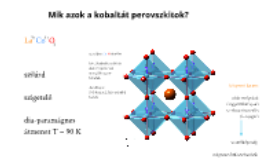
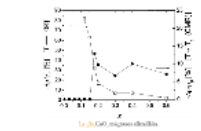
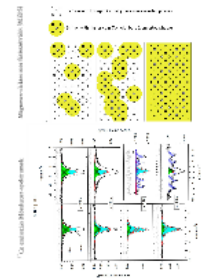
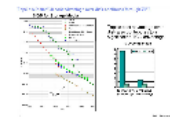
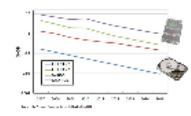
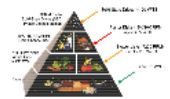
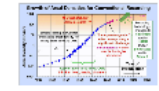


Dr. Péter Kovács



Dr. Péter Kovács
 Dr. Zoltán Bor
 Dr. Péter Kovács



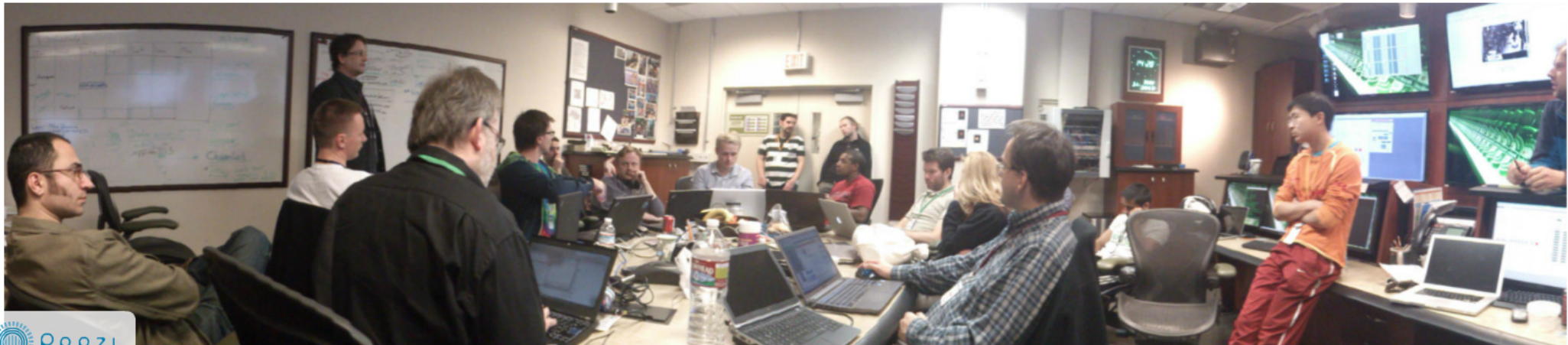
Köszönöm a figyelmet!

Quo vadis, merevlemez?

