Spatially and Time Resolved Kinetics of Indirect Magnetoexcitons

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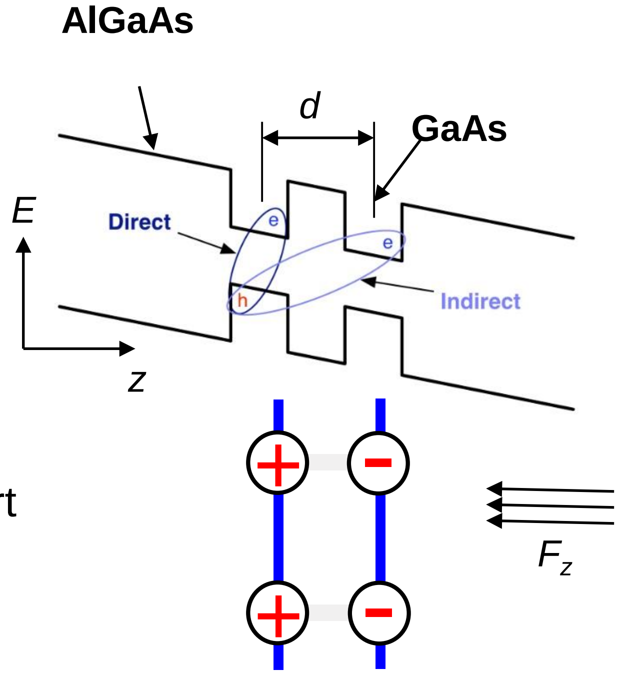
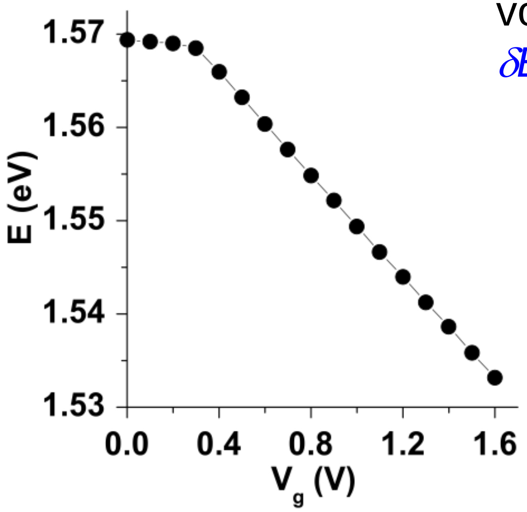
Indirect excitons

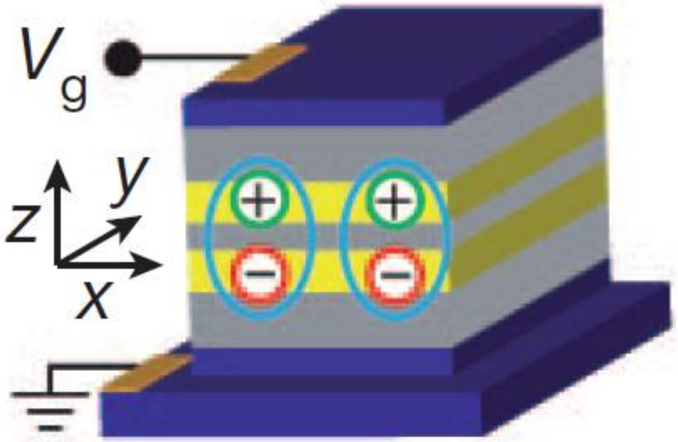
Exciton: bound pair of an electron and a hole.

Indirect excitons: electron and hole are confined to spatially separated quantum wells. Properties:

- bosons
- long and controllable lifetime → long-range exciton transport
- built-in dipole moment → excitons screen disorder → long-range exciton transport
- built-in dipole moment → control of excitons by voltage: $\delta E = edF_z$







