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High-energy electronic excitations in nanoparticles of lanthanide phosphates

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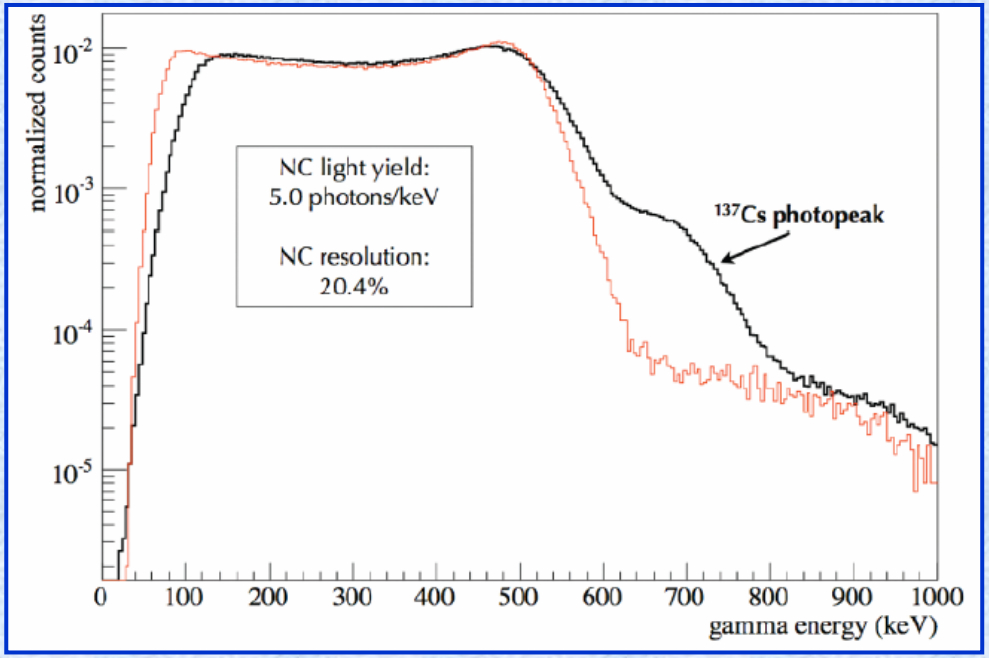
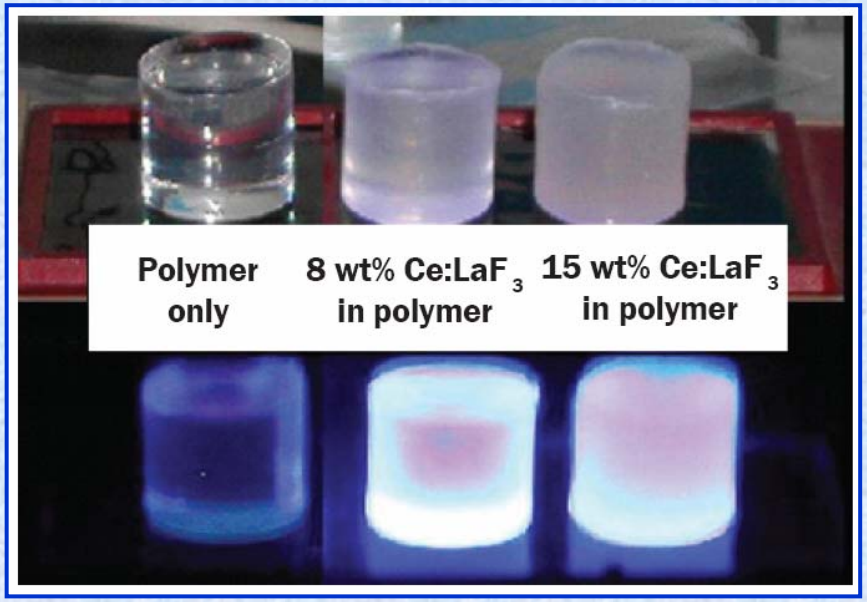
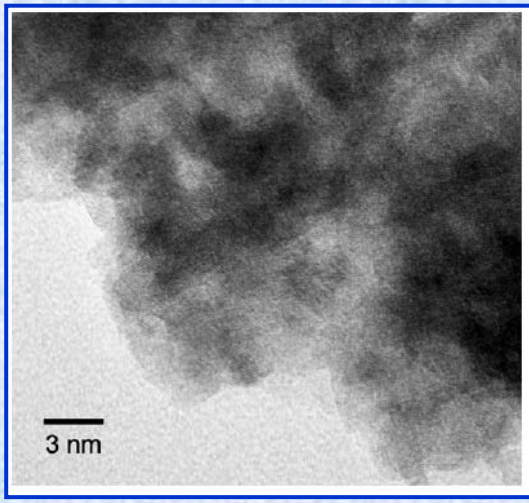
Nanocomposite scintillators





R. E. Del Sesto, E. A. McKigney. et al. Development of nanocomposite scintillators / Materials Research Highlight, 2007



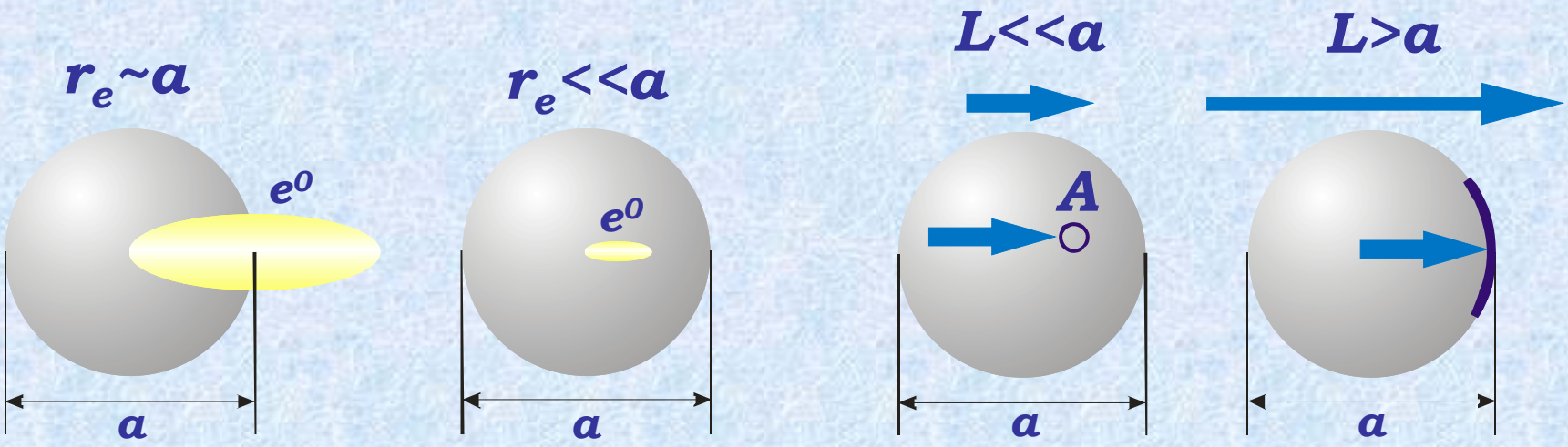
Contents

- Size effects in nanoparticles
- Recombinational luminescence
- STE emission in $LaPO_4$
- Hole recombinational luminescence of $LaPO_4$-Eu
- Electron recombinational luminescence of $LaPO_4$-Pr