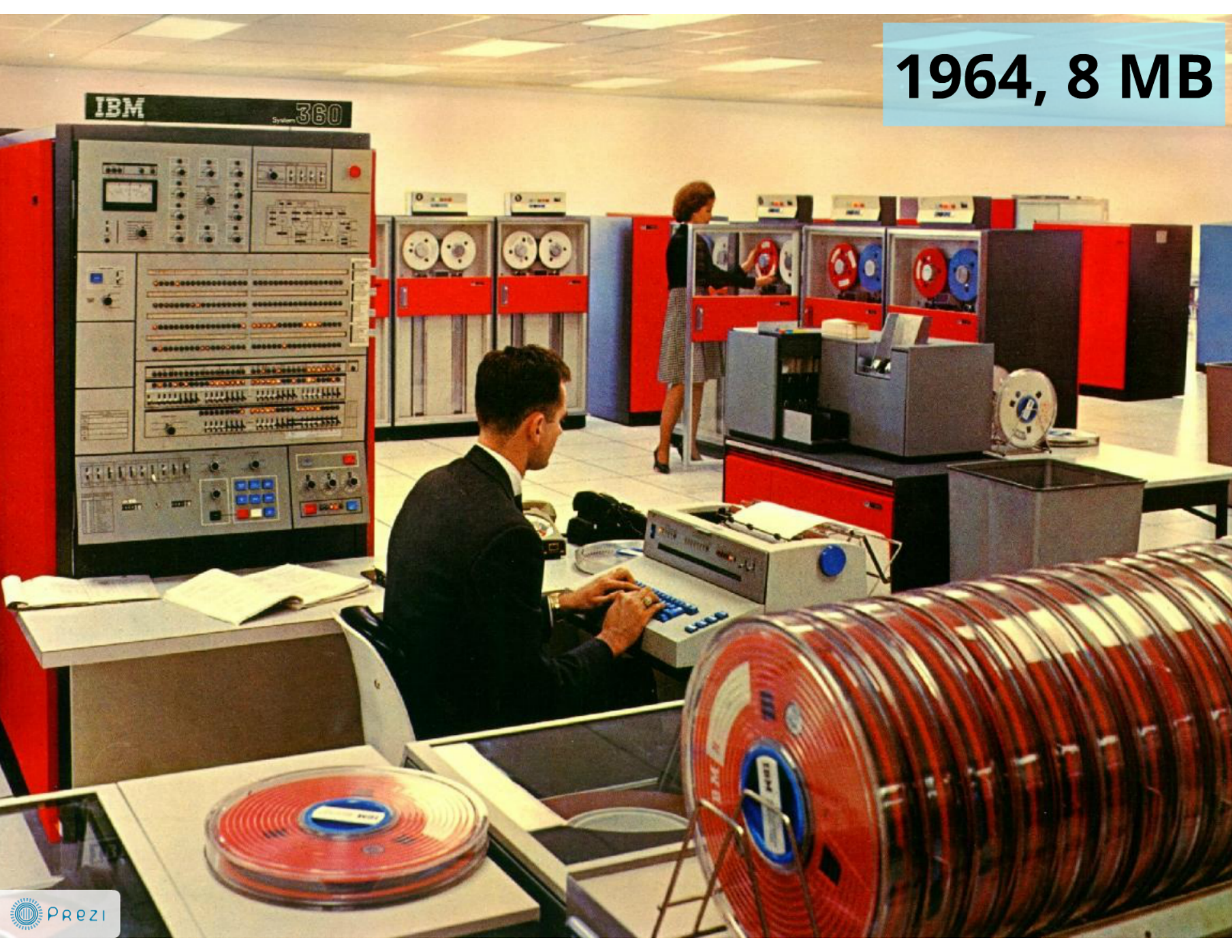
Németh Zoltán

MTA Wigner FK
RMI Nukleáris Anyagtudomány Osztály
Röntgenspektroszkópia Csoport





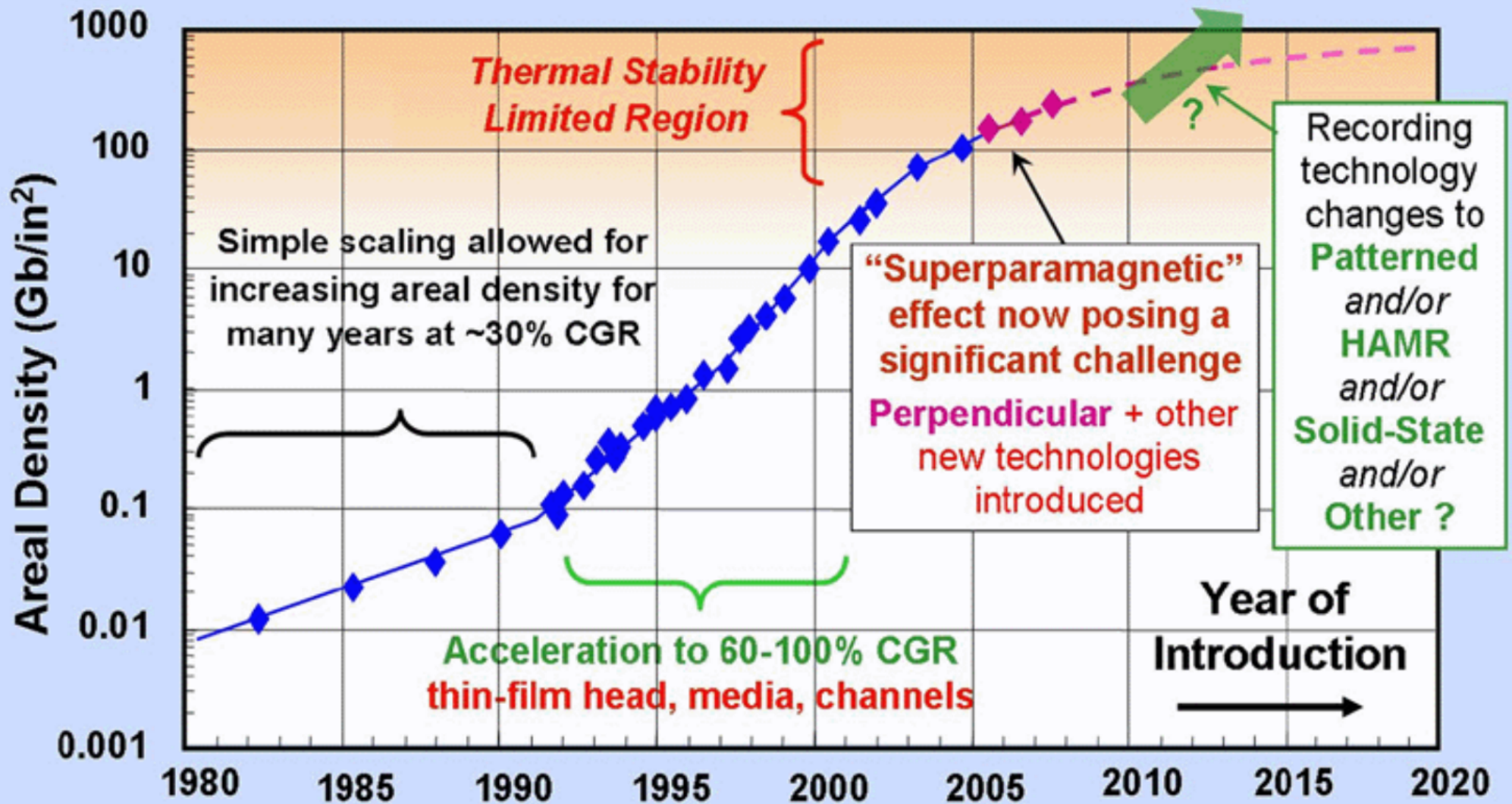
1964, 8 MB



**2006, 120 GB
120 000 MB
40 000 dal**

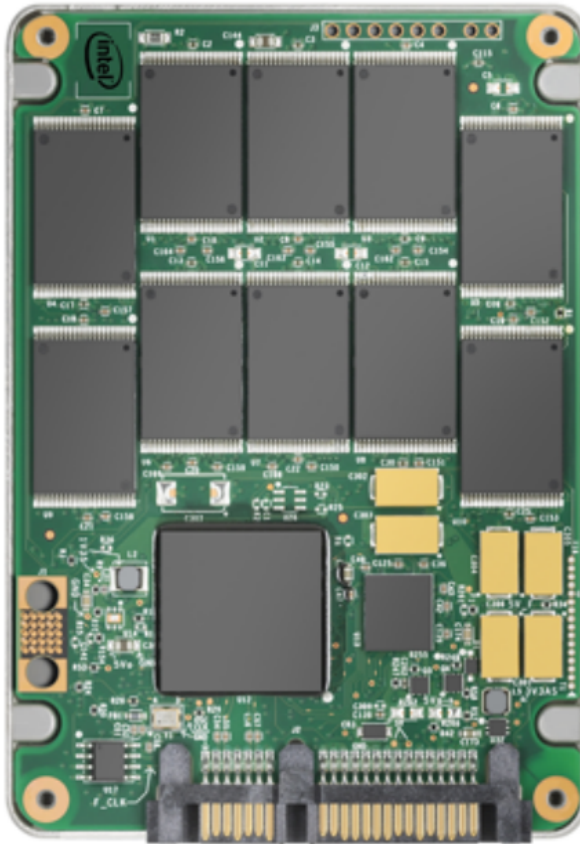


Growth of Areal Densities for Conventional Recording

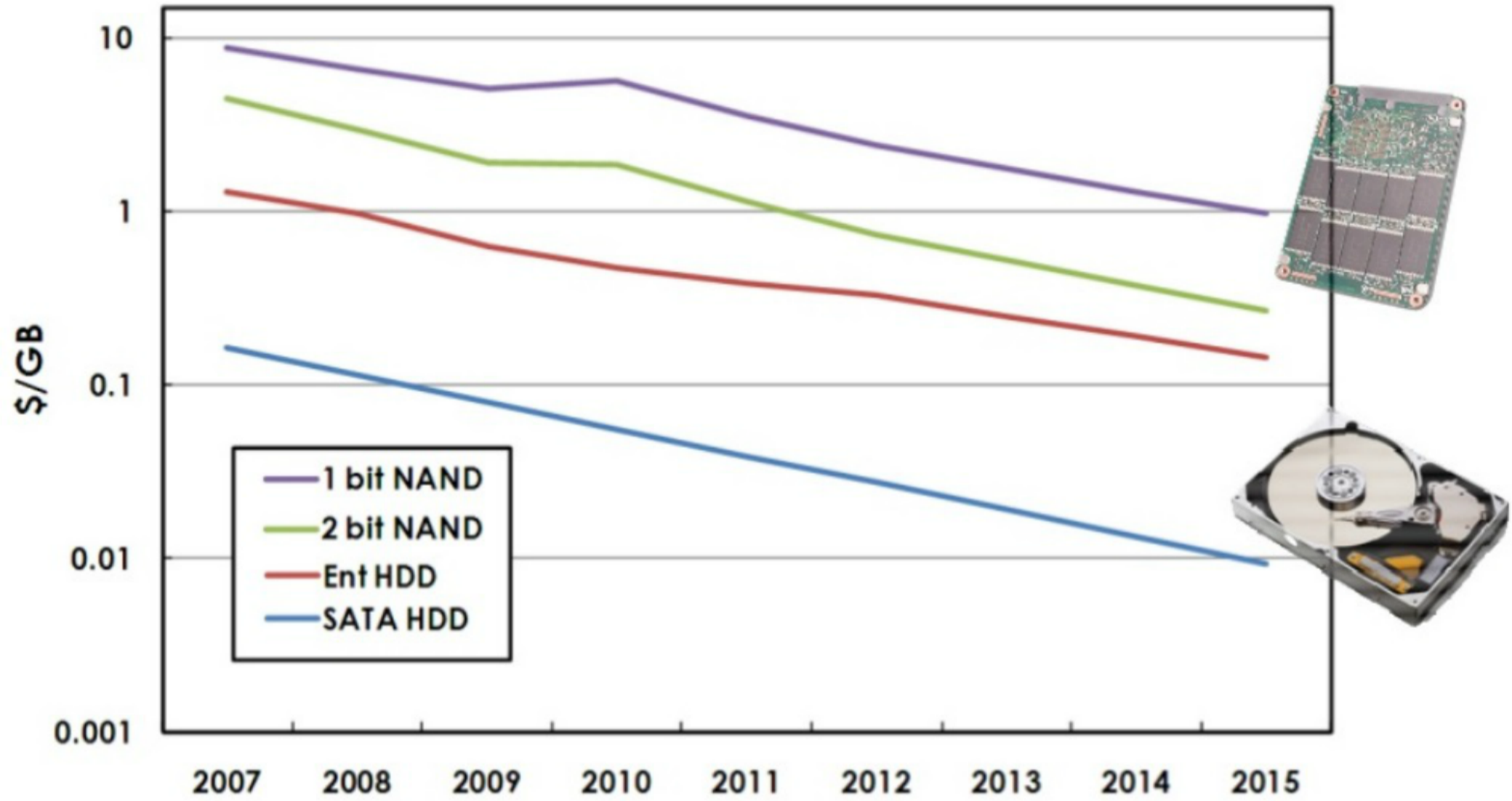


HDD / SSD

merevlemez / szilárdtest -meghajtó







Source: IBM Almaden Research, Steven R. Hetzler, Sep 2009



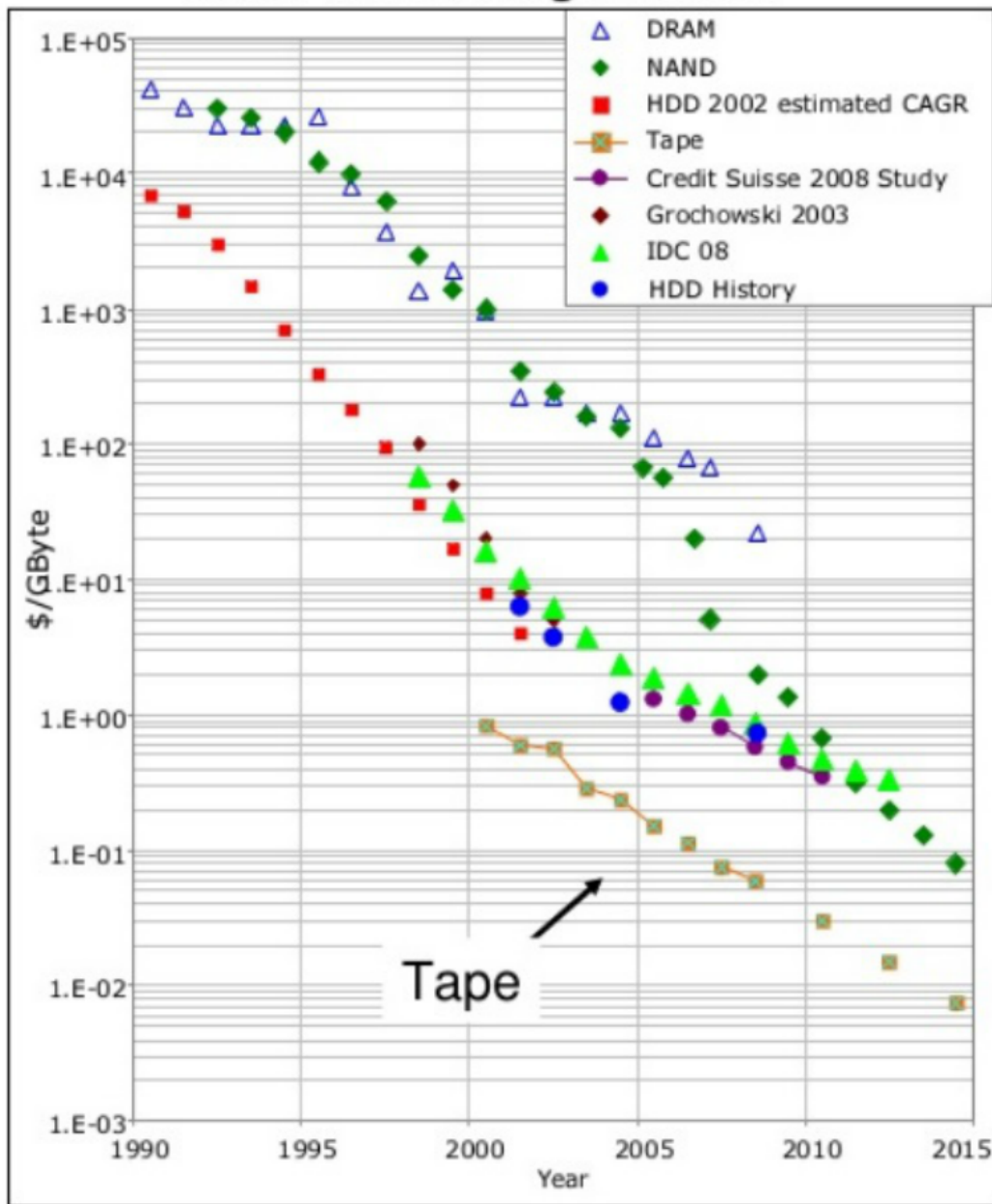
2013, szalagos kazetták

2 100 PB

2 100 000 000 GB

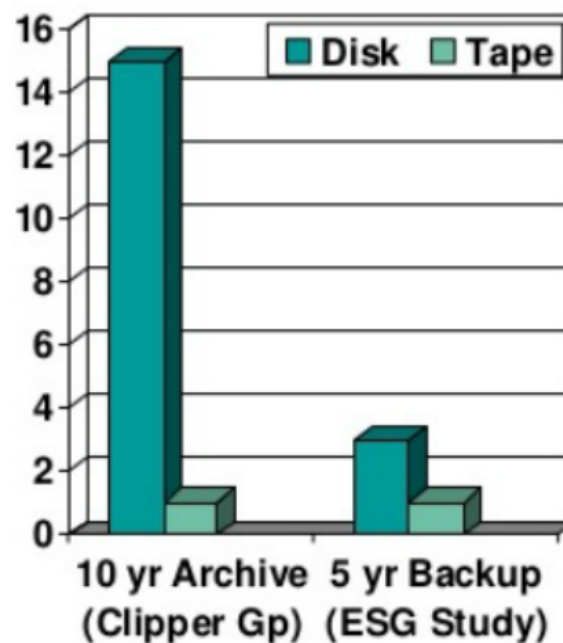
Tape's substantial cost advantage over disk continues through 2015