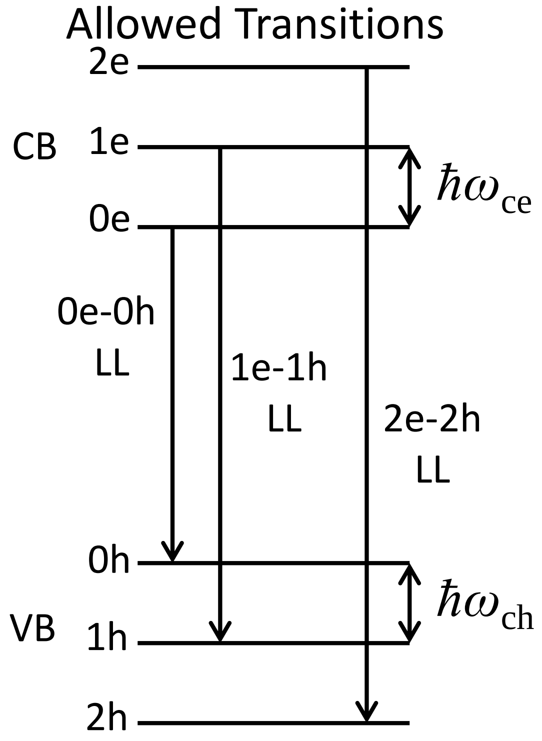
High magnetic field regime for excitons

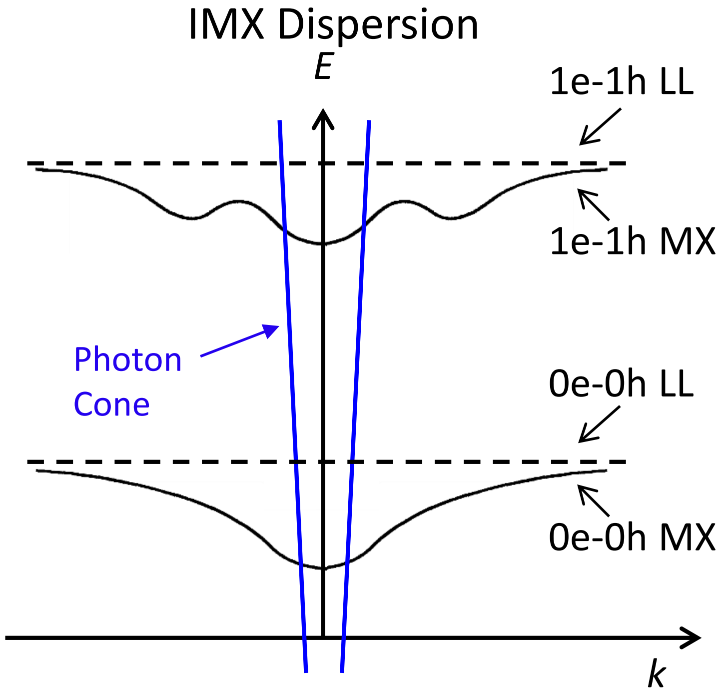
Strong magnetic field regime for composite bosons:
$\hbar\omega_c \geq E_b$
cyclotron energy ≥ binding energy

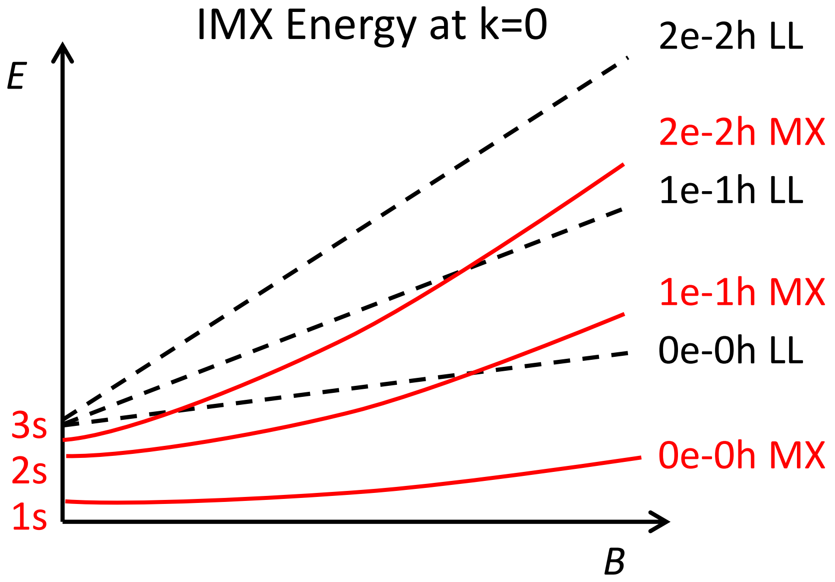
This requires
- ~ 10^6 Tesla for atoms
- Just a few Tesla for excitons

due to large $\hbar\omega_c = \hbar eB/(\mu c)$
and small $E_b \approx (\mu e^4)/(2\varepsilon^4 \hbar^2)$

