Excitation energy dependence of the exciton inner ring

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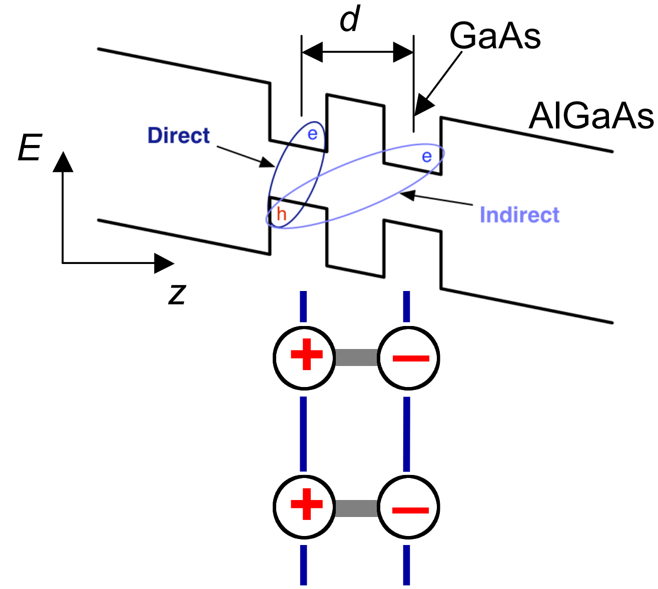
Indirect excitons

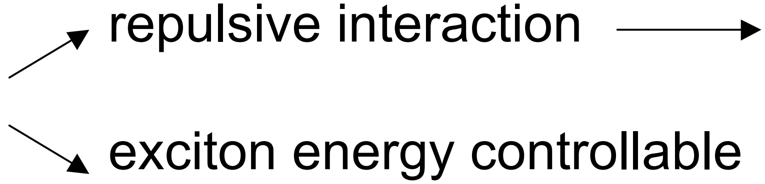


An exciton is a bound electron-hole pair.

Indirect excitons: e and *h* are confined to spatially separated quantum wells.

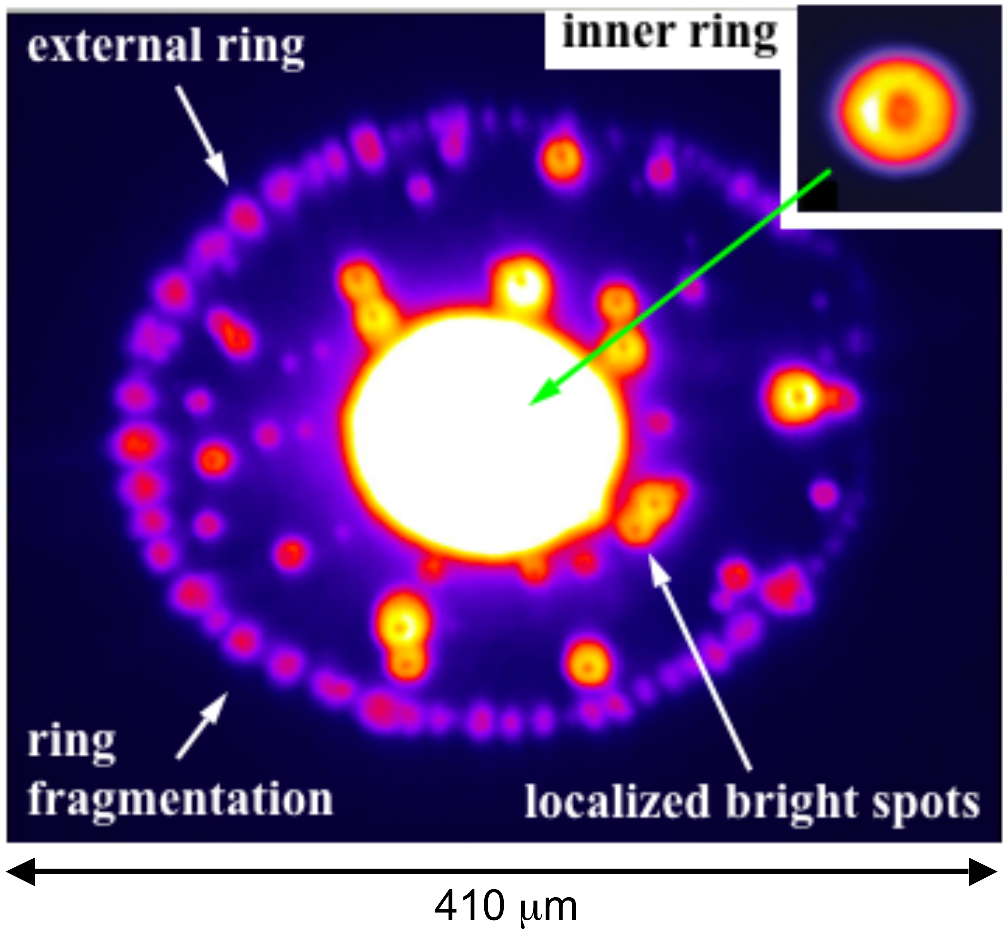
Properties of indirect excitons:

- increased lifetime and transport distance



- oriented dipoles → repulsive interaction → excitons screen disorder
- oriented dipoles → exciton energy controllable by applied voltage

Exciton pattern formation



L.V. Butov, A.C. Gossard, and D.S. Chemla, arXiv:0204482; Nature 418, 751 (2002)

New phenomena in external and LBS rings
A.A. High, Session Y15 - Fri, March 25, 10:48 AM
A.A. High, A.T. Hammack, J.R. Leonard, Sen Yang, L.V. Butov, T. Ostatnicky, A.V. Kavokin, A.C. Gossard, arXiv:1103.0321v1 (2011)

Formation of the inner ring

excitons cool as they travel
away from the excitation spot

↓

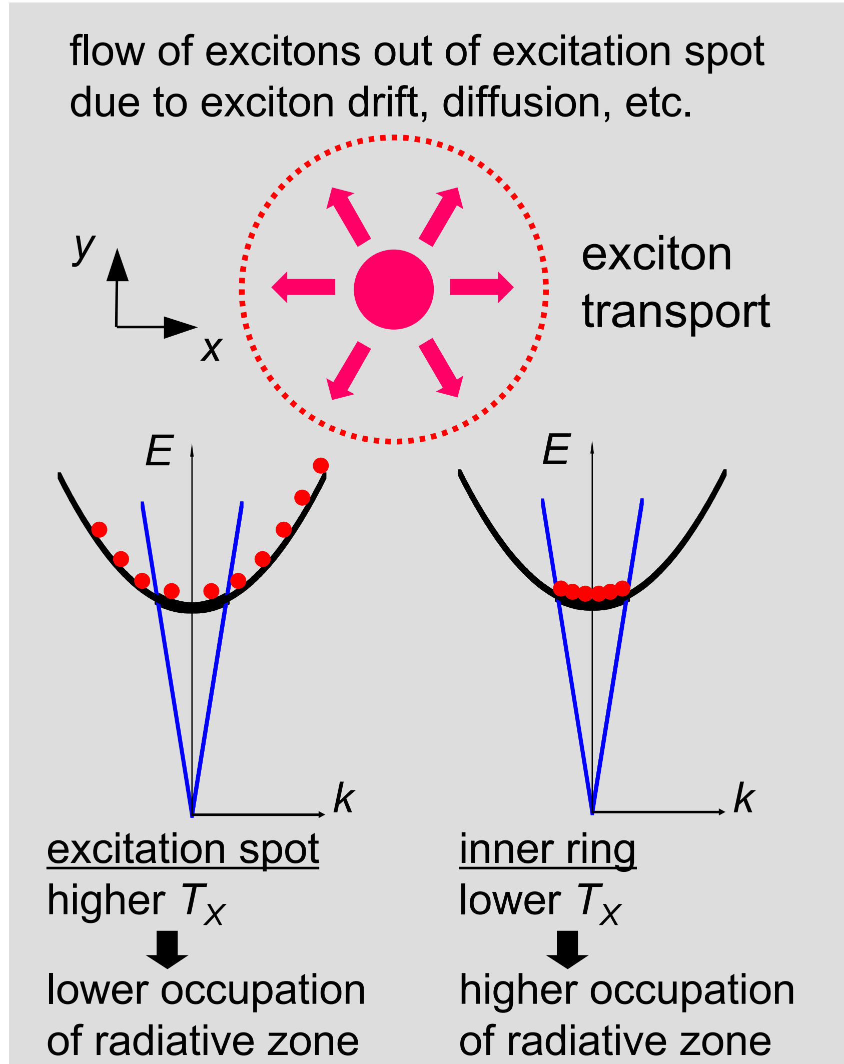
increased occupation
of radiative zone

↓

enhancement of PL intensity

↓

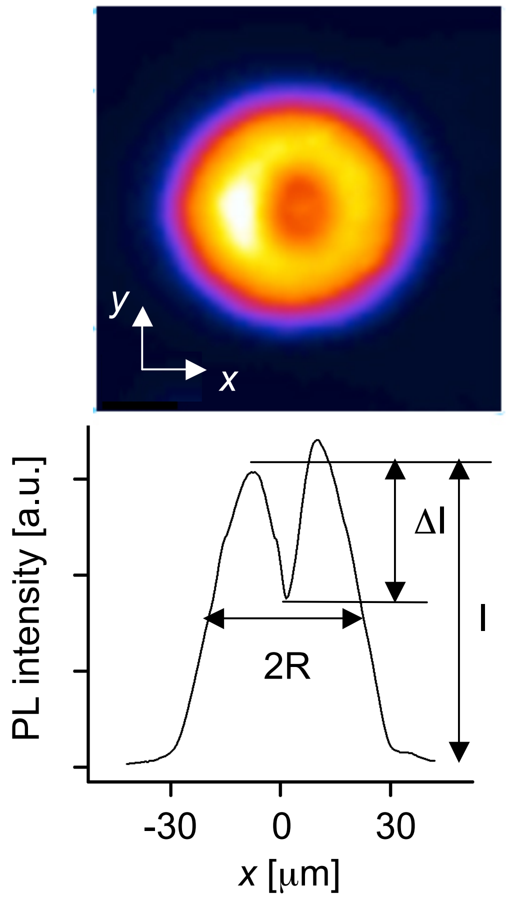
inner ring

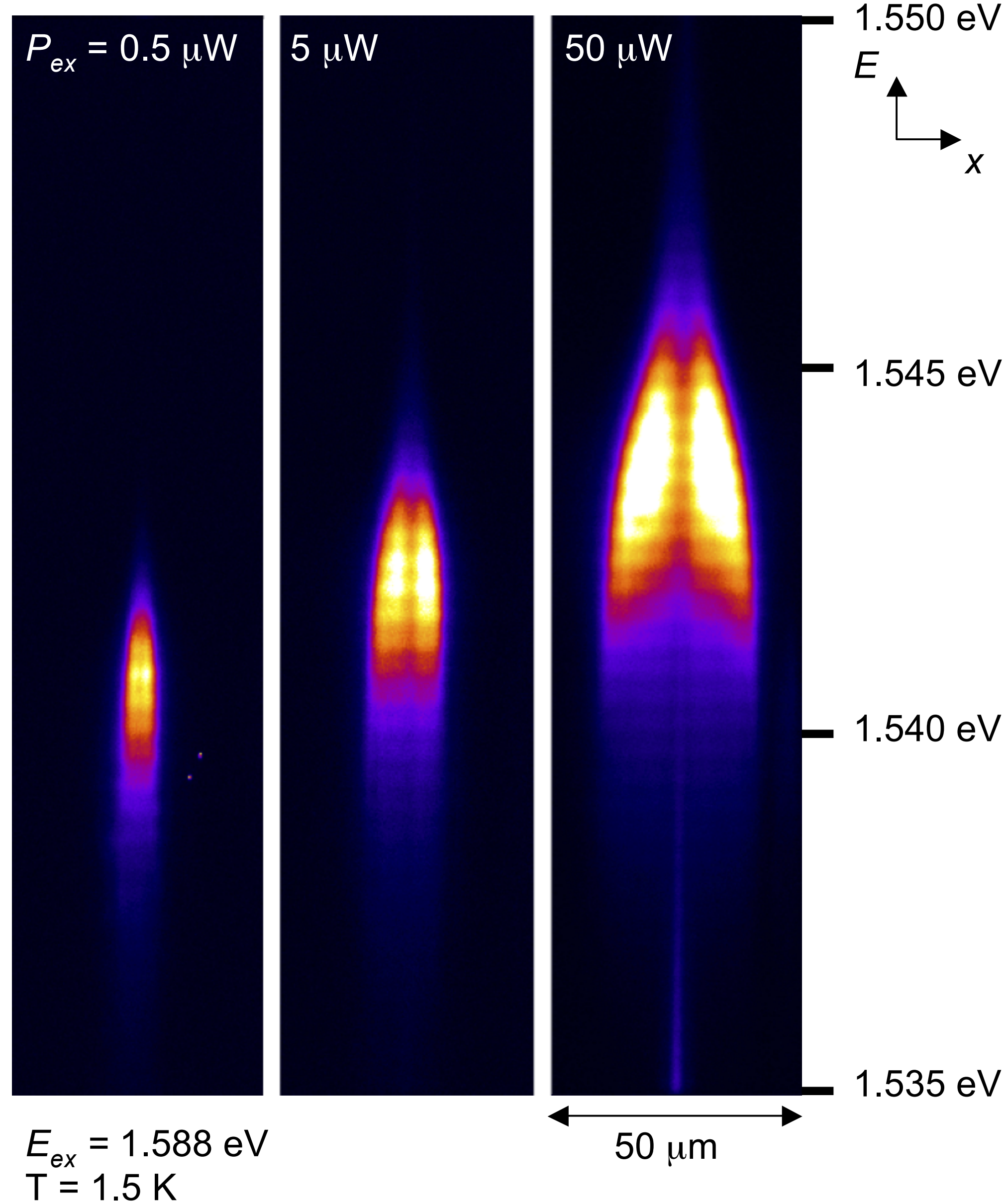


A.L. Ivanov, L.E. Smallwood, A.T. Hammack, Sen Yang, L.V. Butov, A.C. Gossard, arXiv:0509097 (2005); EPL 73, 920 (2006)

A.T. Hammack, L.V. Butov, J. Wilkes, L. Mouchliadis, E.A. Muljarov, A.L. Ivanov, A.C. Gossard, arXiv:0909.0790v1, PRB 80, 155331 (2009)