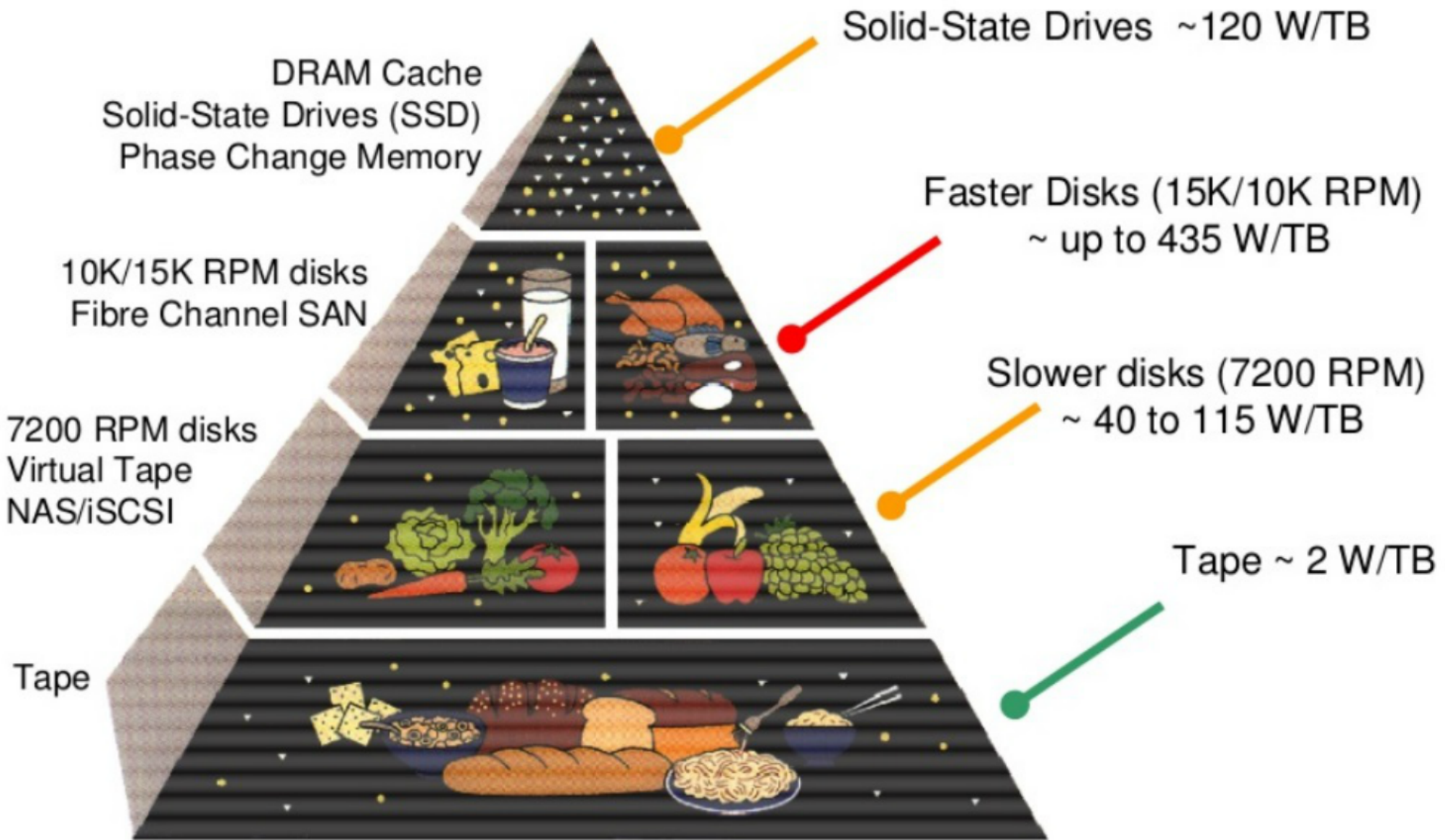
\$/GB for Storage Media



Tape's cost advantage over disk also contributes to a significant TCO advantage

TCO Comparison





Solid-State Drives ~120 W/TB

DRAM Cache
Solid-State Drives (SSD)
Phase Change Memory

Faster Disks (15K/10K RPM)
~ up to 435 W/TB

10K/15K RPM disks
Fibre Channel SAN

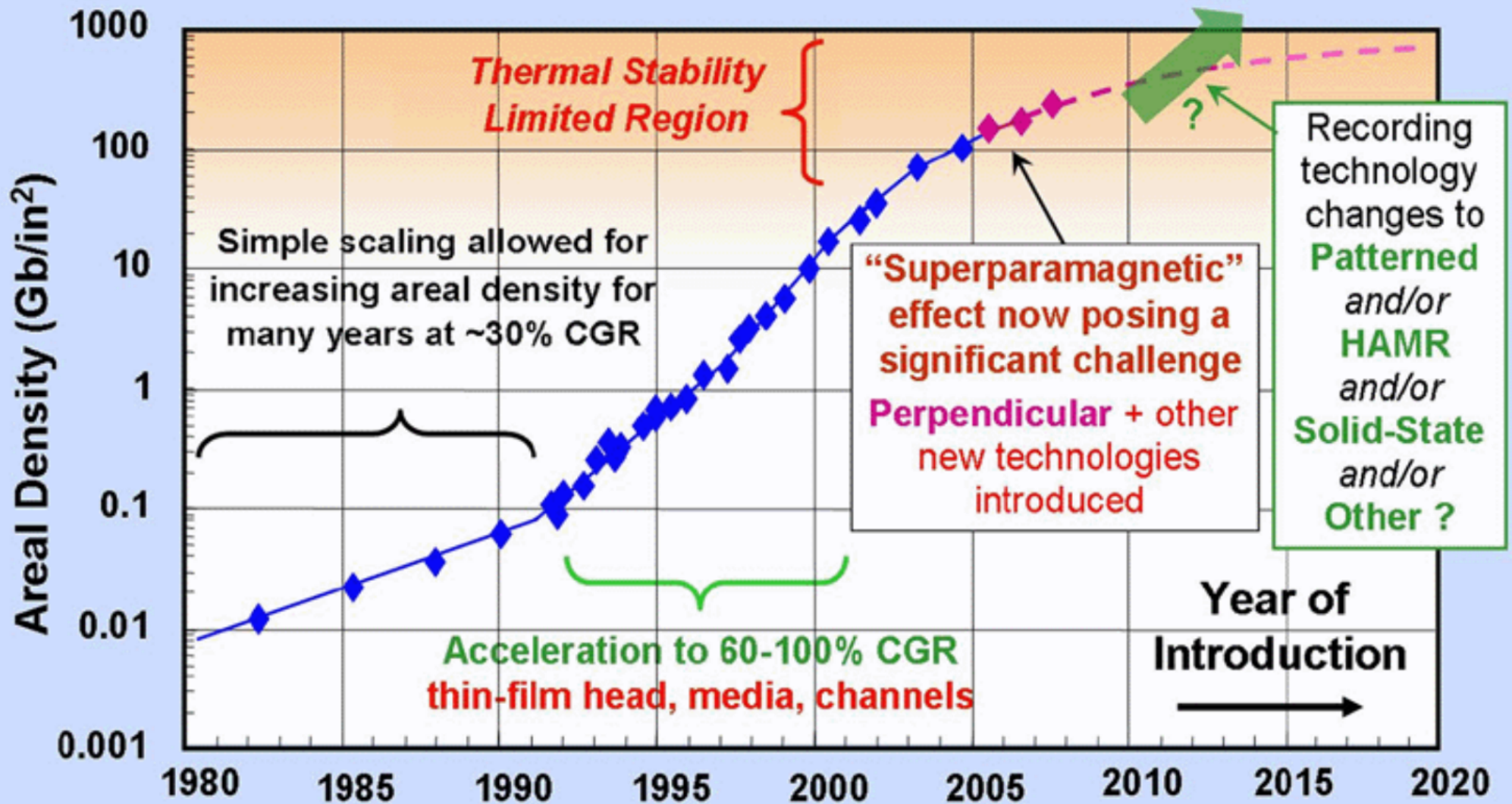
Slower disks (7200 RPM)
~ 40 to 115 W/TB

7200 RPM disks
Virtual Tape
NAS/iSCSI

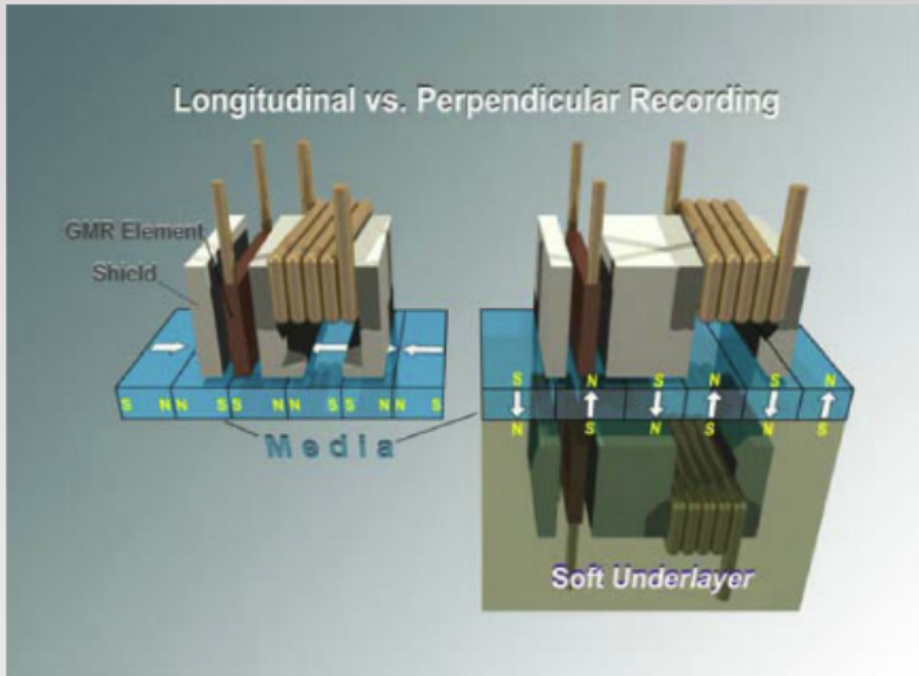
Tape ~ 2 W/TB

Tape

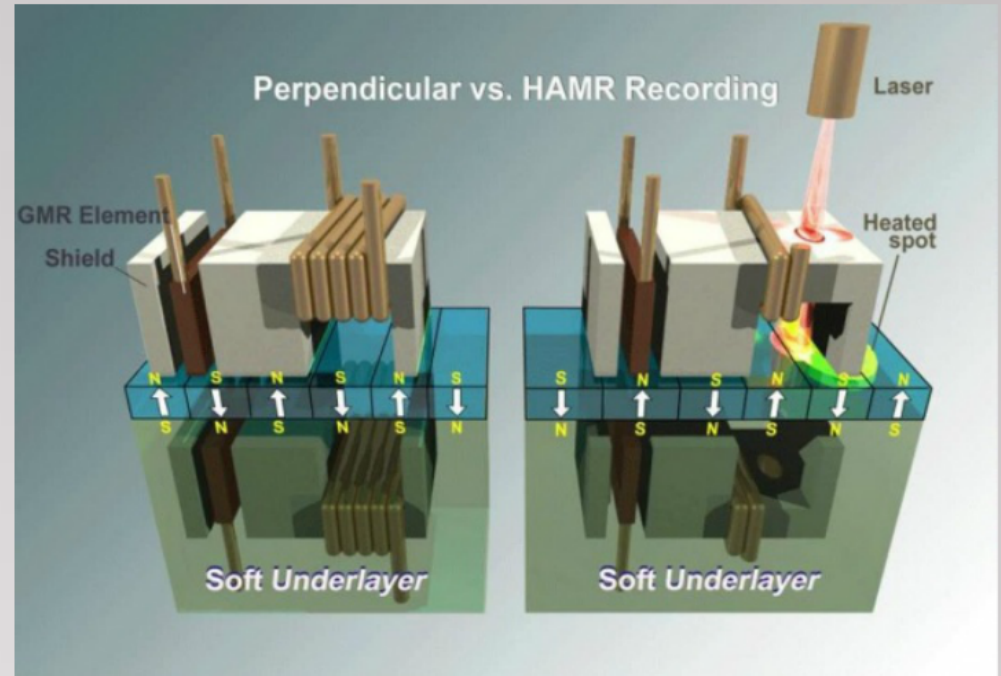
Growth of Areal Densities for Conventional Recording







2005, 5x



2014/15, 10x



2015, 5u 2017, 5u

GMR Head Structure

Integrated Lead Suspension/ Pico Slider



Inductive Write Head
P2 Layer

Inductive Write
GMR Read Sensor

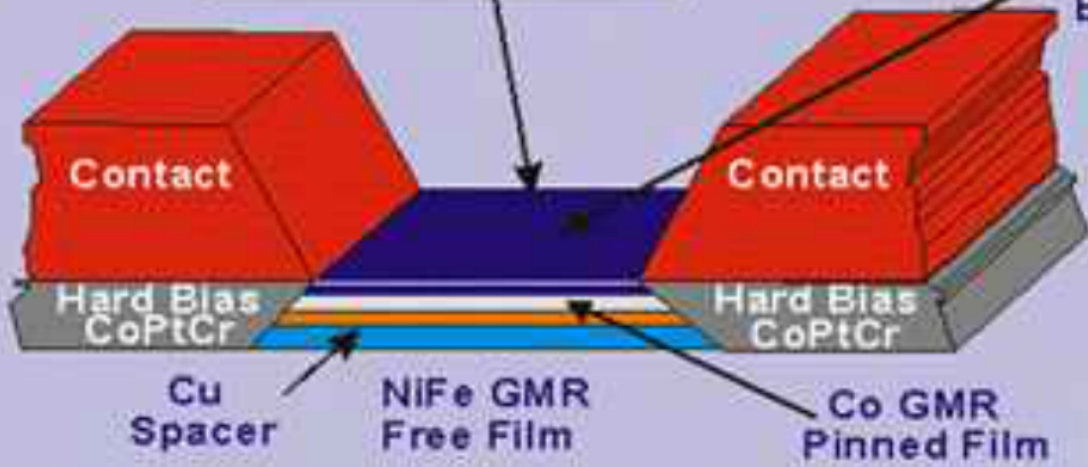
Inductive Head P1
Shield2

Shield1

Antiferromagnetic
Exchange Film

Copper Write Coils

Spin Valve/GMR
Sensor



Contact

Contact

Hard Bias
CoPtCr

Hard Bias
CoPtCr

Cu
Spacer

NIFe GMR
Free Film

Co GMR
Pinned Film



The Nobel Prize in Physics 2007

Albert Fert, Peter Grünberg

The Nobel Prize in Physics 2007



Photo: U. Montan

Albert Fert



Photo: U. Montan

Peter Grünberg

The Nobel Prize in Physics 2007 was awarded jointly to Albert Fert and Peter Grünberg *"for the discovery of Giant Magnetoresistance"*

