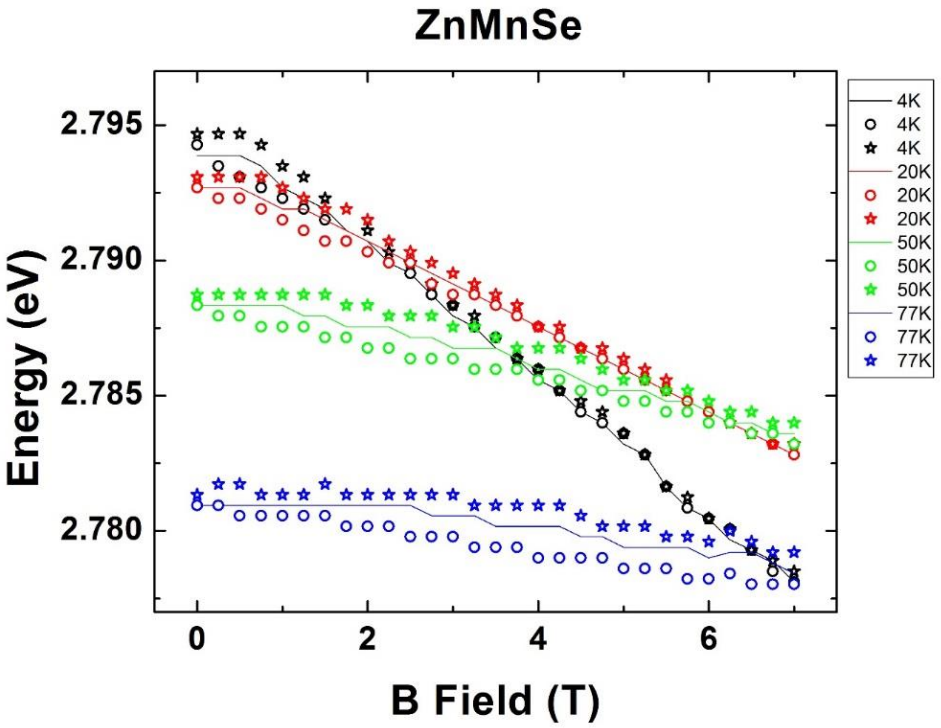
The matrix exhibits classic paramagnetism. We see increasing polarization with field, and decreasing polarization with temperature.

The matrix exhibits no behavior, which is normal considering there is no Mn in this Matrix.

Zeeman Energy



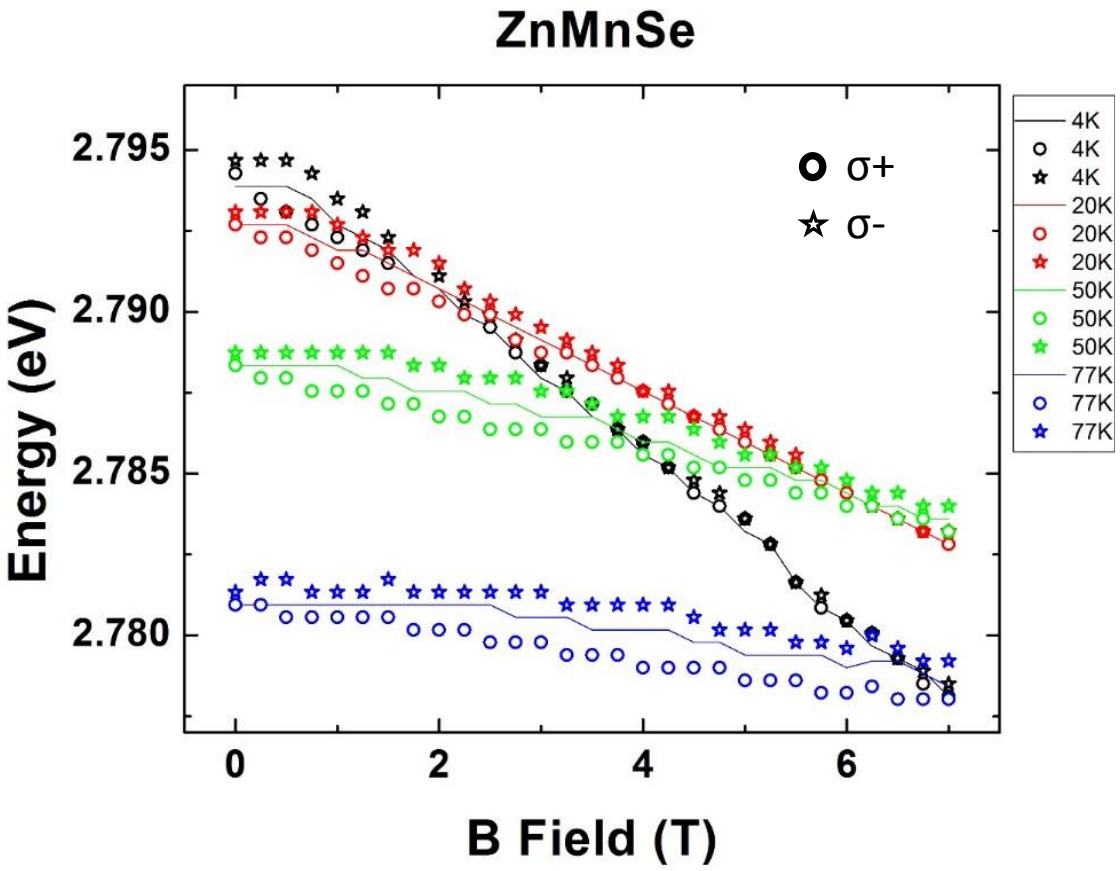
Here is the Zeeman energy behavior for a conventional paramagnet.*