Luminescent properties and nanoparticle size

r_e – *free exciton radius*

L – *electron (hole) free path*



Confinement effect
Blue shift of absorbtion edge

Large particle
~ 100 nm

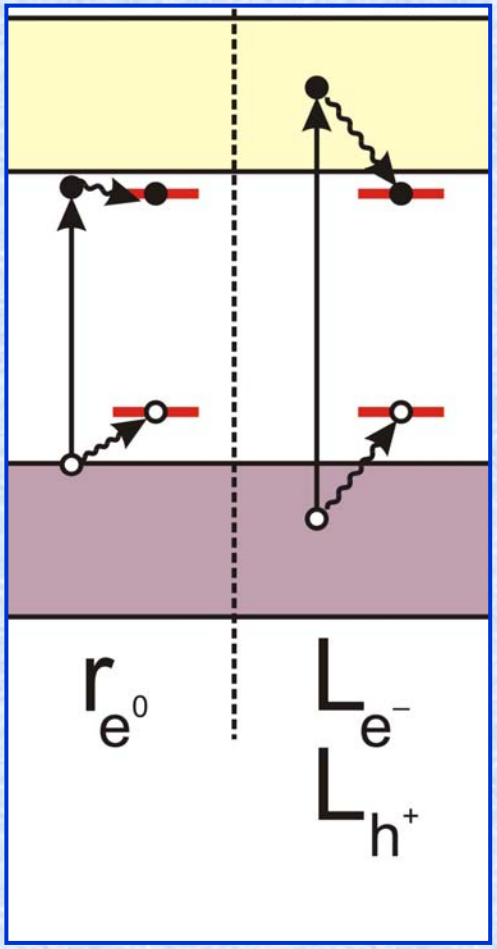
Small particle
~ 20 nm

Recombination processes

Luminescence of excitons

Optical creation of excitons