MR: mágneses ellenállás, az elektromos vezetőképesség drasztikus megváltozása külső mágnes hatására

GMR: kb. 100% effektus

CMR: kb. 100 000%

- kolosszális

- de: szűk hőmérséklettartomány, erős mágnes



The Nobel Prize in Physics 2007

Albert Fert, Peter Grünberg

The Nobel Prize in Physics 2007



Photo: U. Montan

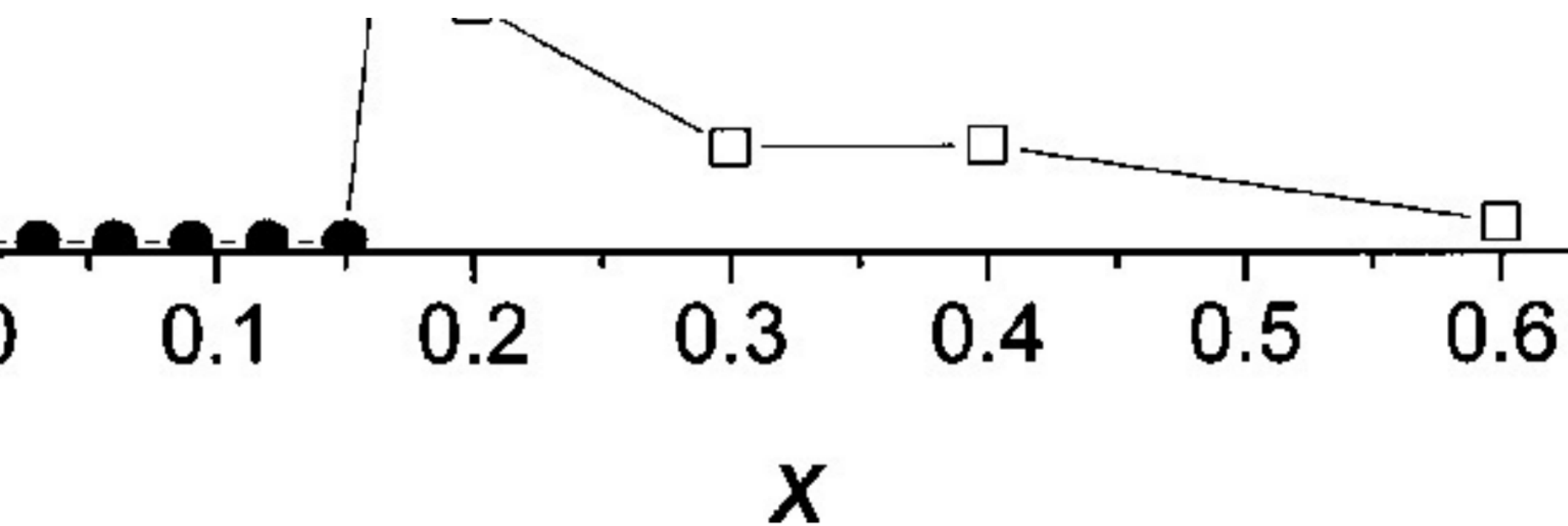
Albert Fert



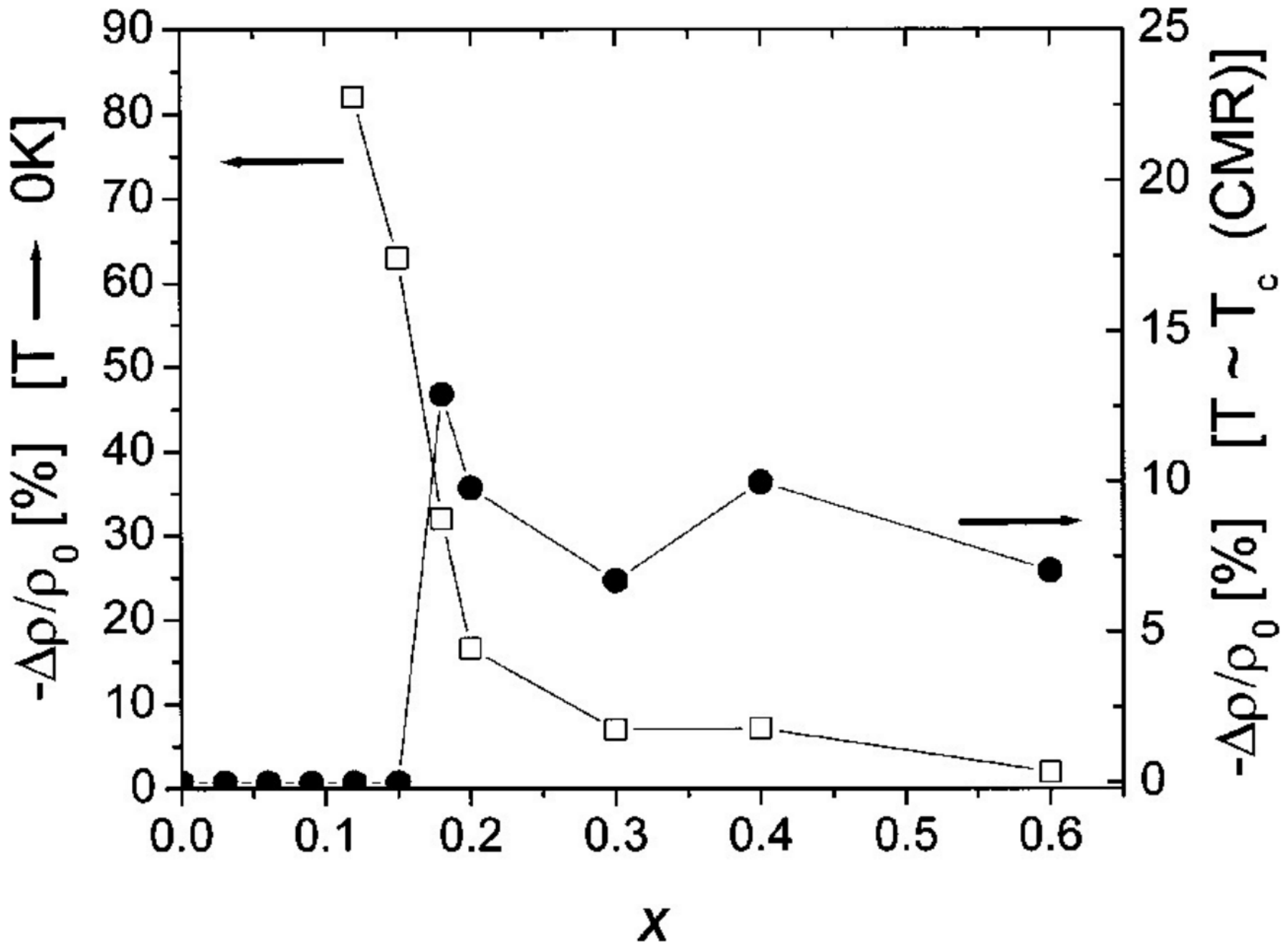
Photo: U. Montan

Peter Grünberg

The Nobel Prize in Physics 2007 was awarded jointly to Albert Fert and Peter Grünberg *"for the discovery of Giant Magnetoresistance"*



$\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$ mágneses ellenállása



$\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$ mágneses ellenállása

Mik azok a kobaltát perovszkitok?