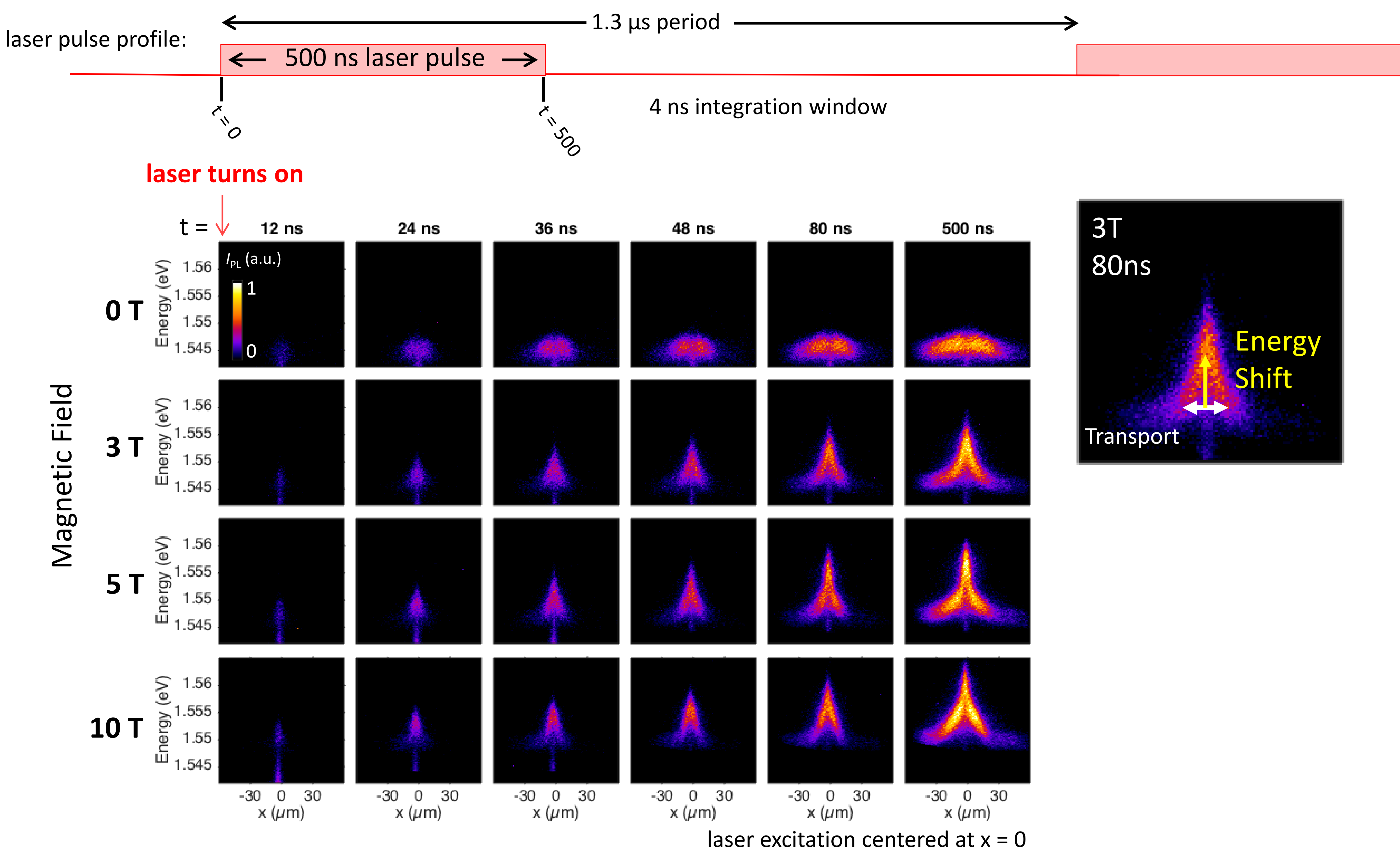
because of small mass and $\varepsilon > 1$
strong magnetic field regime for excitons is achieved in the lab







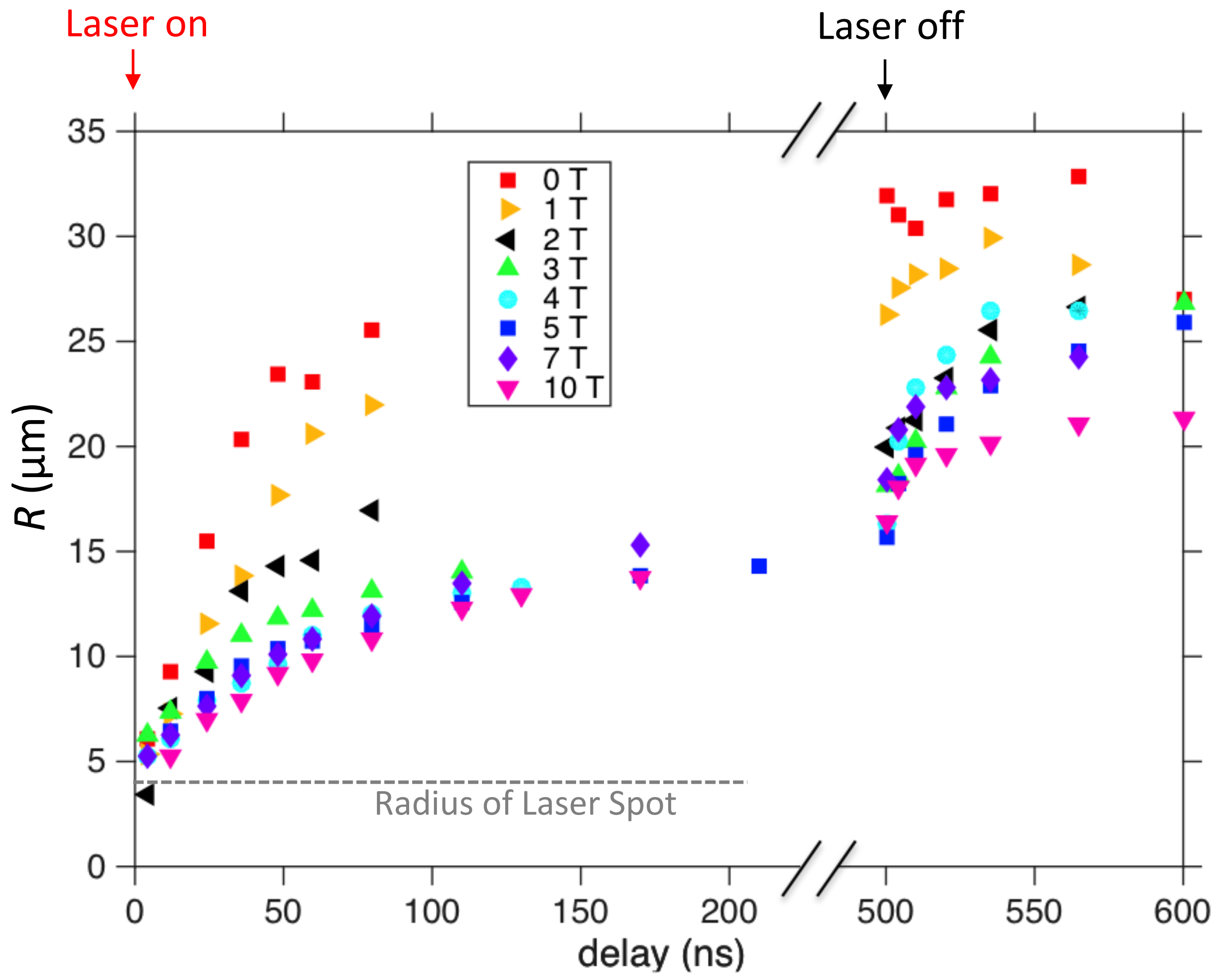
Spatial-Temporal Evolution of Magnetoexciton Emission