Exciton inner ring

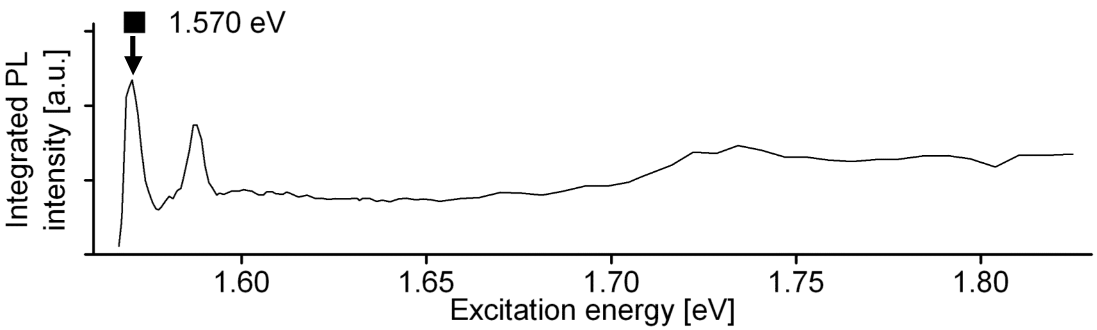


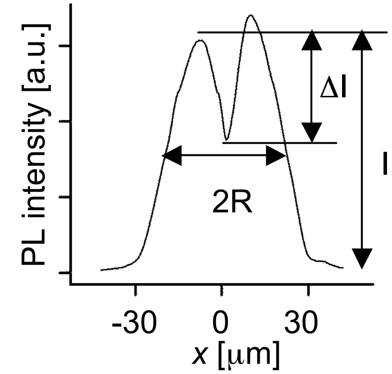


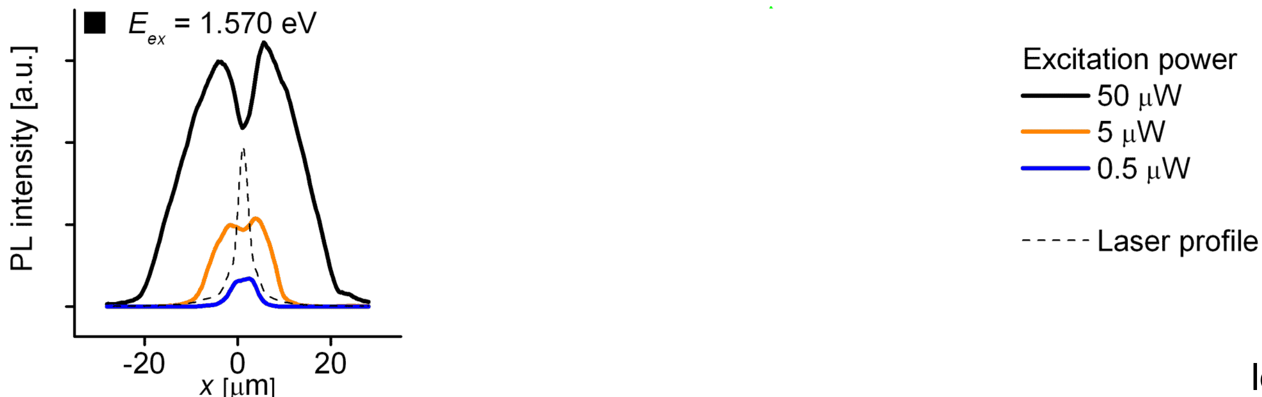
R - measure of exciton transport

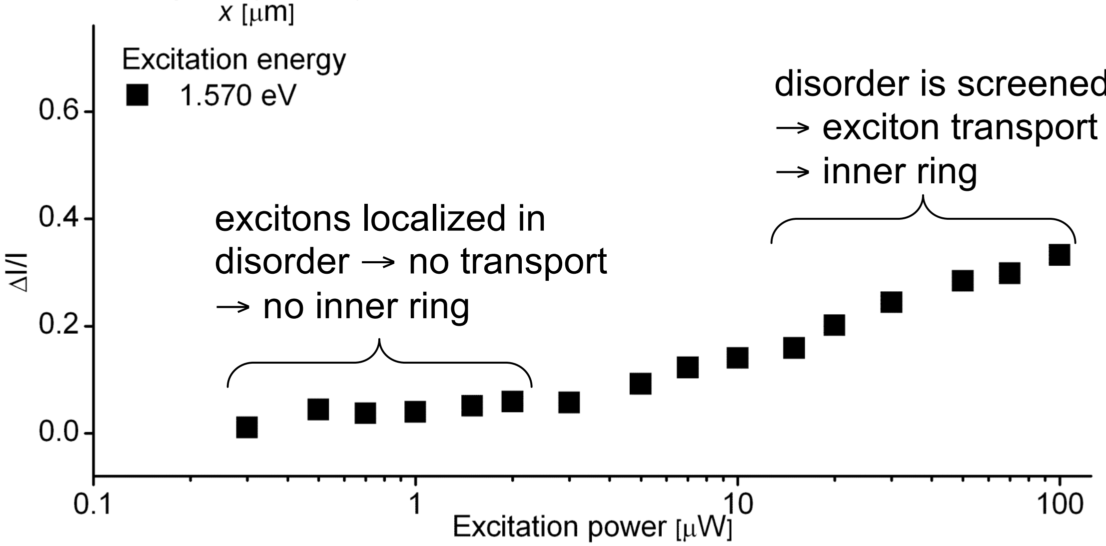