szilárd

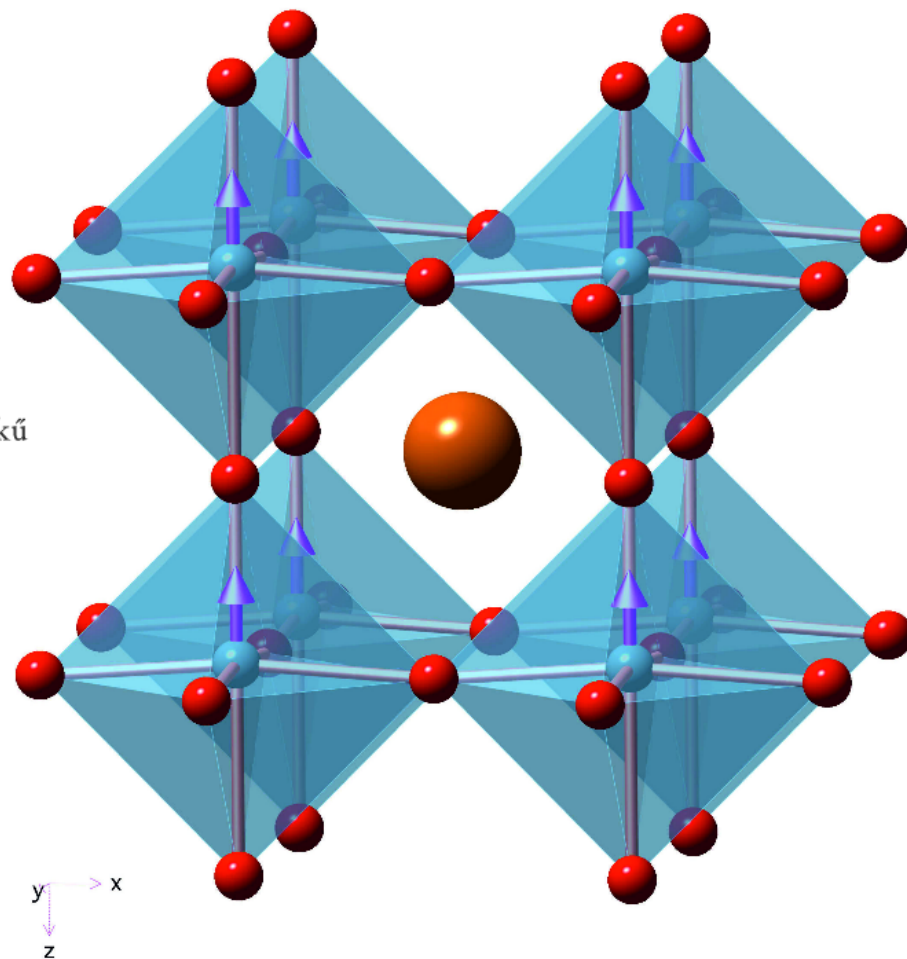
szigetelő

dia-paramágnes
átmenet $T = 90 \text{ K}$

szabályos Co-O oktéder

kristálytérfelhasadási és
elektronpárosítási
energiák nagyon
közeliek

alapállapot:
 $S=0$ kisspinű, háromértékű
kobalt



mágnes

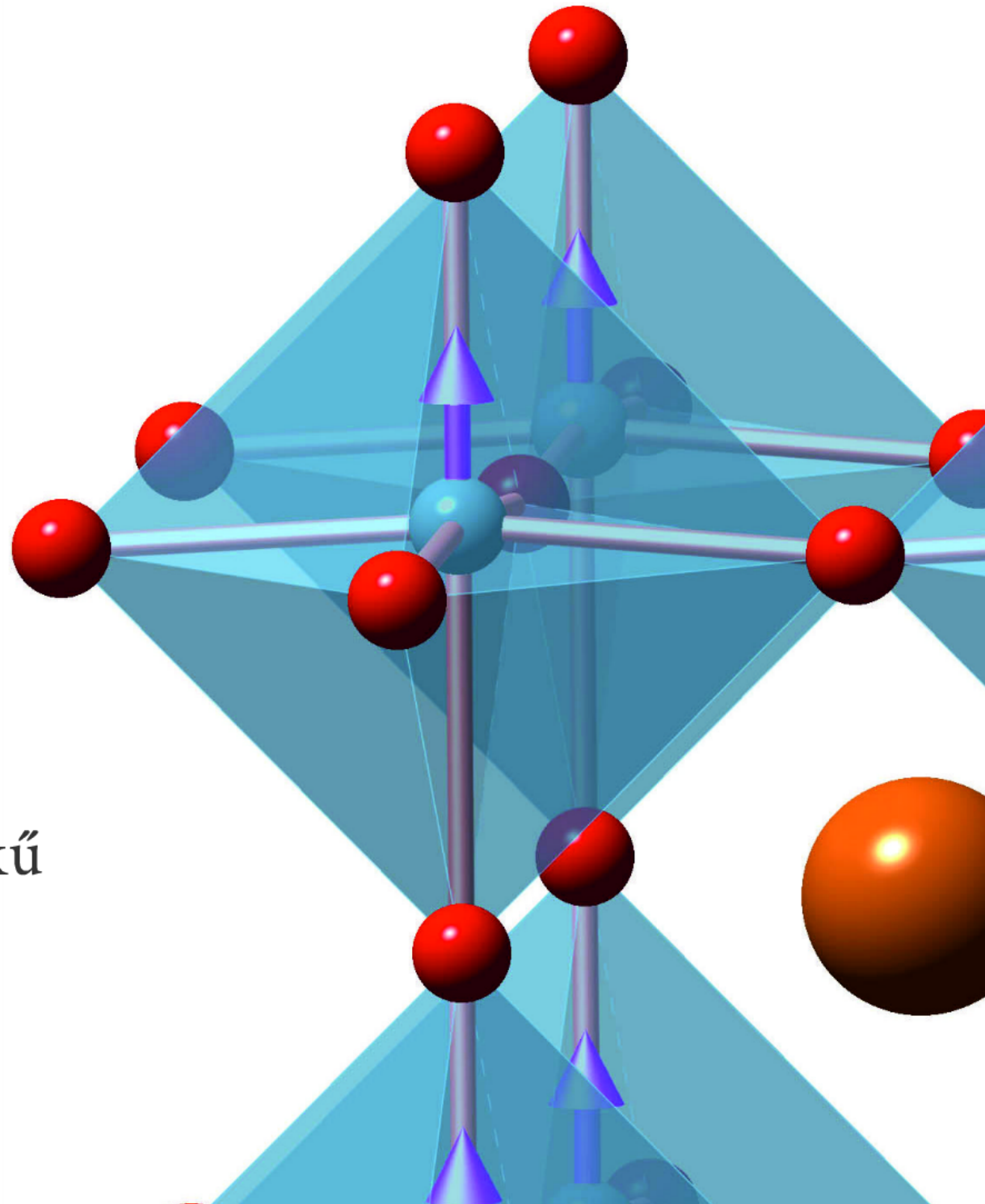
szabályos Co-O oktéder

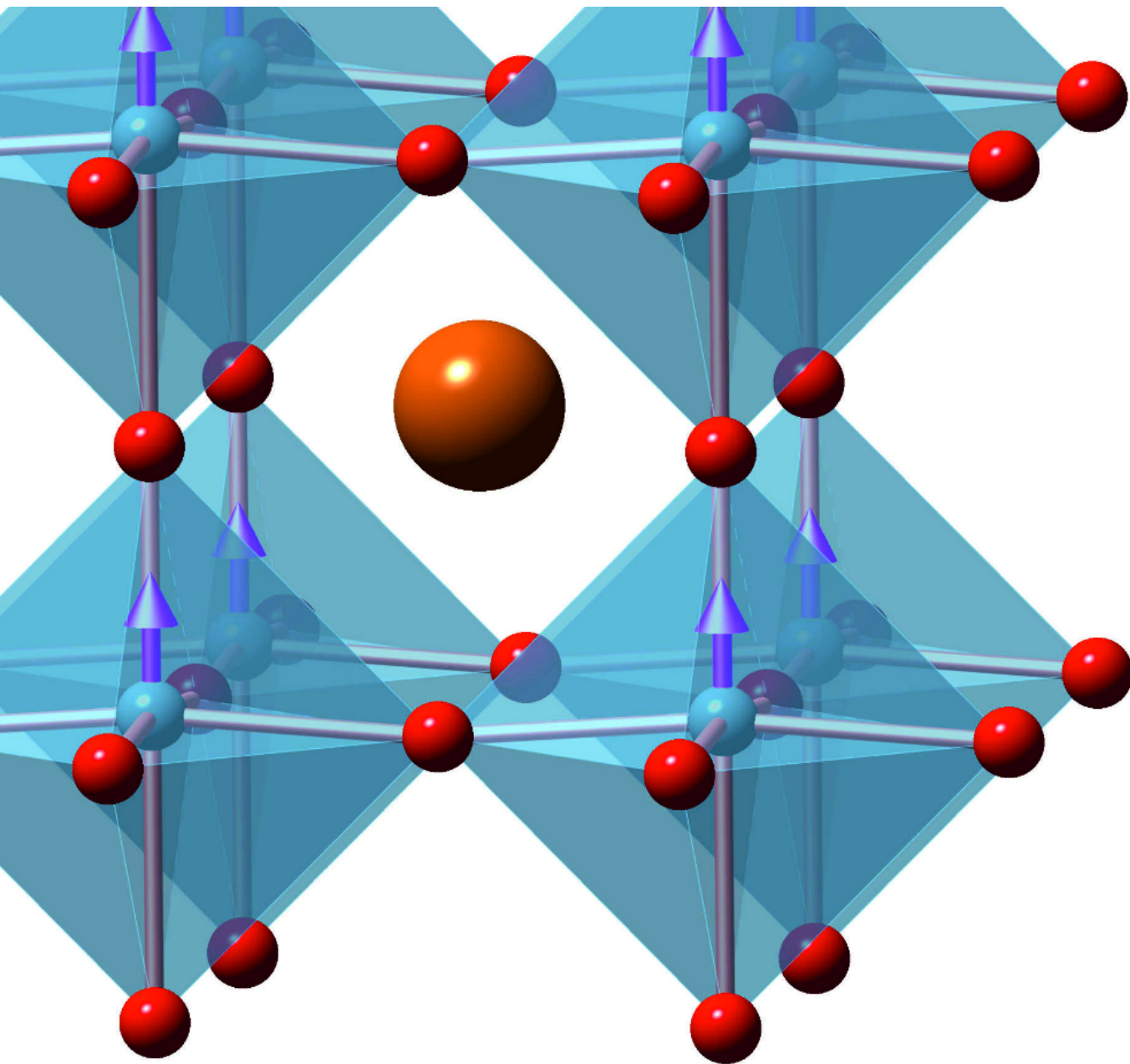
kristályterefelhasadási és
elektronpárosítási
energiák nagyon
közeliek

alapállapot:

$S=0$ kisspinű, háromértékű

kobalt





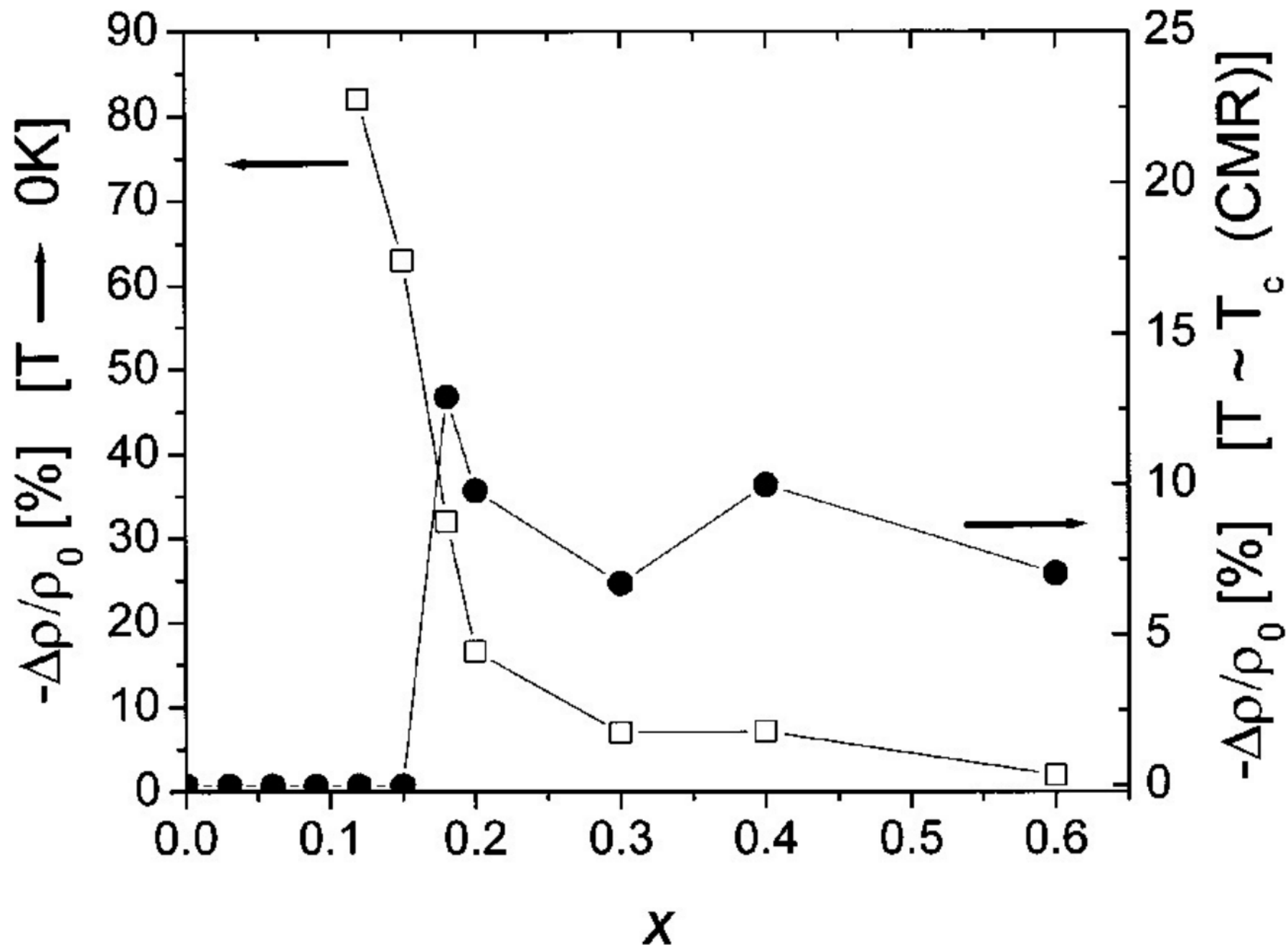
központi kation:

elektronlyukak
(vegyértékállapot)
szerkezeti torzulás
(ionsugár)