Recombinational creation of excitons



r_e – exciton radius,

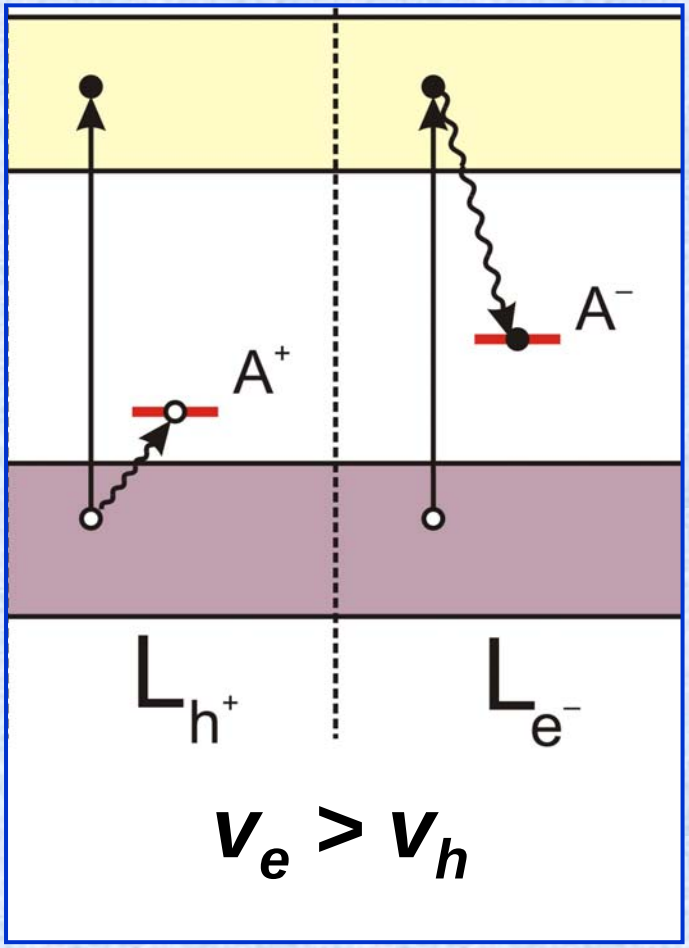
L_e – free path of photoelectron,

L_h – free path of photohole

Luminescence of impurities

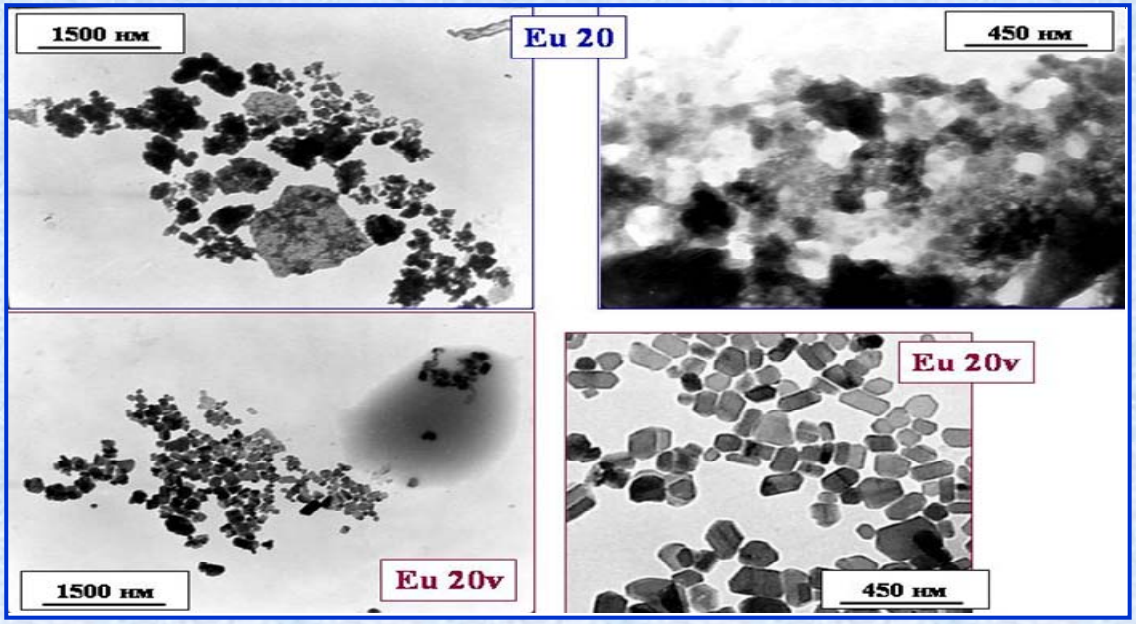
Electron recombination

Hole recombination

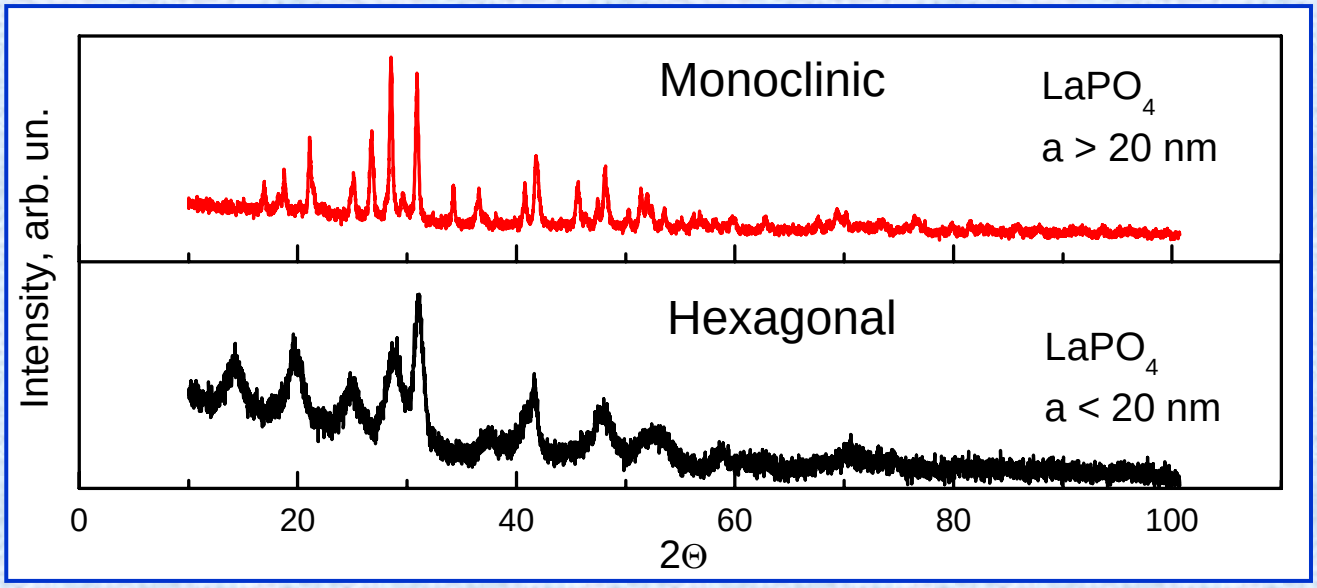


$LaPO_4$

Structure of $LaPO_4$ nanoparticles