ΔI/I - measure of laser-induced heating of excitons

Excitation power dependence of the inner ring







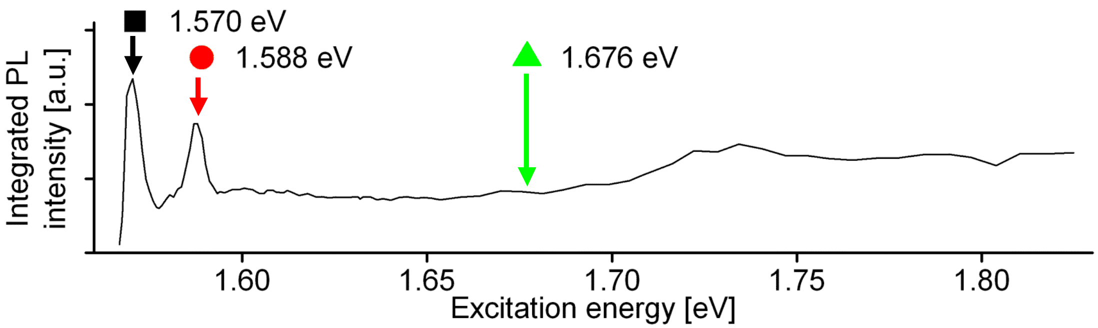


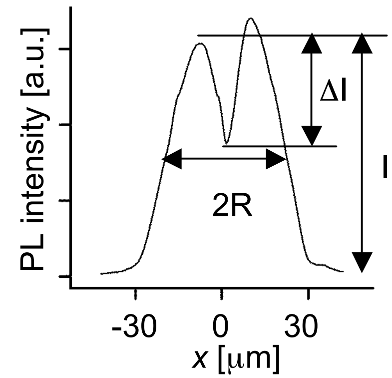
localization-delocalization transition (LDT) in disorder potential