vezetőképesség

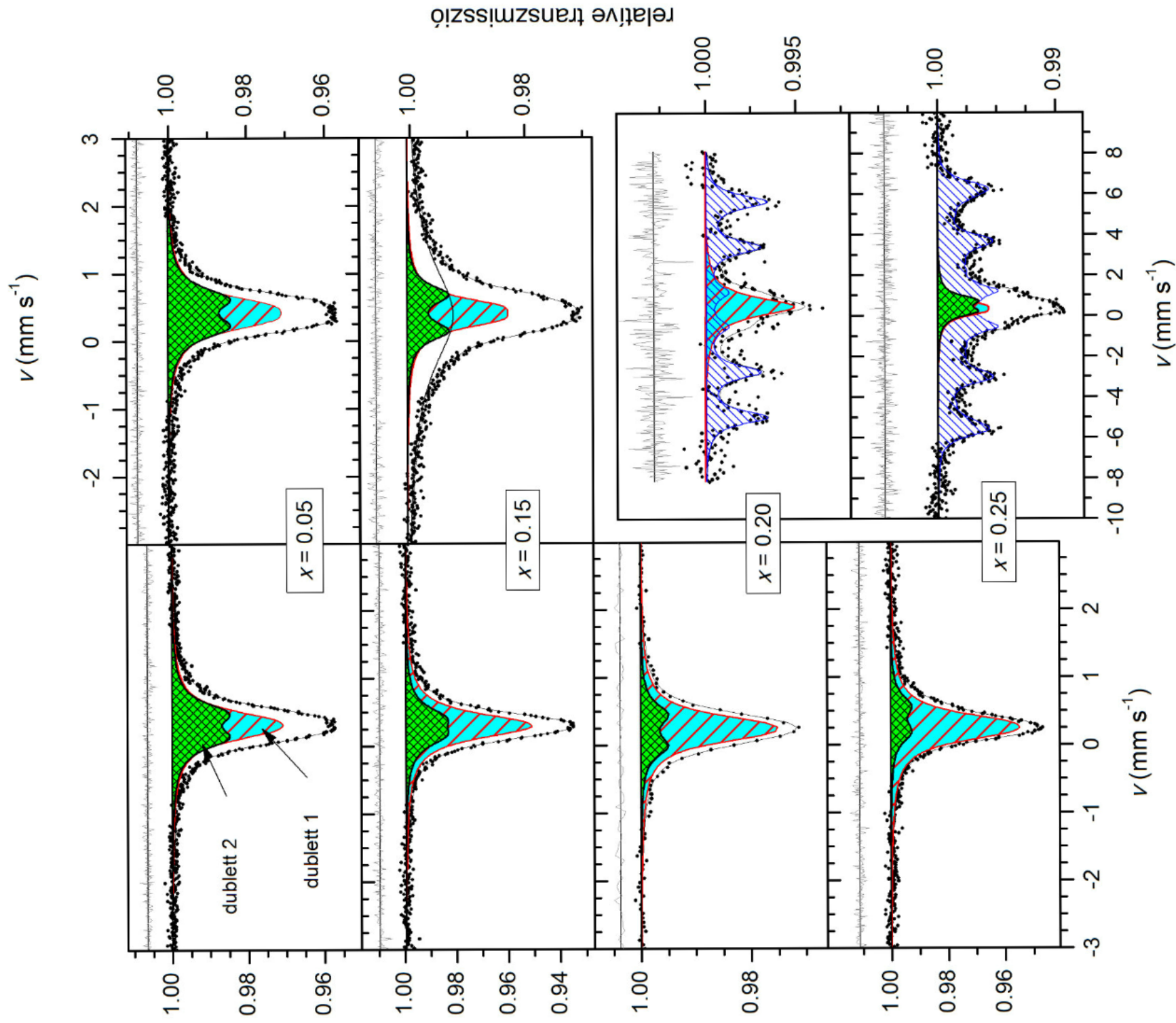
mágneses kölcsönhatások



$\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$ mágneses ellenállása

^{57}Co emissziós Mössbauer-spektrumok

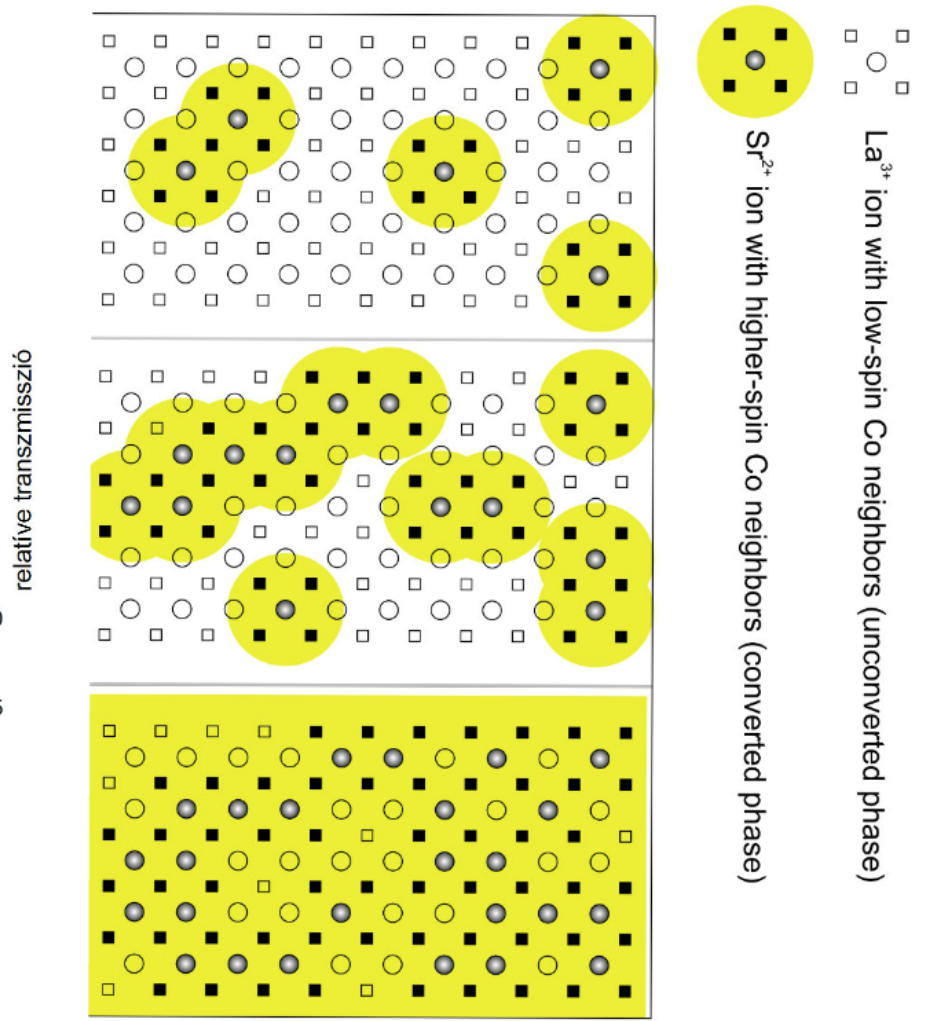
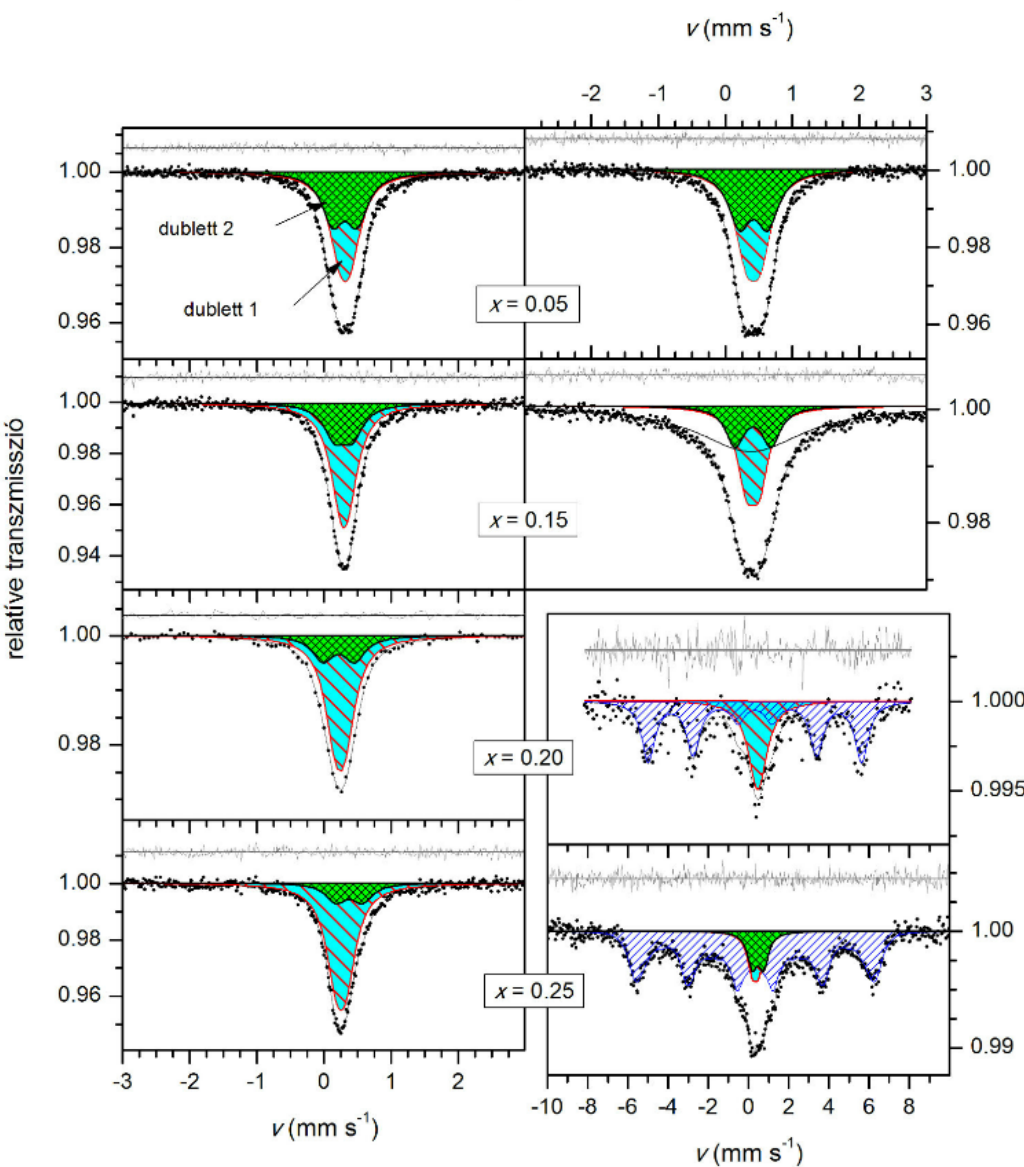
300 K | 80 K