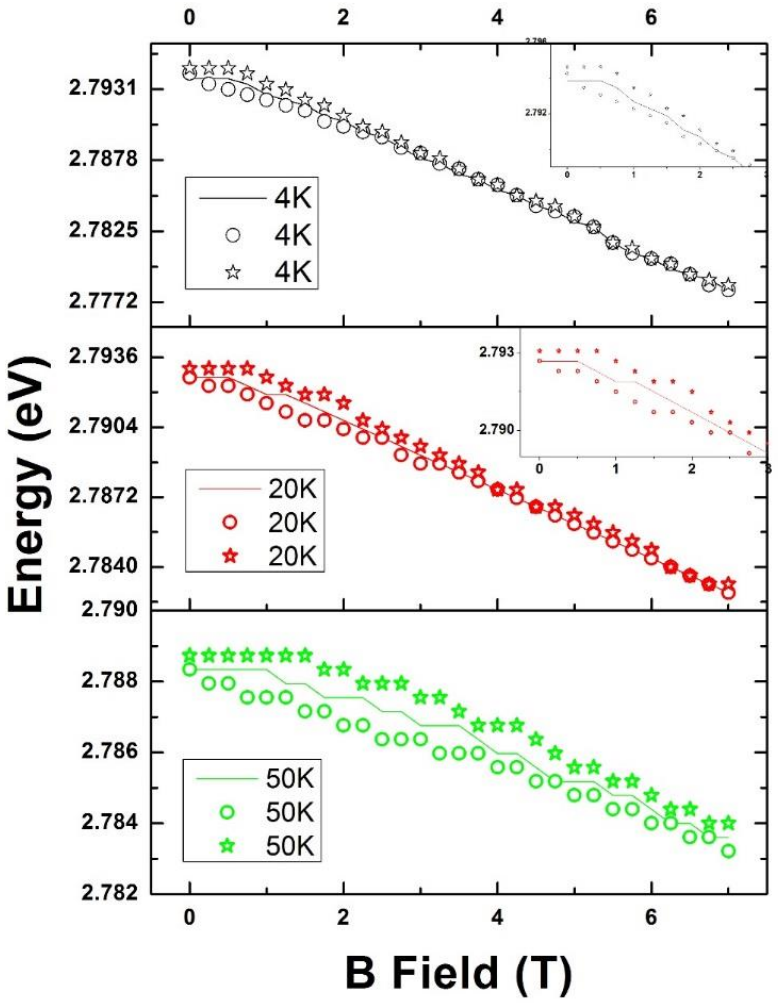


Here is what we see.

* J. K. Furdyna, Journal of Applied Physics **64**, R29 (1988).

Zeeman Energy Behavior





Future Work

- Magnetoreflectivity - This will help us determine whether we are really seeing σ-
- We will reverse the applied magnetic field to measure hysteresis in the photoluminescence spectra.
- We are collaborating with the Colorado School of Mines to understand exactly where the Mn impurities are in our samples.
  - Cross Sectional Transmission Electron Microscopy (TEM)
  - Atomic Force Topography (AFT)

- Questions?