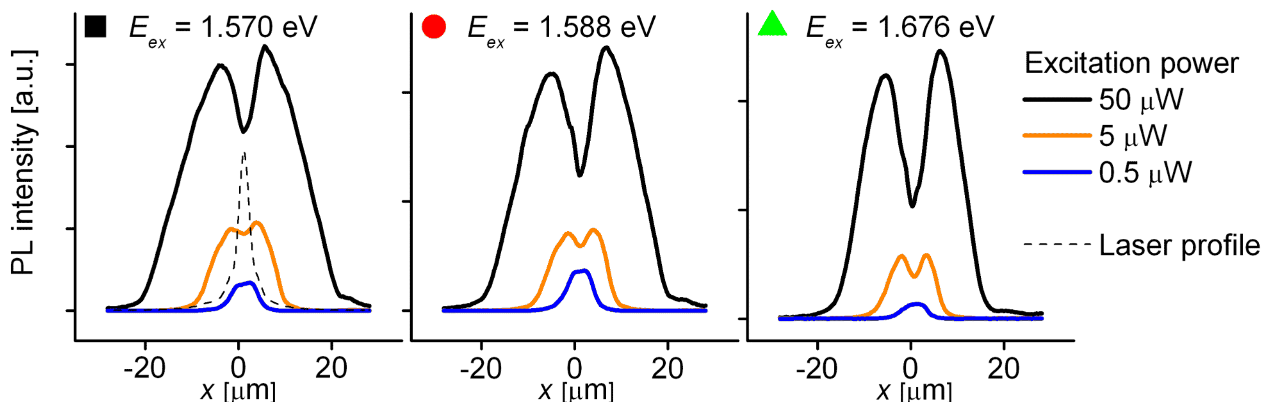
dLDT in conveyers
J.R. Leonard, Session P32
Wed, March 23, 10:24 AM

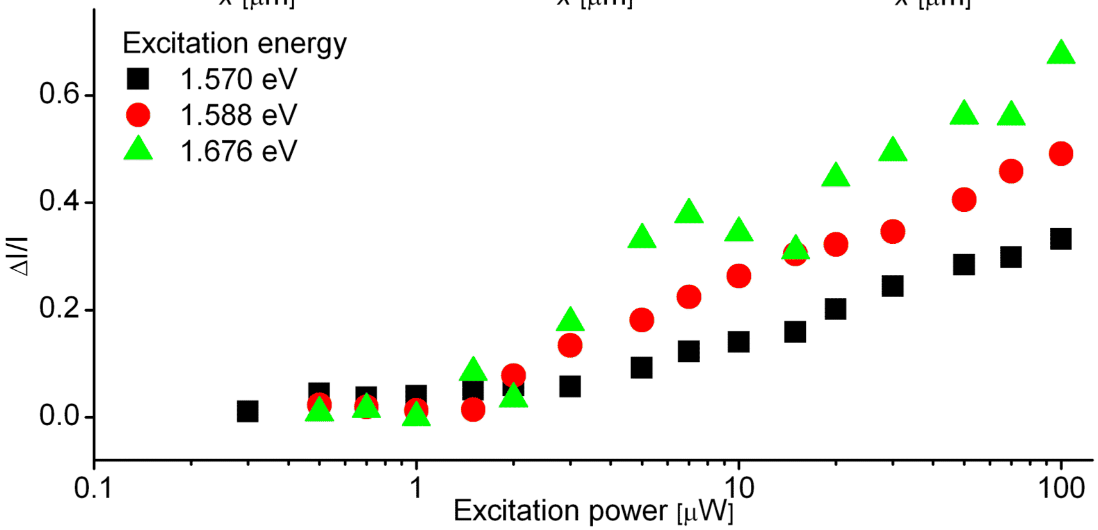
LDT in lattices
M. Remeika, Session W12
Thurs, March 25, 1:03 PM

Excitation power & energy dependence of the inner ring







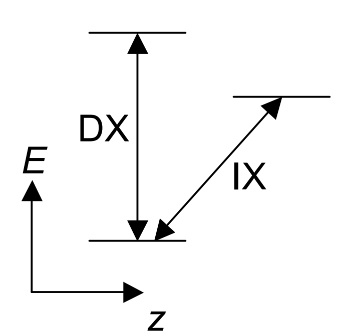


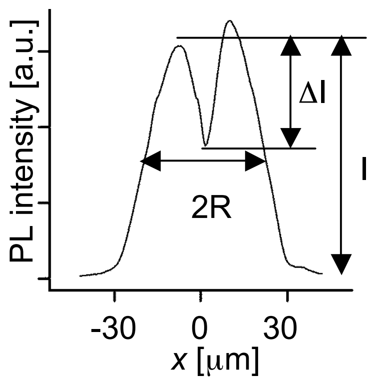
heating of exciton gas in the excitation spot increases with excitation energy