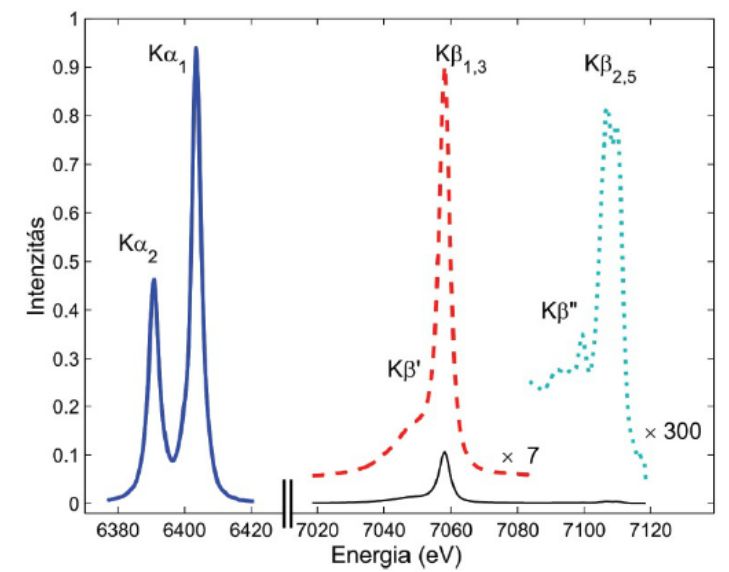
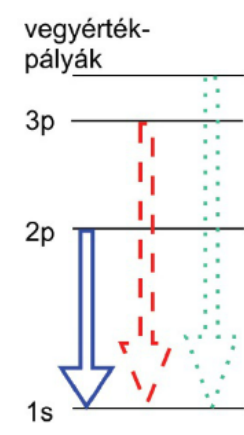
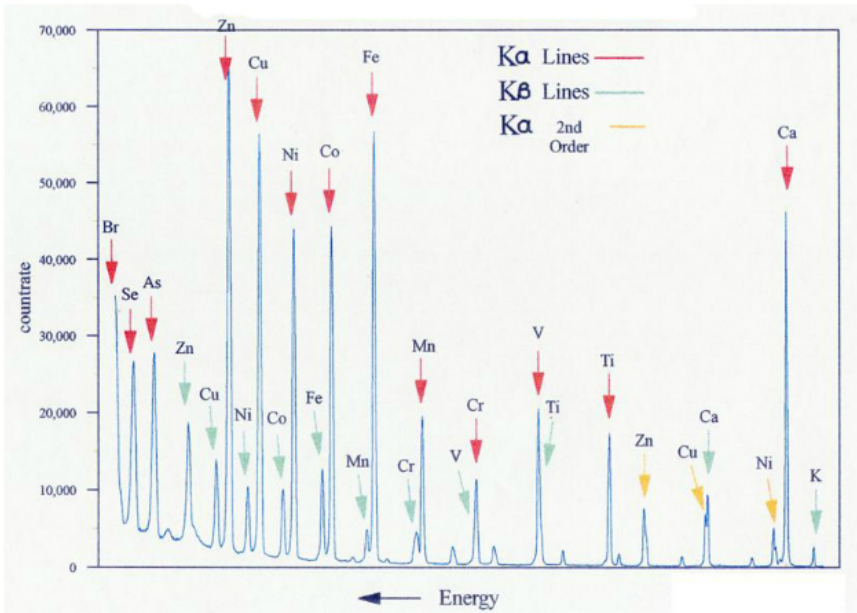
⁵⁷Co emissziós Mössbauer-spektrumok

Mágneses-elektromos fázisszétválás (MEPS)

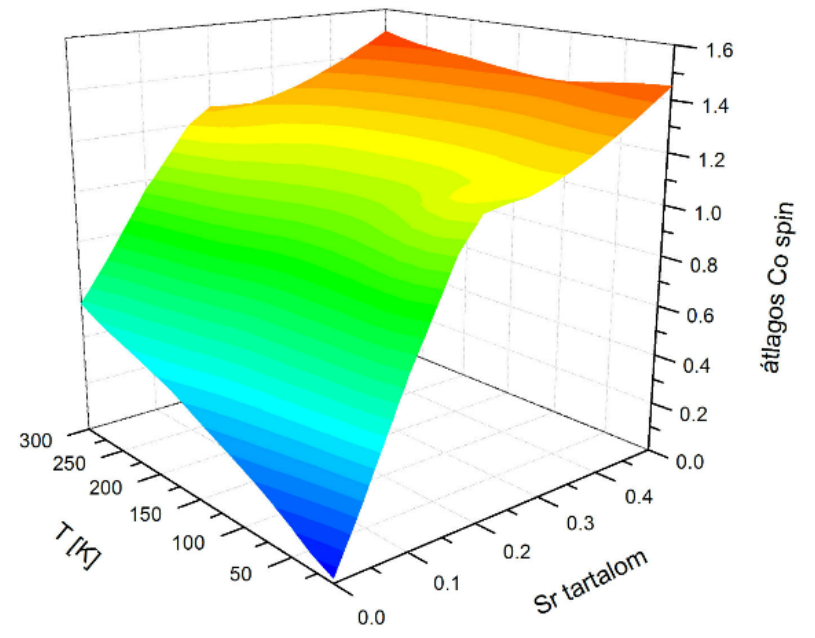
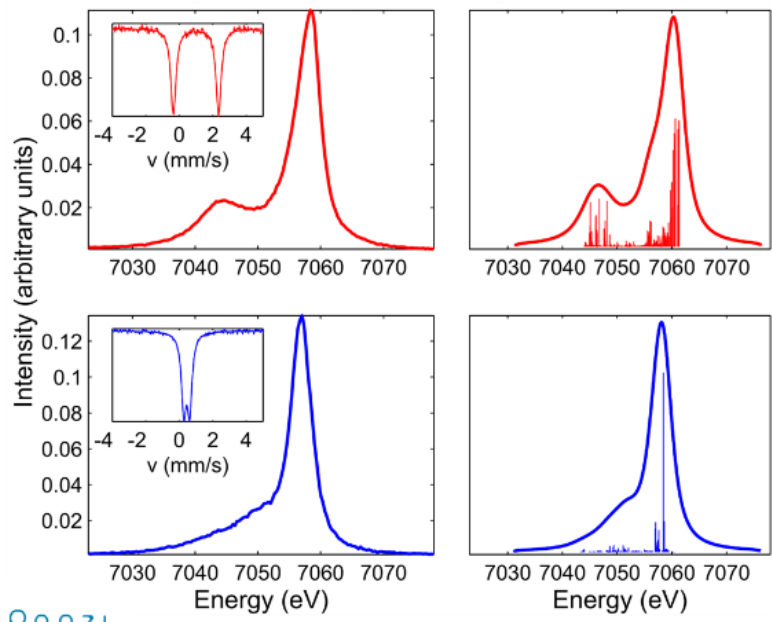
300 K | 80 K

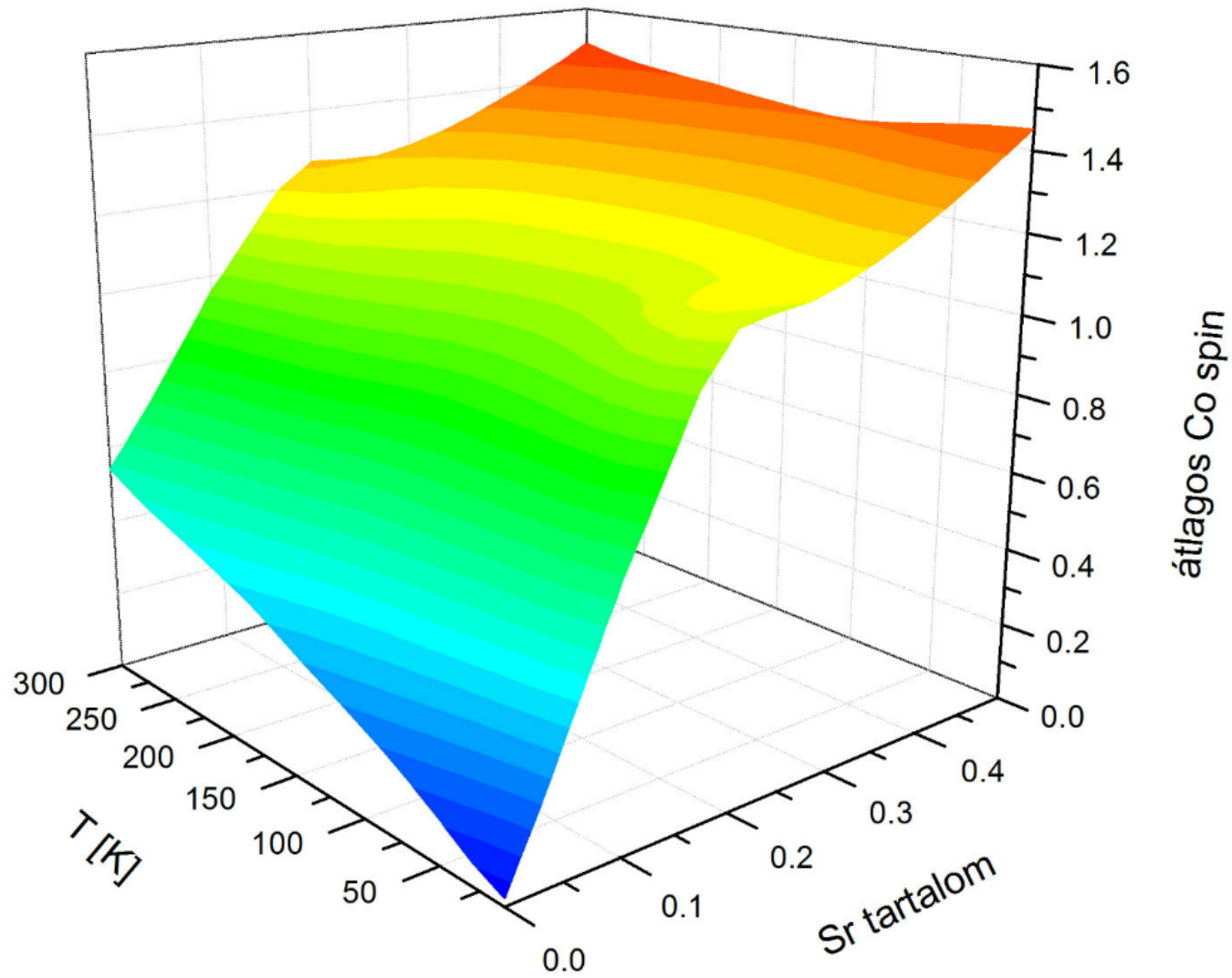


Nagyfelbontású röntgenemissziós spektroszkópia



Vankó György, A kémia újabb eredményei 100. kötet 133-240. (2008.)



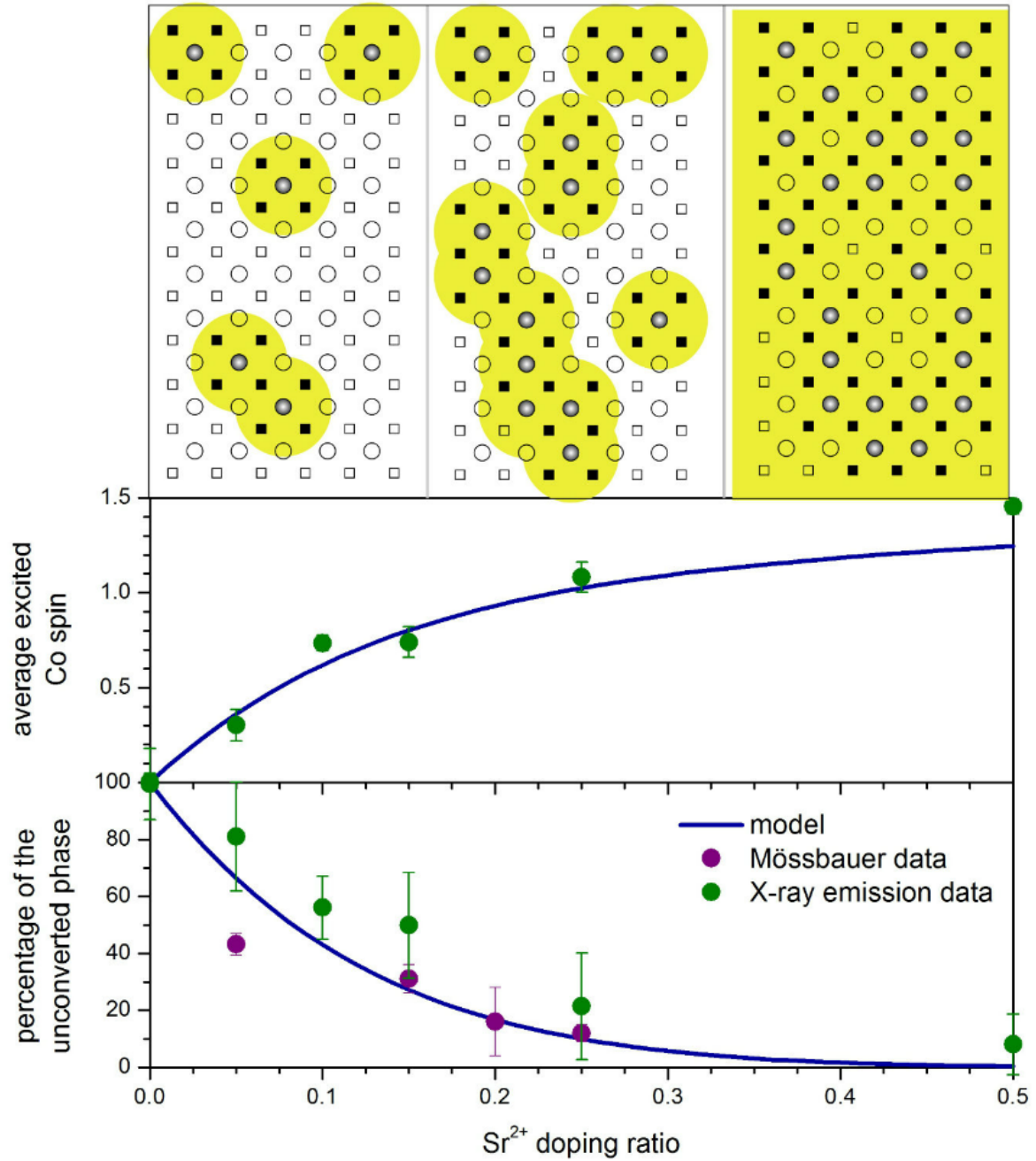


kobaltionok átlagos spinje $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$ perovszkitokban