Radius of Magnetoexciton Cloud vs Time

R as a function of time – Direct measurements of exciton transport

MX **transport is slower** with increasing *B* ➔ **MX mass increase**



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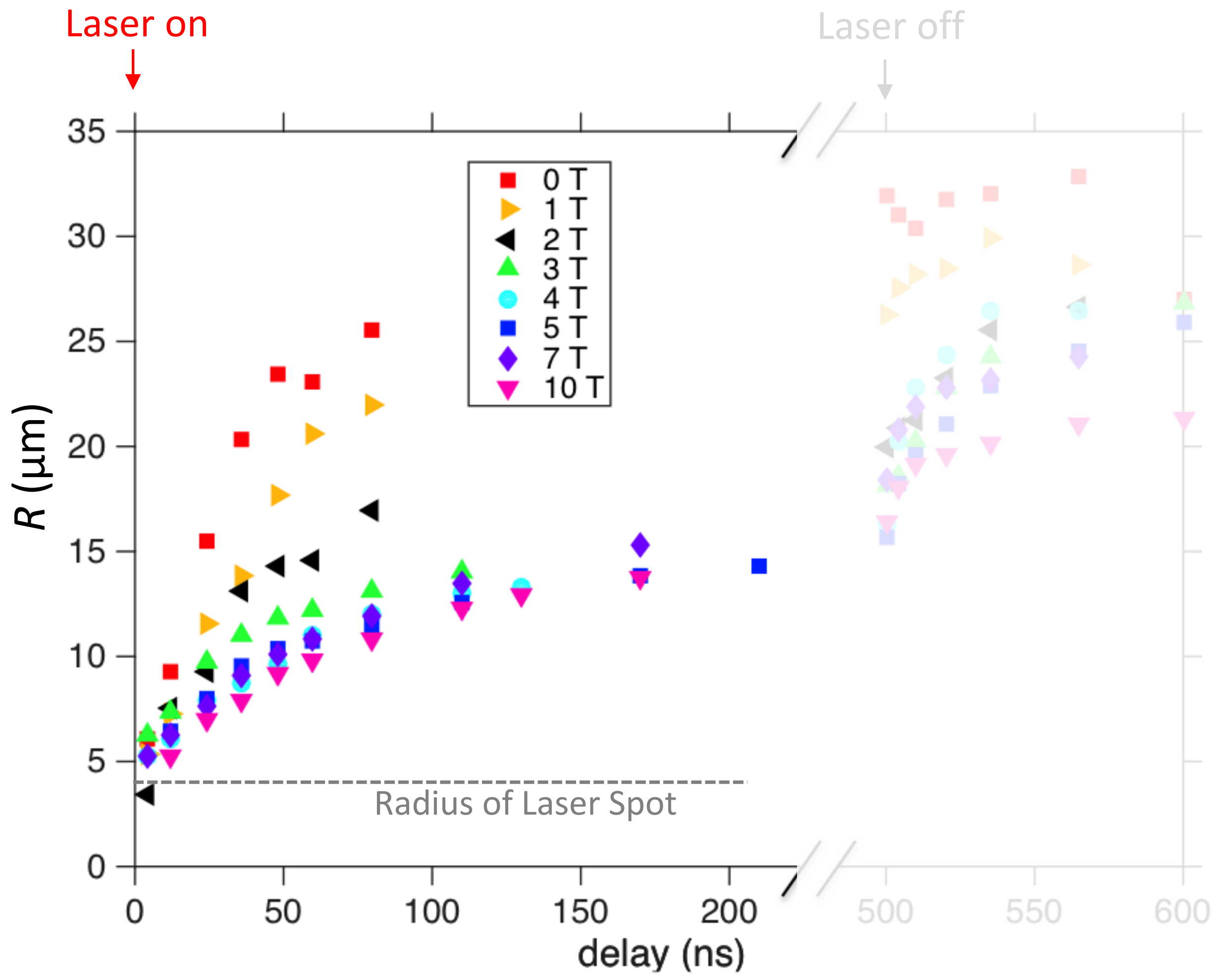
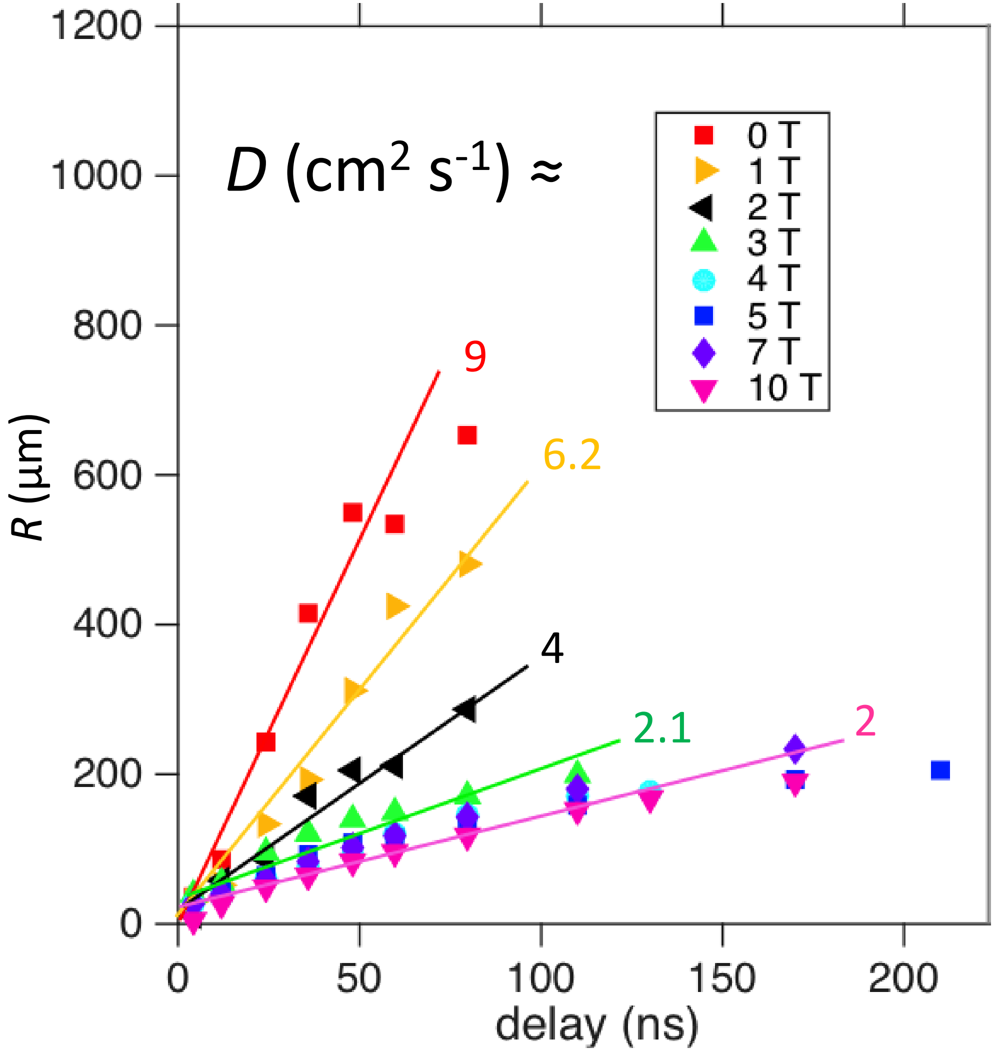
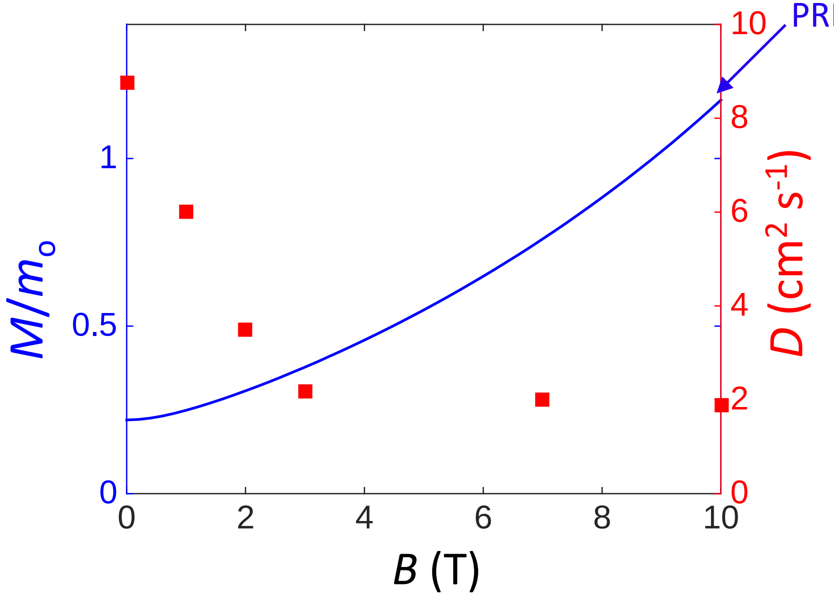