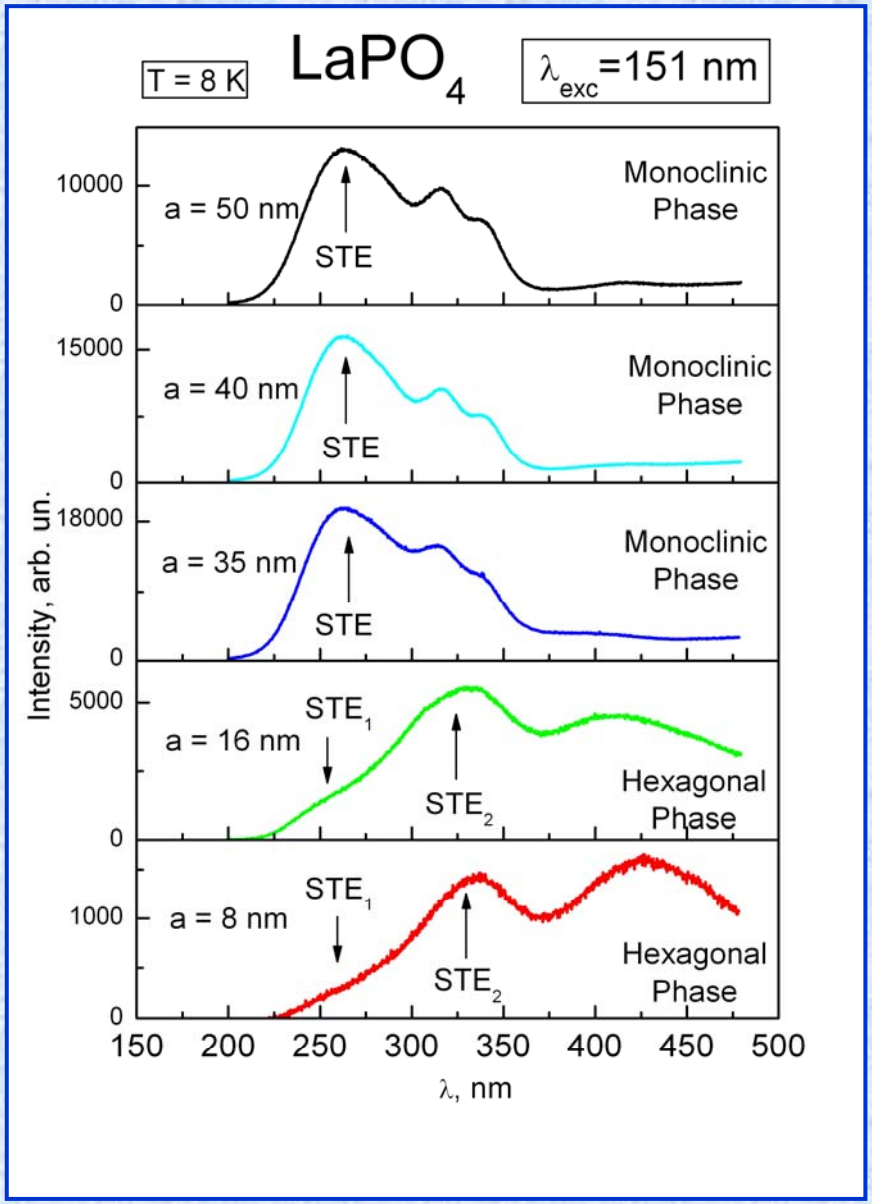


TEM imaging

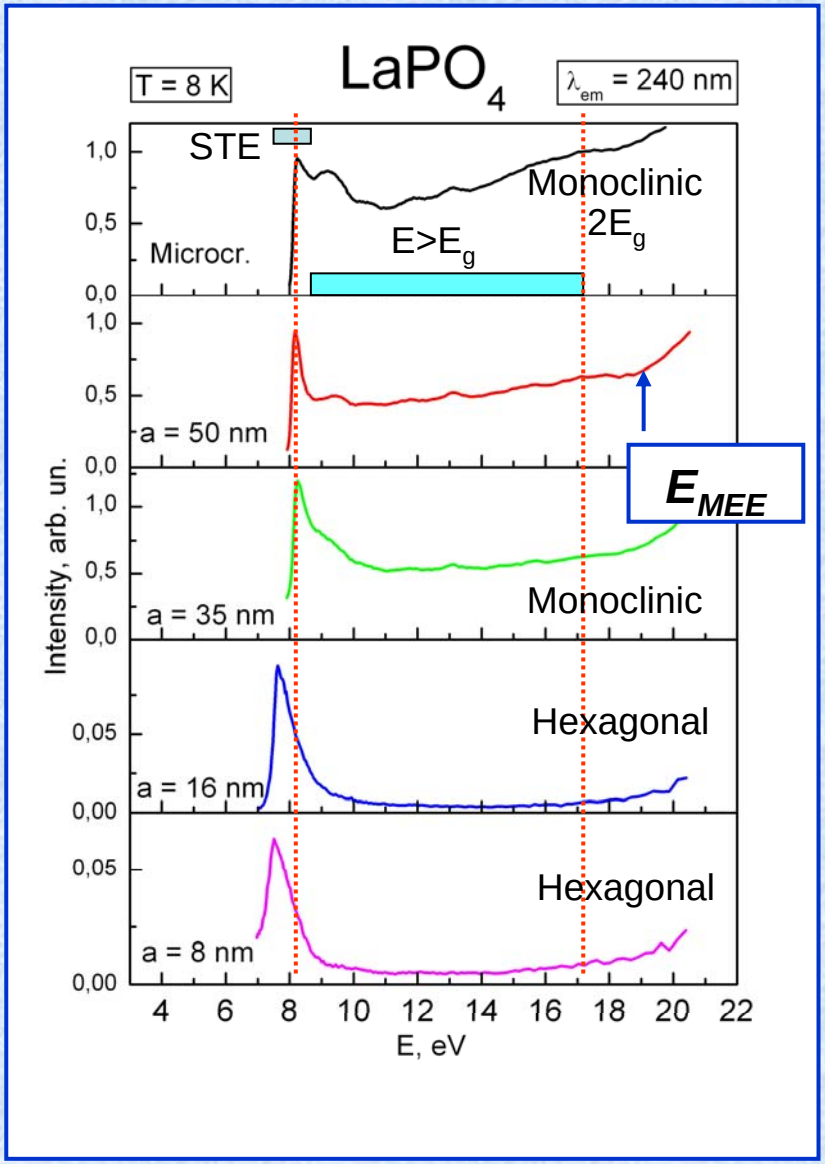


X-ray diffraction

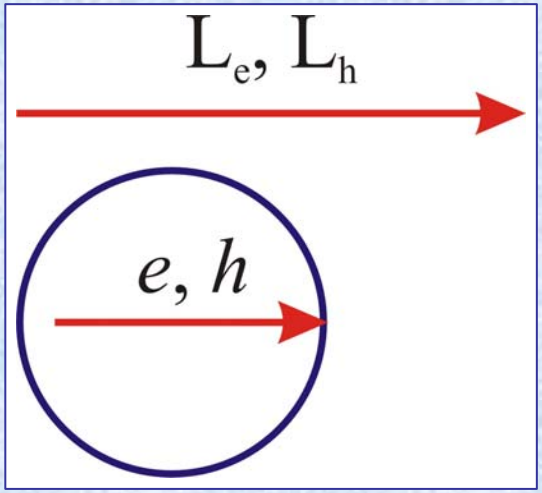
Luminescence of $LaPO_4$ nanoparticles



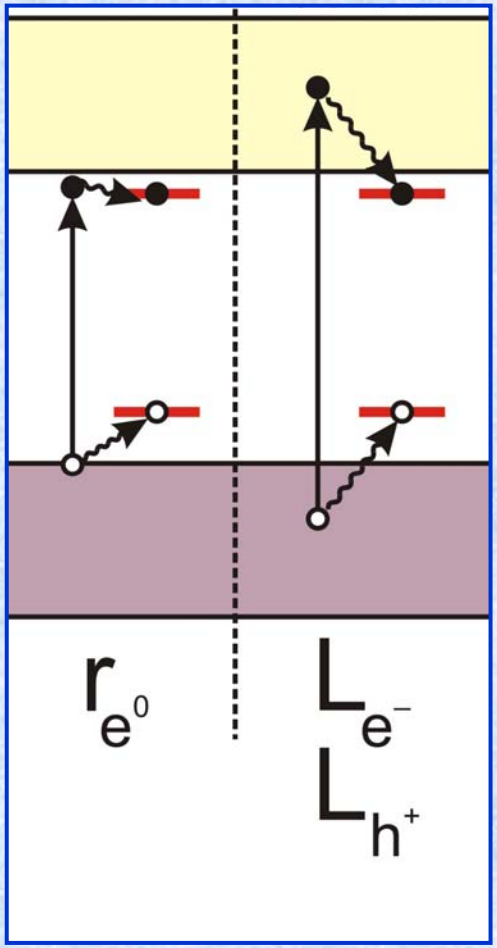
Luminescence excitation spectra of intrinsics emisssion in $LaPO_4$ nanoparticles