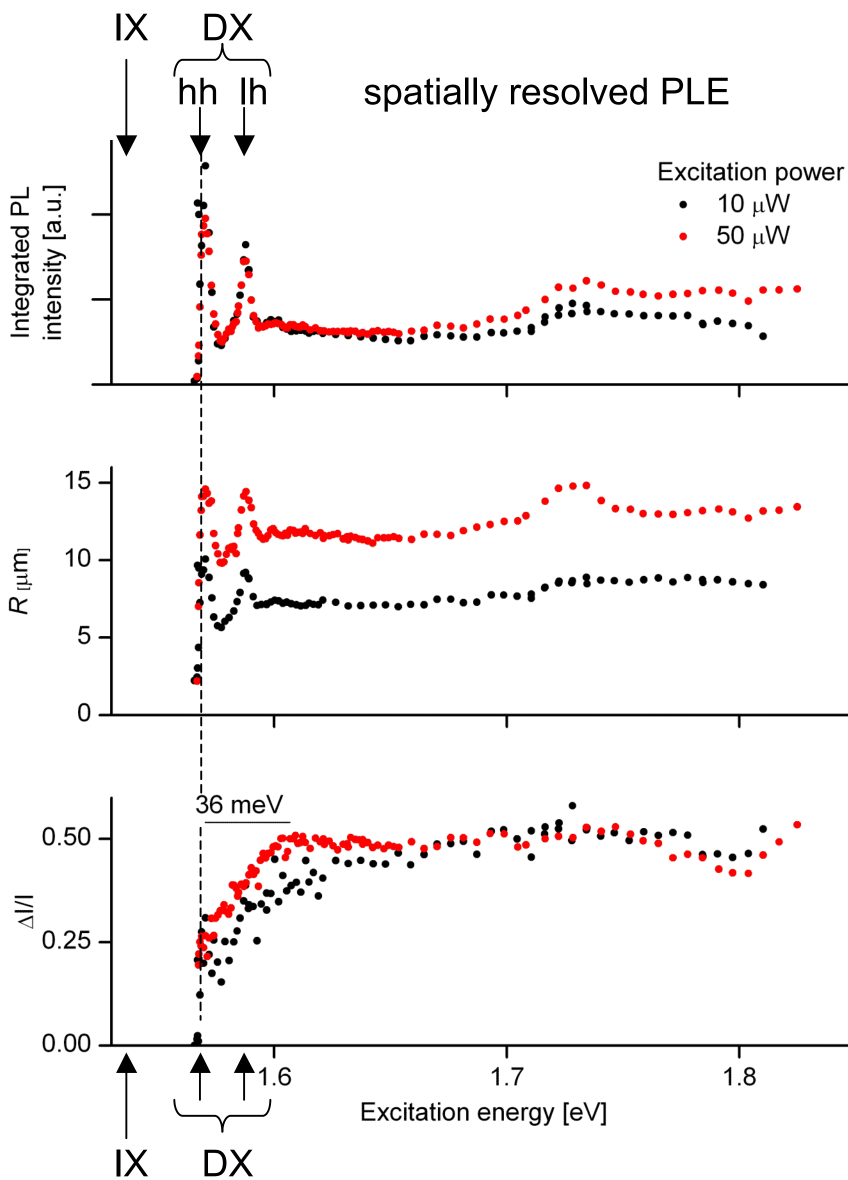
↓

contrast of the inner ring increases with excitation energy

Excitation energy dependence of the inner ring







increase of absorption coefficient at heavy hole and light hole resonances

↓

higher exciton density

↓

higher integrated PL intensity

higher exciton density

↓

better disorder screening by excitons

↓

larger exciton transport distance

↓

larger ring radius R

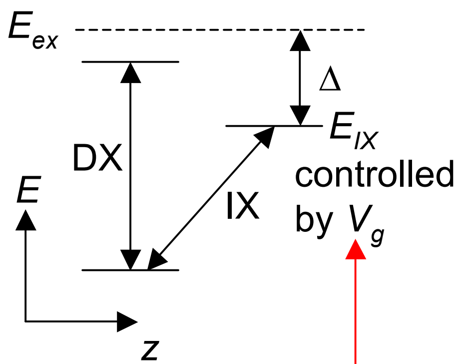
exciton heating is suppressed when E_{ex} decreases