Estimating Magnetoexciton Diffusion Coefficient



Y. Y. Kuznetsova *et al*, PRB 95, 125304 (2017)



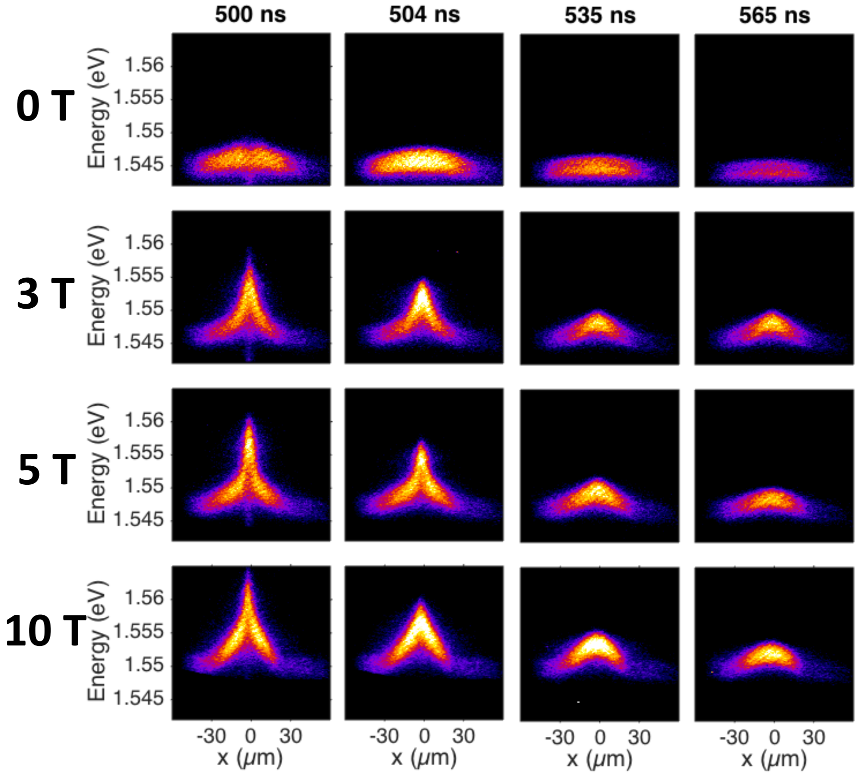
$R^2 = R_o^2 + D^* t$ is used for a rough estimate of D

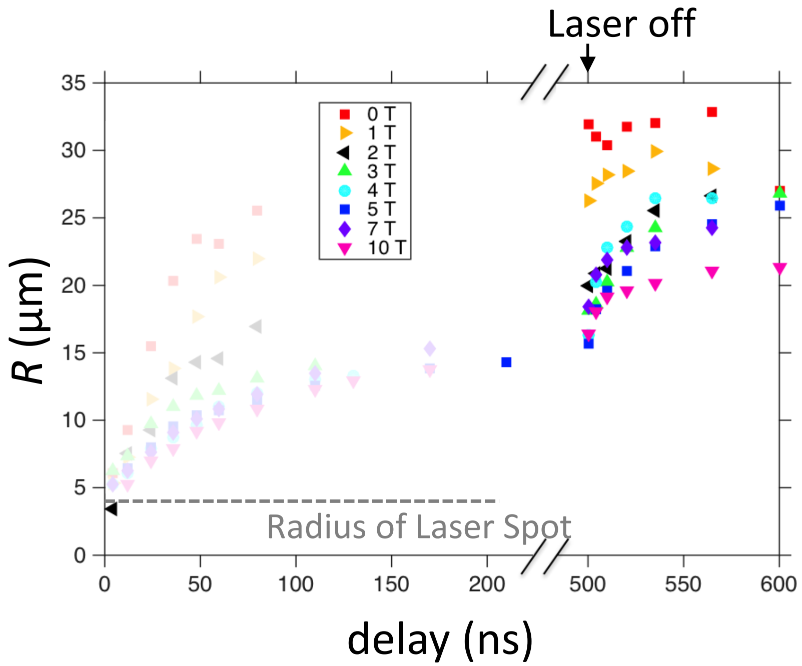
Mass enhanced with increased magnetic field