Optical creation of excitons

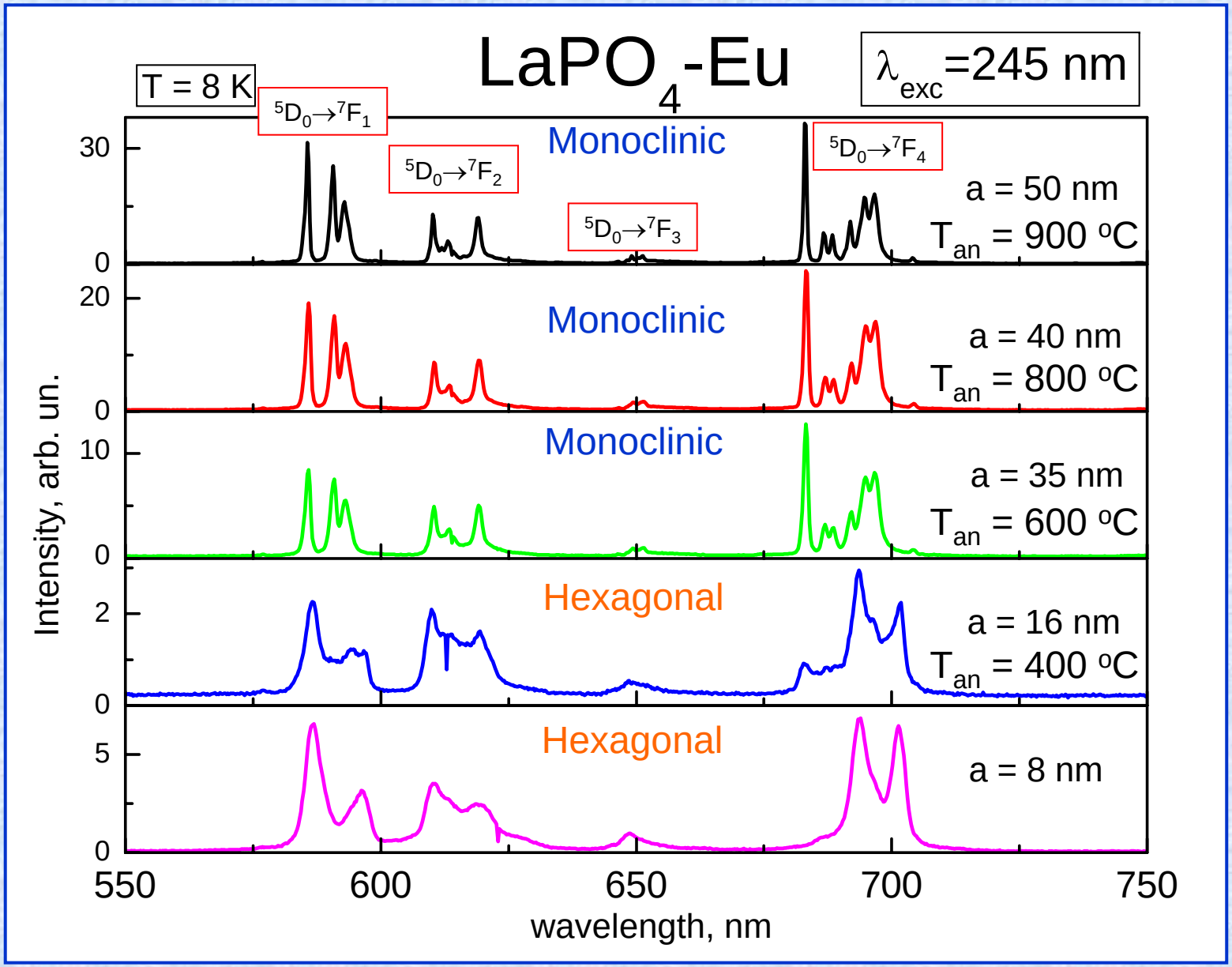


Recombinational creation of excitons

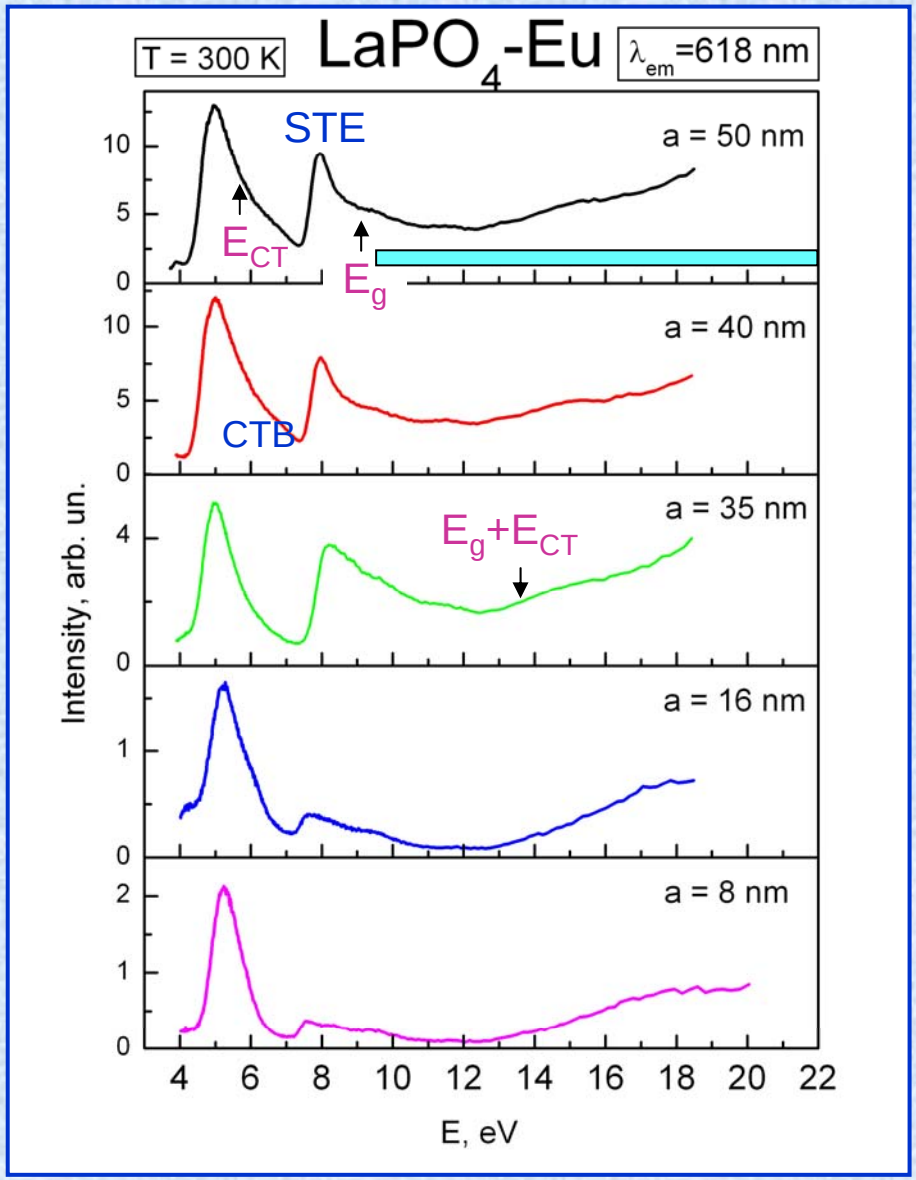


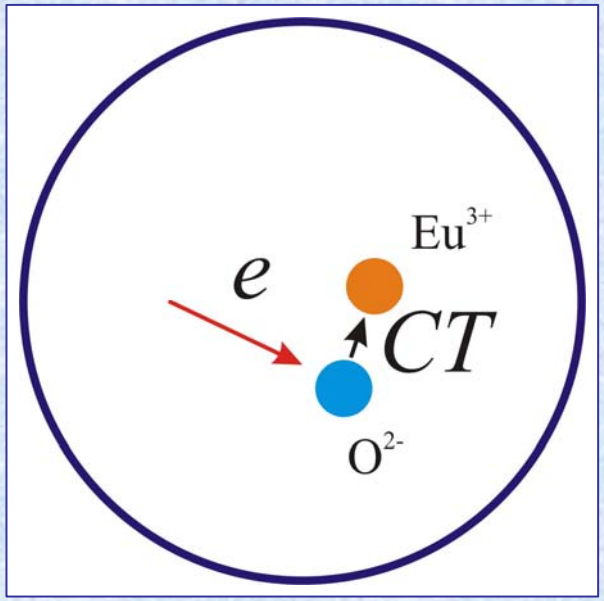
$LaPO_4$-Eu

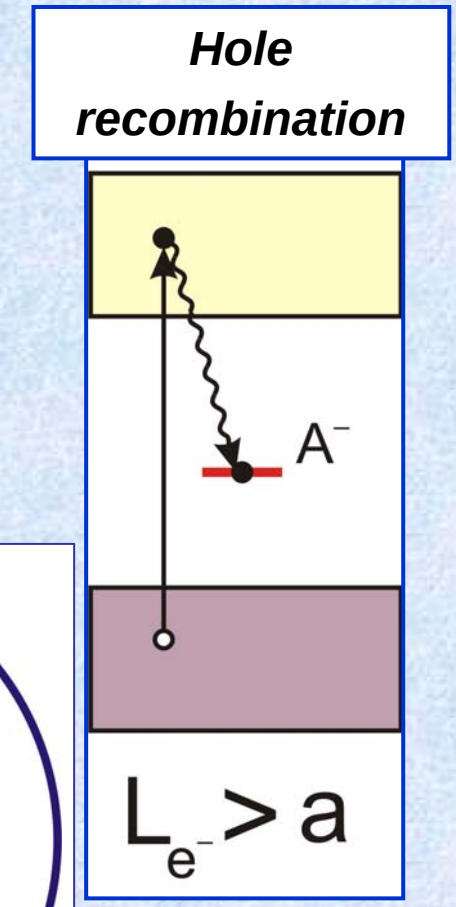
Emission of $LaPO_4$-Eu nanoparticles



Luminescence excitation spectra of europium luminescence in $LaPO_4$-Eu nanoparticles