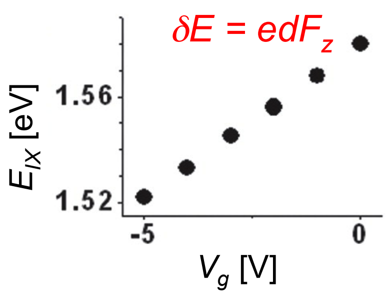
↓

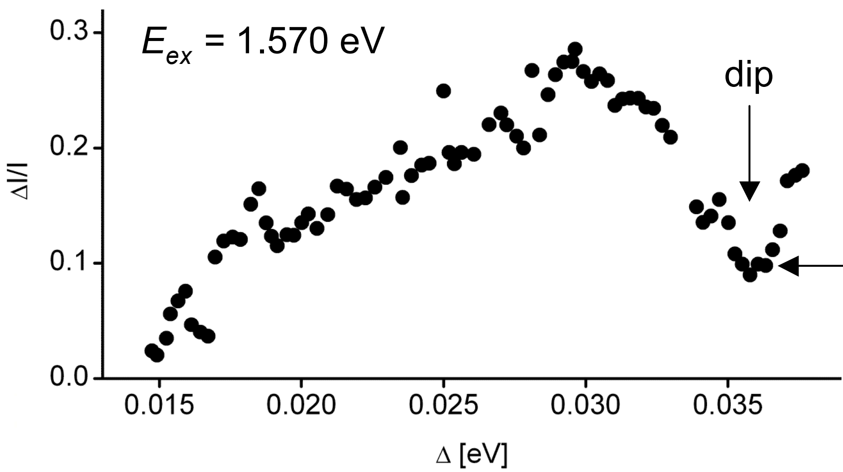
generation of cold excitons at excitation at DX hh resonance

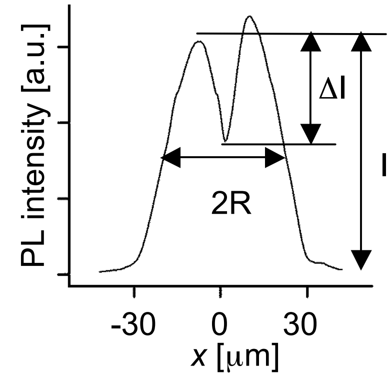
R and $\Delta I/I$ are approximately constant at high E_{ex} ($E_{ex} - E_{DX} \gtrsim \hbar\Omega_{LO}$)

Excitation energy and exciton energy dependence of the inner ring



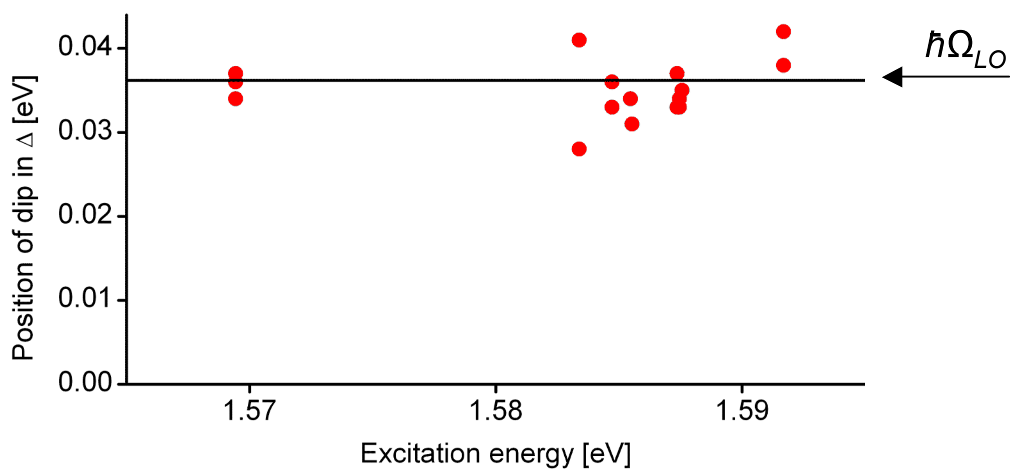






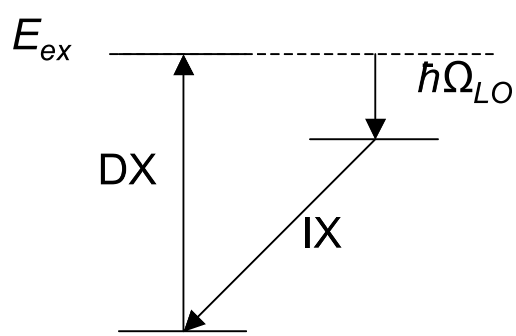
increase in energy relaxation rate at E_{ex} - E_{IX} ≈ $\hbar\Omega_{LO}$

low signal to noise
→ weak effect



Cold exciton excitation scheme:

- excitation to DX → high absorption coefficient
- E_{ex} - E_{IX} = $\hbar\Omega_{LO}$ → faster cooling
- long lifetime of IX → accumulation of cold
  and dense exciton gas



Conclusion

- Studied excitation energy dependence of the exciton transport and cooling using spatially resolved PLE of the inner ring

- Excitation by low-energy laser light tuned to the direct exciton resonance effectively suppresses the laser-induced heating of indirect excitons