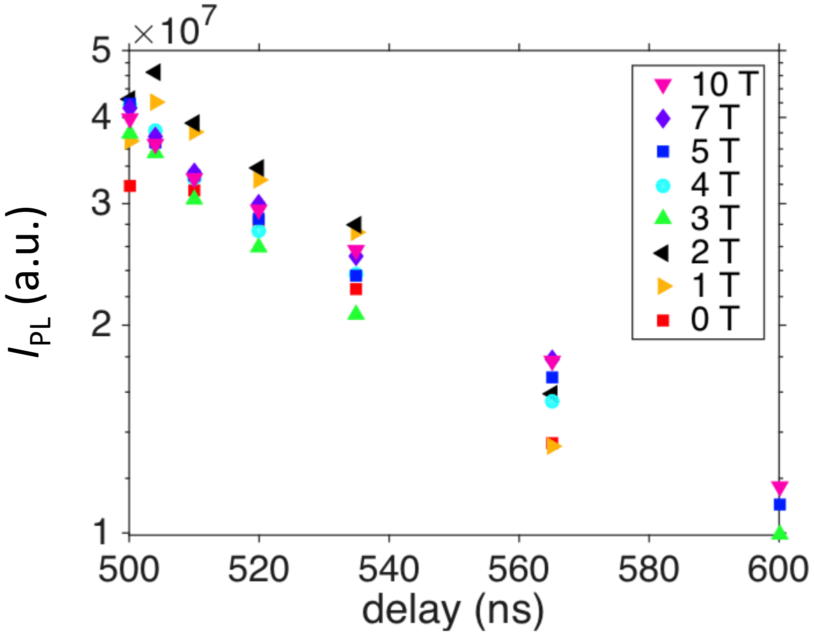
D reduced with increased Magnetic field

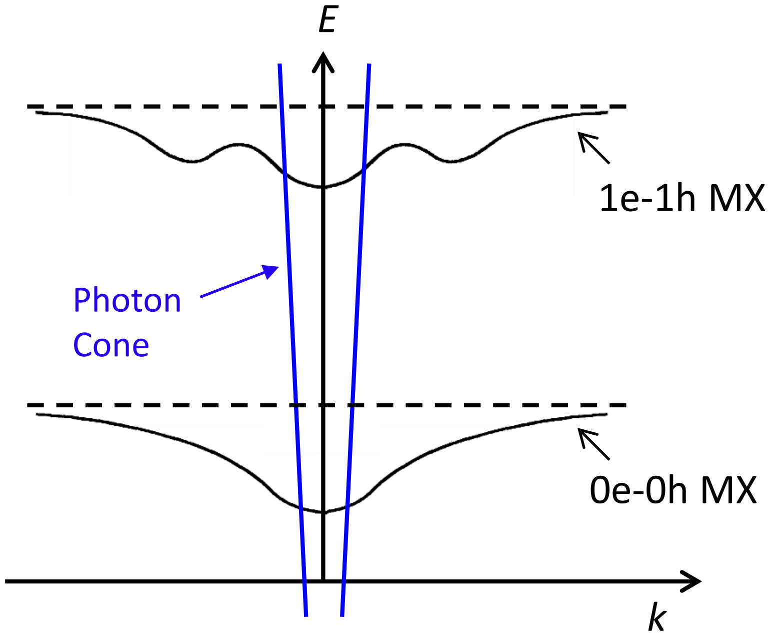
$D \propto 1/M$

Magnetoexciton Emission Images After Laser Pulse

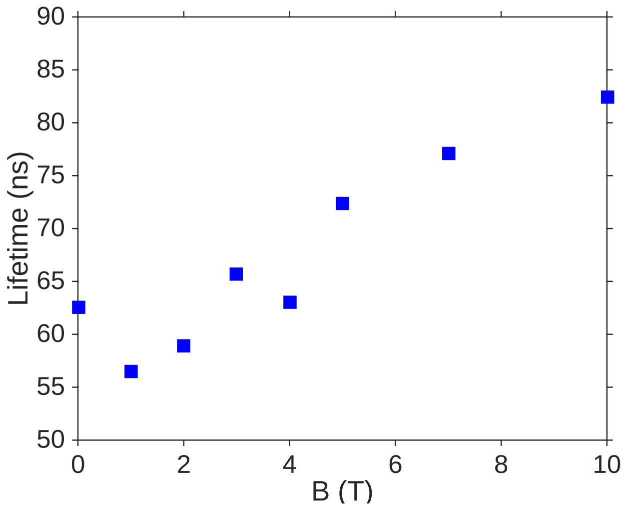




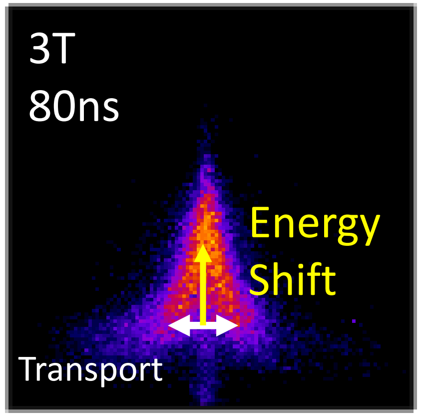




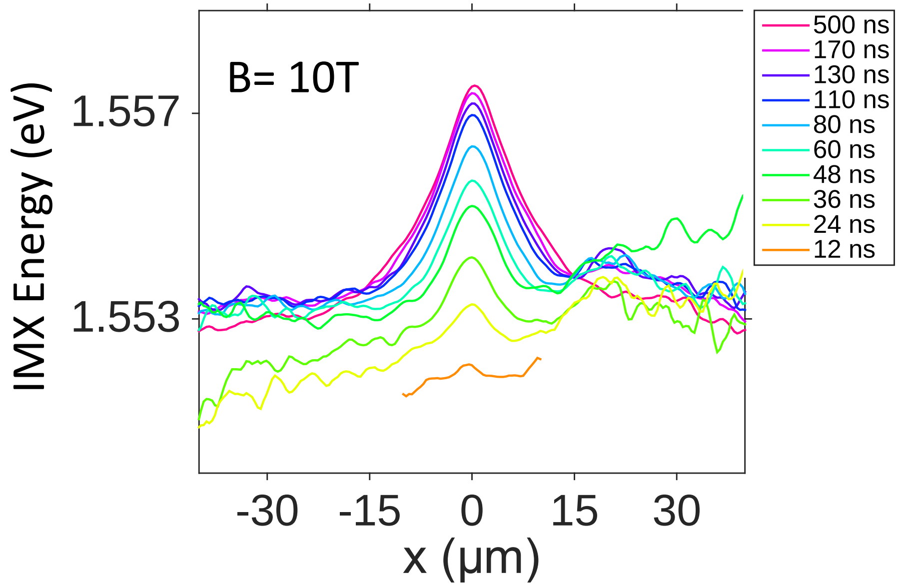
IMX lifetime for different magnetic fields