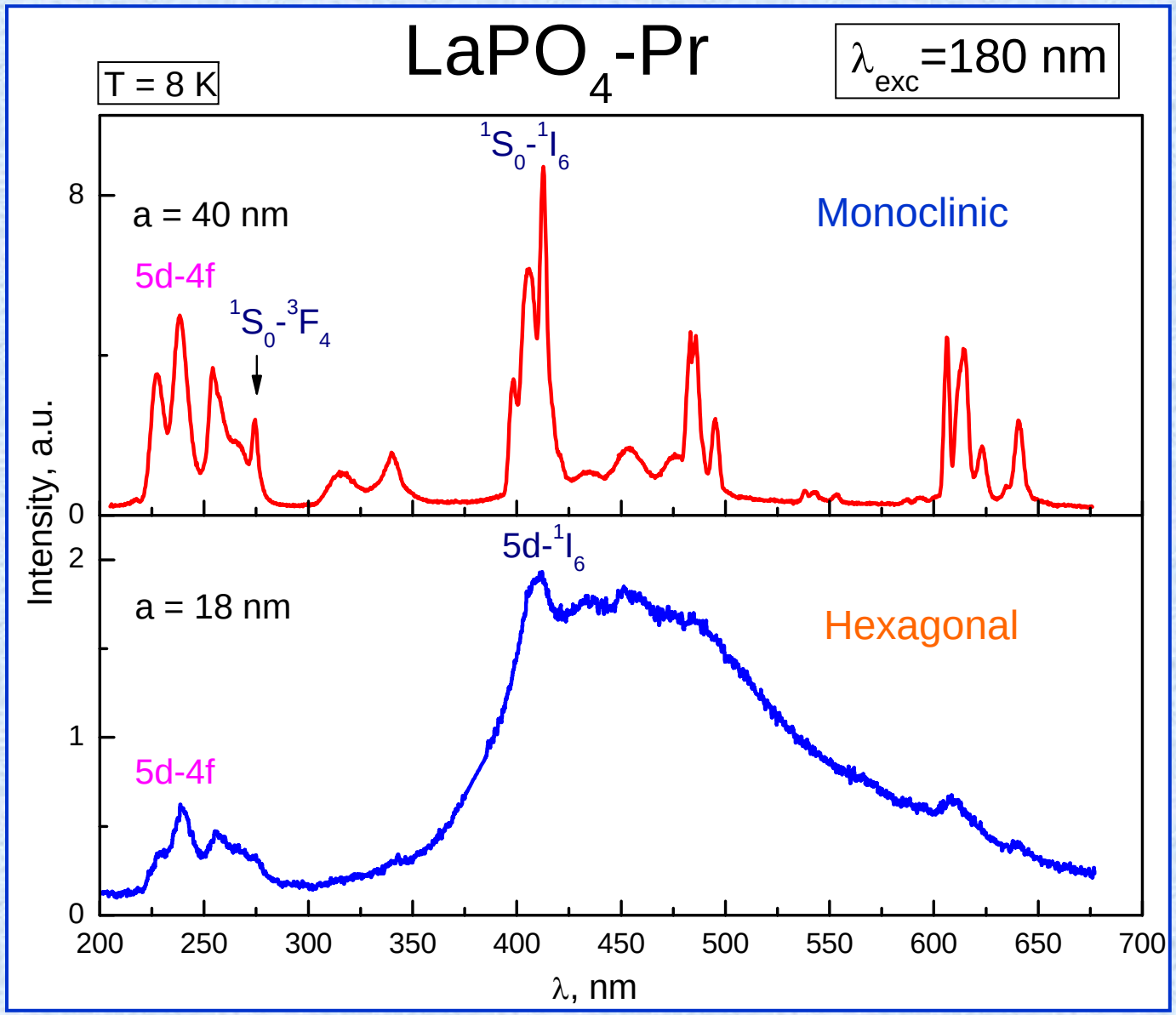


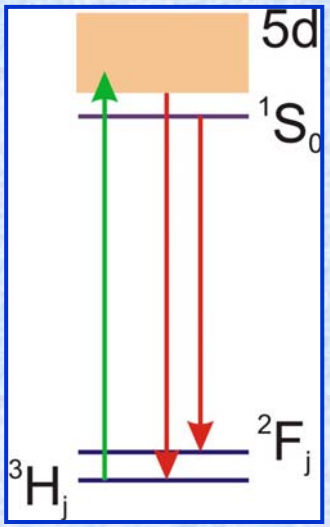


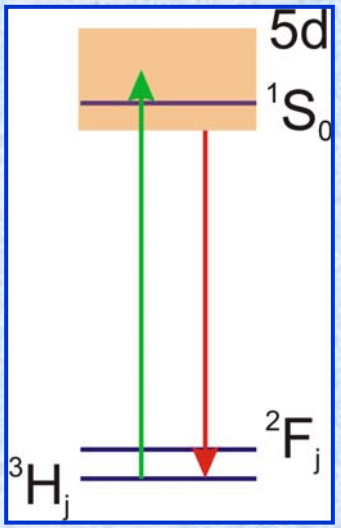


$LaPO_4$-Pr

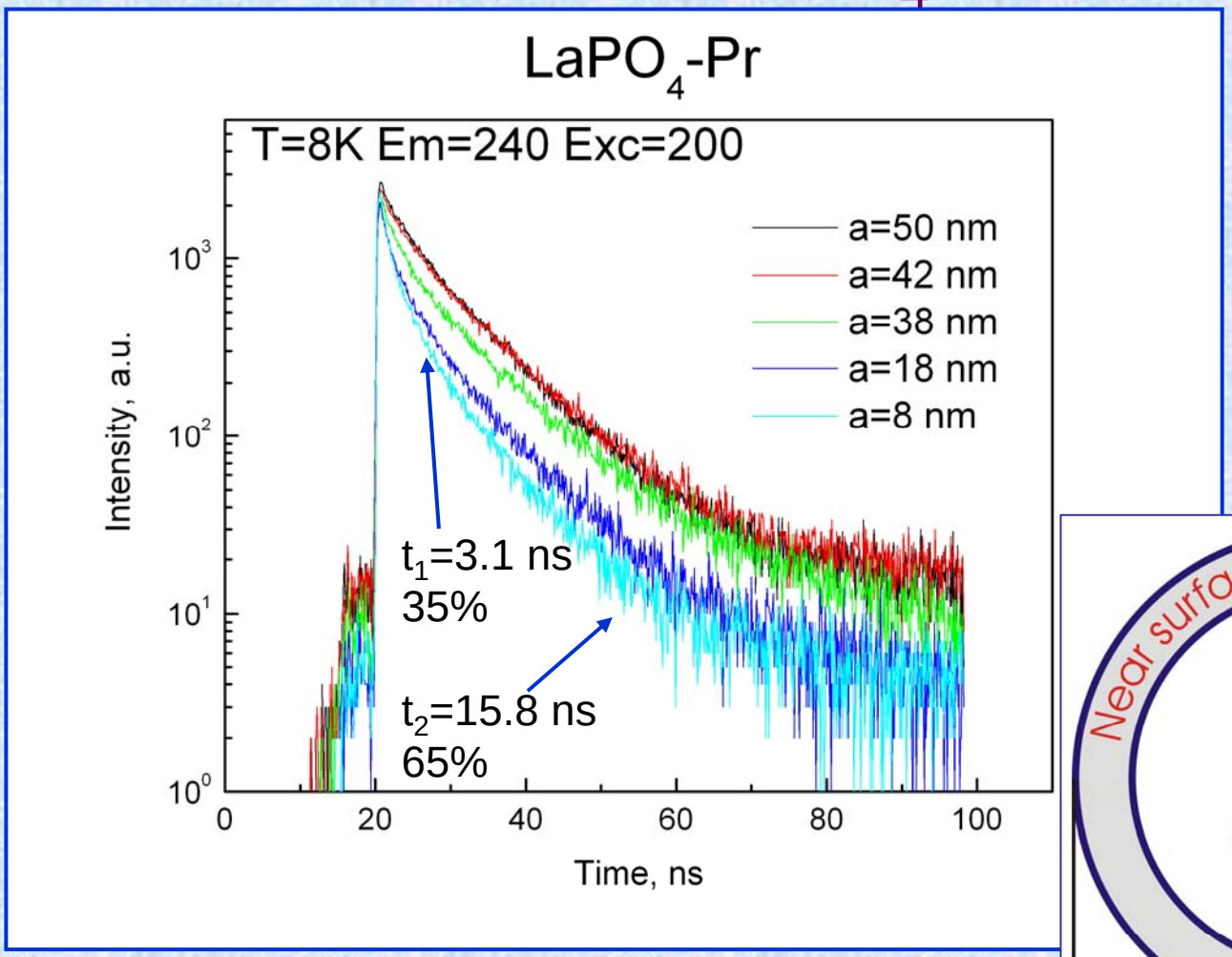
5d-4f and 4f-4f emission of $LaPO_4$-Pr

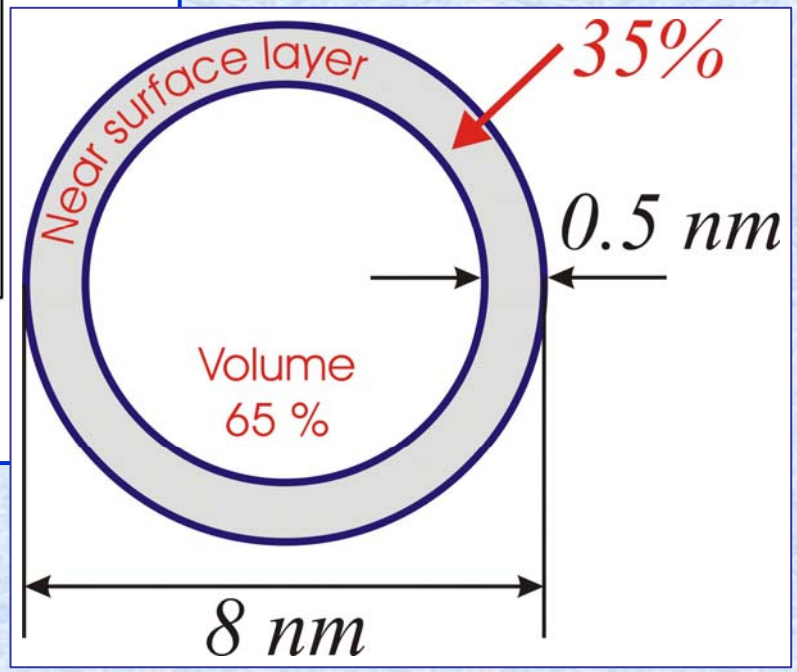




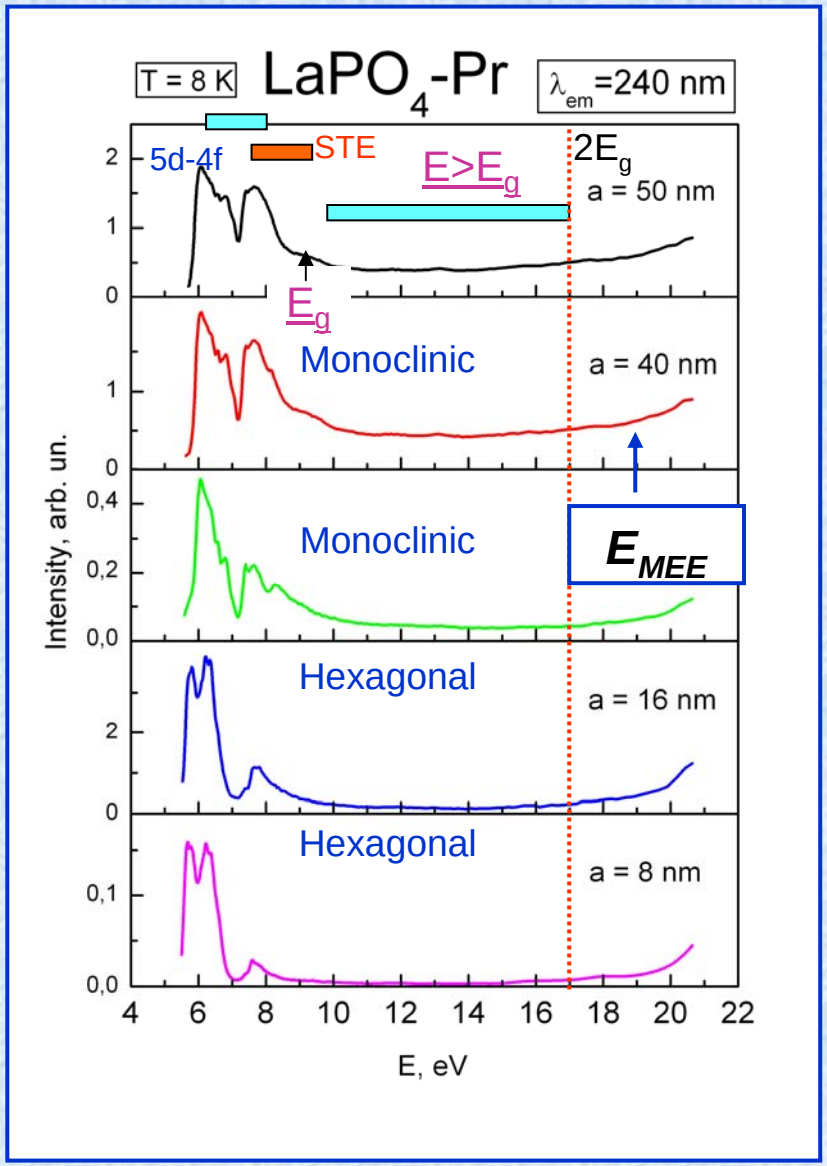


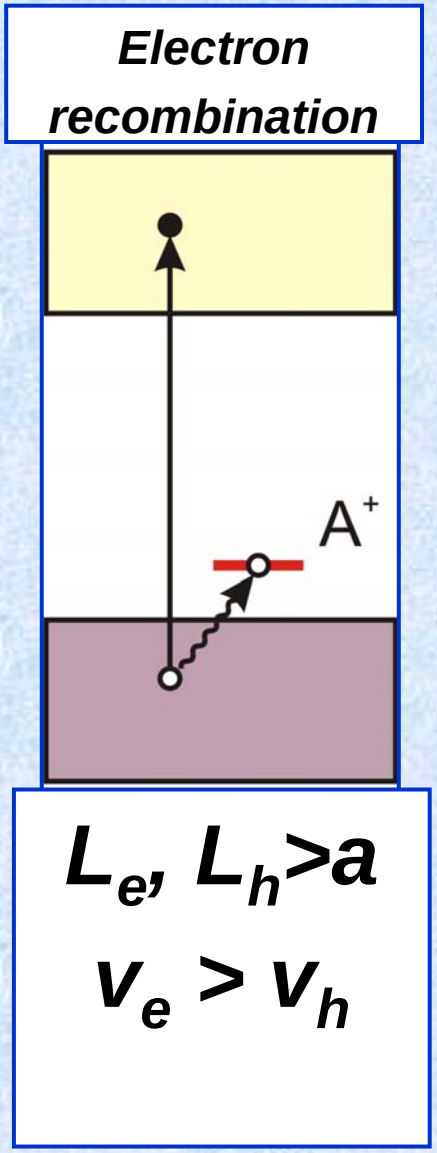
Luminescence decay kinetics of 5d-4f-emission in $LaPO_4$-Pr nanoparticles



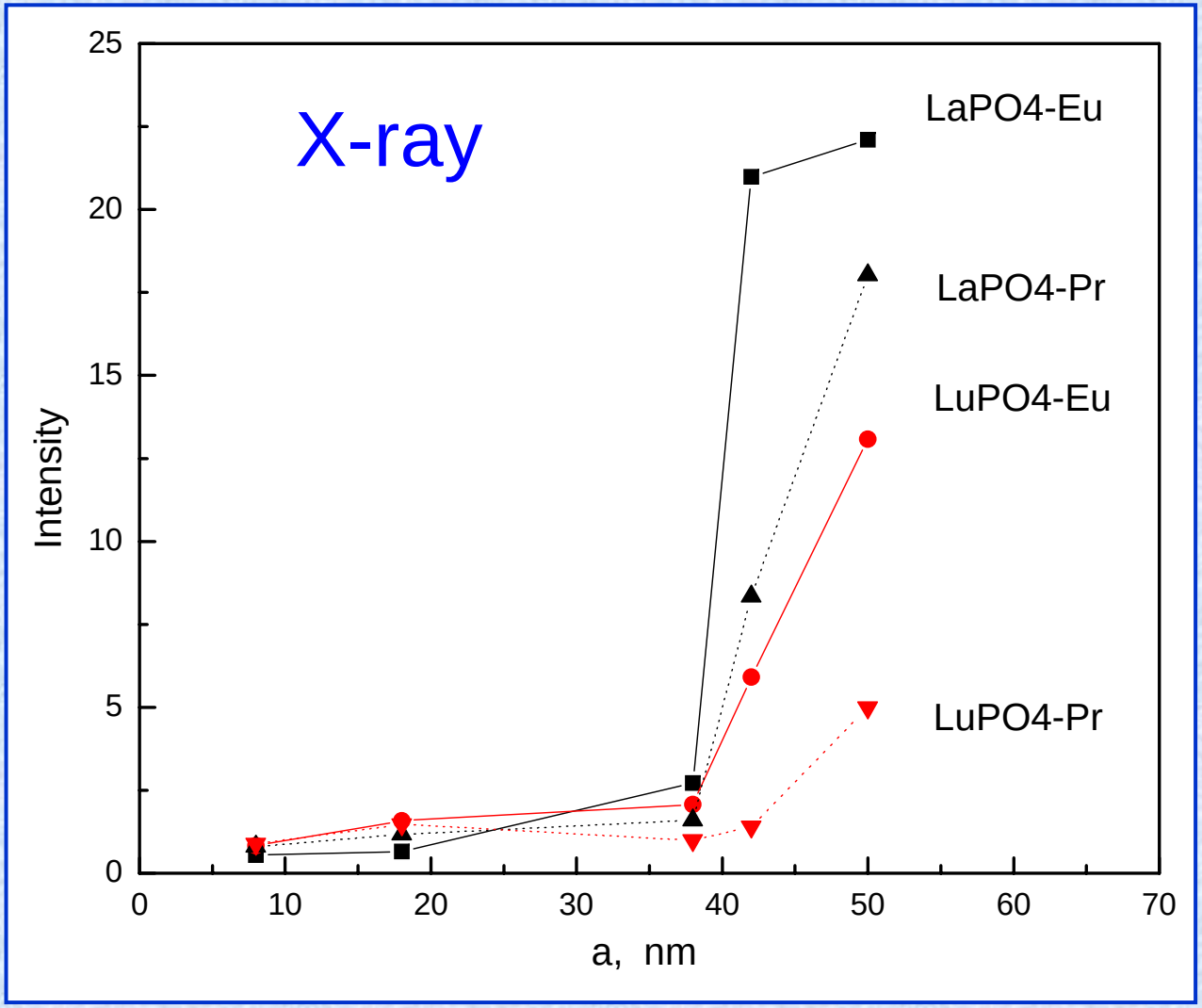


Luminescence excitation spectra of $LaPO_4$-Pr nanoparticles





X-ray excited luminescence of nanoparticles



Conclusions

1. The intensity of intracentre luminescence and optically created self trapped exciton depends slowly on nanoparticle size.

2. The common regularity is the increasing of the luminescence intensity due to non radiative losses on surface defects

3. In the range of band to band transitions the ratio between nanoparticle size and photoelectron free path is determinative. The exceeding of free photoelectron path the nanoparticle size leads to strong decreasing of luminescence intensity.

4. At high energy excitation the impact ionization of oxygen with following electron transfer to europium is realized.

5. Multiplication of electron excitation due to inelastic scattering on valence electrons takes place in nanoparticle.

Thank you!