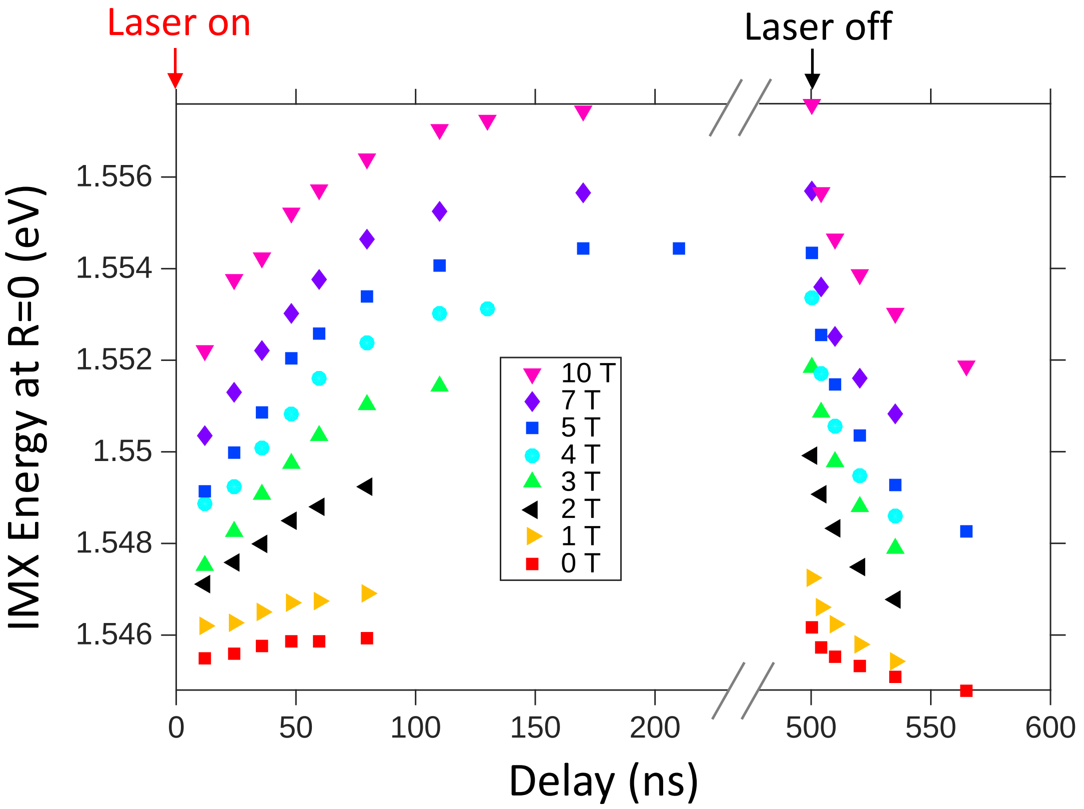


Magnetoexciton Energy Enhancement

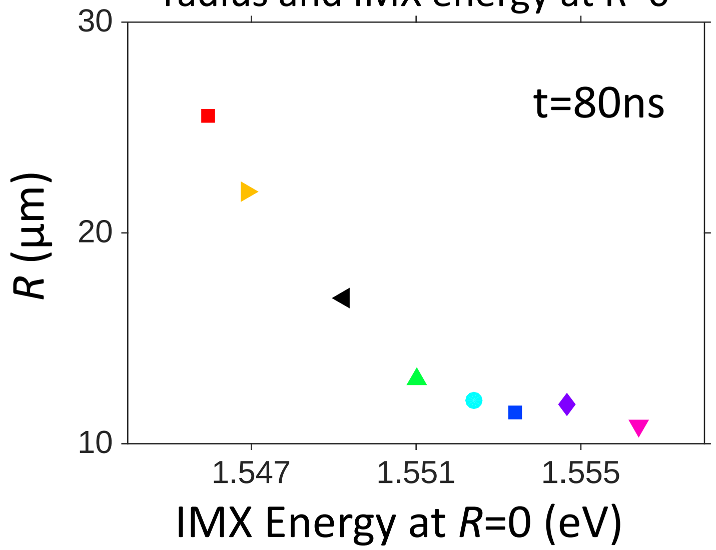


- IX transport suppression
- IX density accumulation near R = 0
- IX energy enhancement





Correlation between IMX cloud radius and IMX energy at R=0



- IX-IX interaction
- IX energy relaxation

Conclusions

-Performed first direct measurements of magnetoexciton (MX) transport

-Found that IMX diffusion coefficient is reduced with higher magnetic field

-Found correlation between IMX diffusion and energy at the origin

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