□ ○ □
□ ○ □ La³⁺ ion with low-spin Co neighbors (unconverted phase)

● Sr²⁺ ion with higher-spin Co neighbors (converted phase)

MEPS



elektronlyuk-bevitel

~~kristályszerkezeti torzulás~~

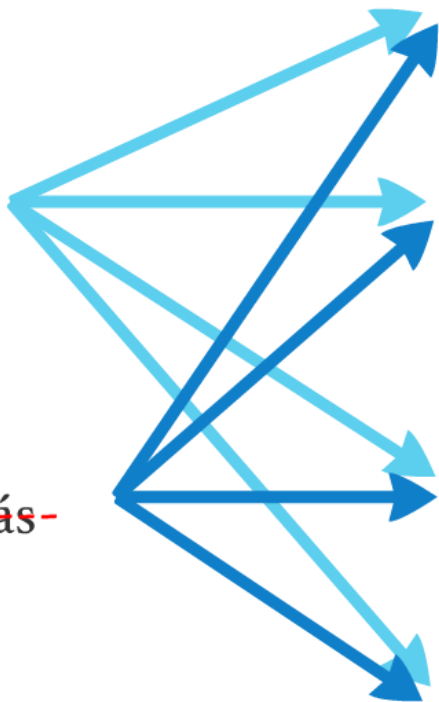
növekvő kobalt spin

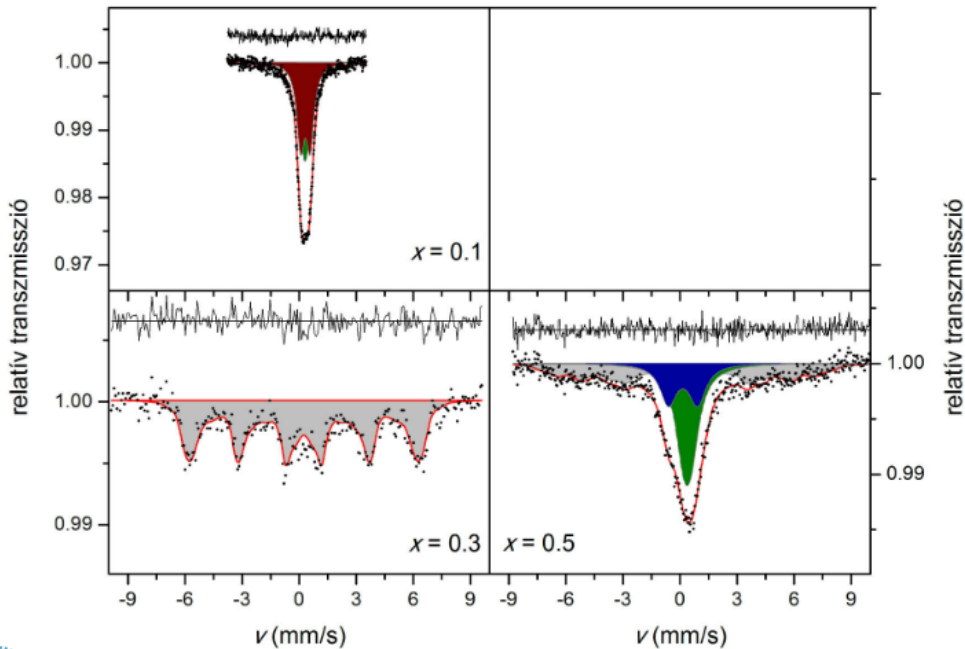
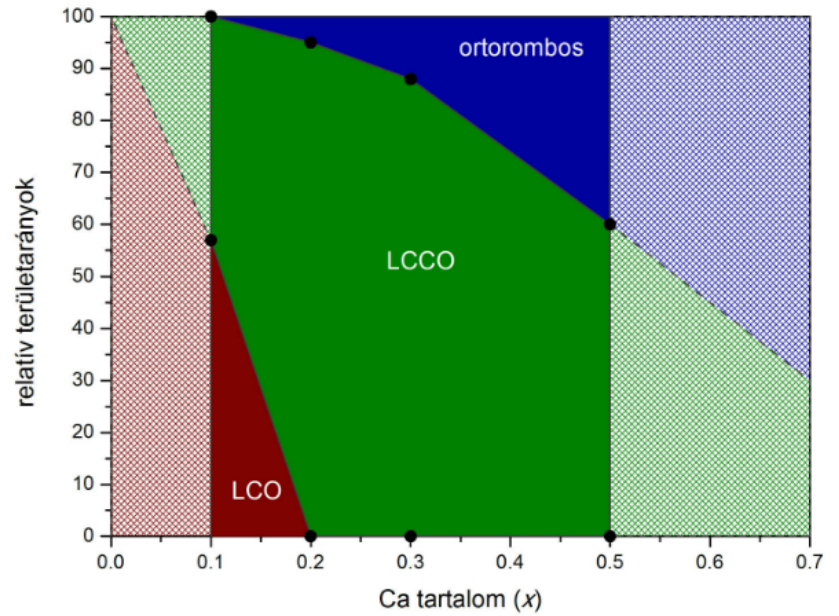
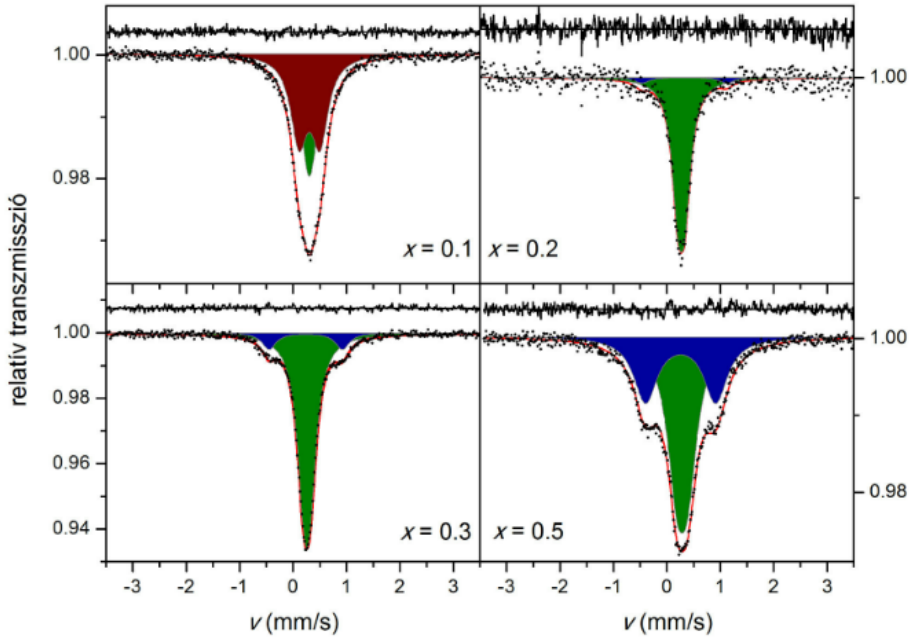
diamágnes - paramágnes - spinüveg -
ferromágnes átmenet

fém - szigetelő átmenet

?

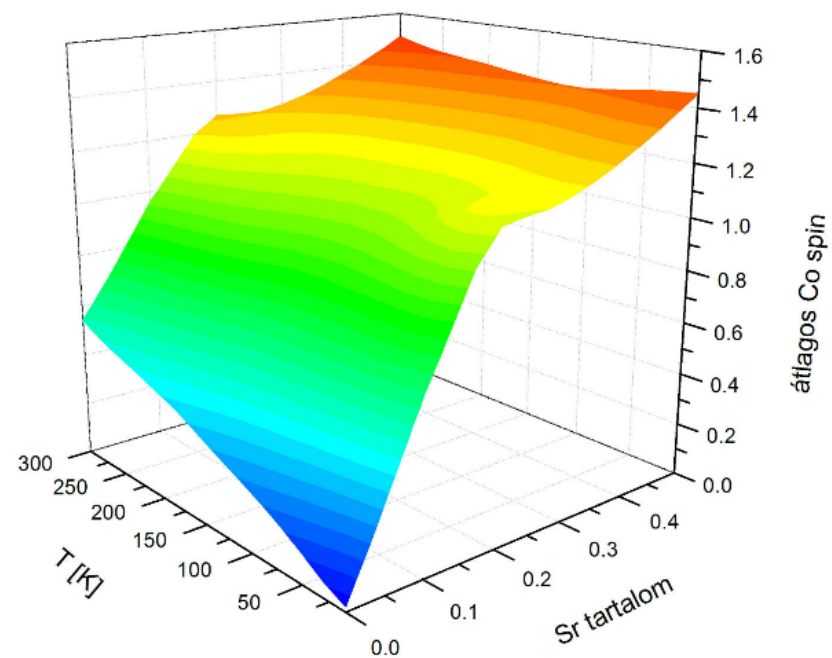
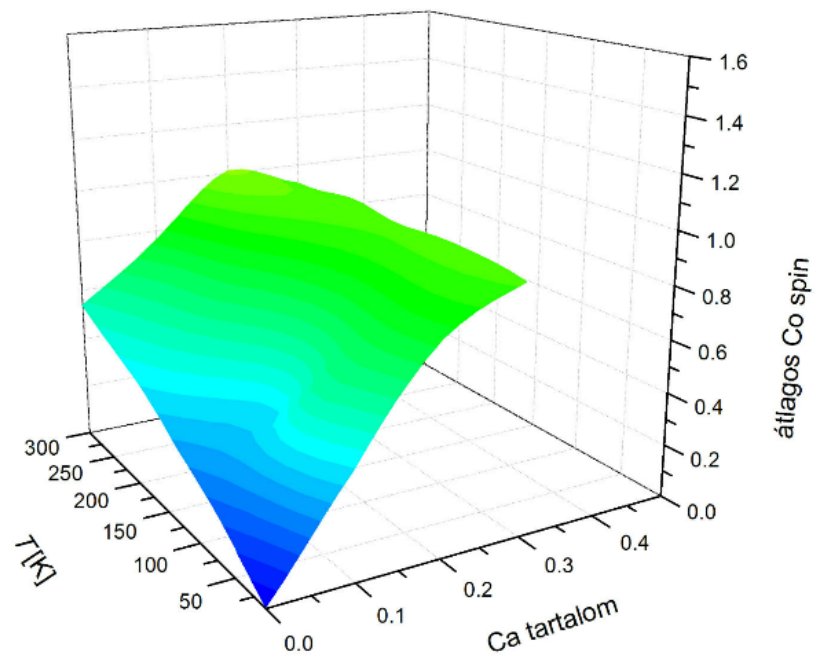
MEPS



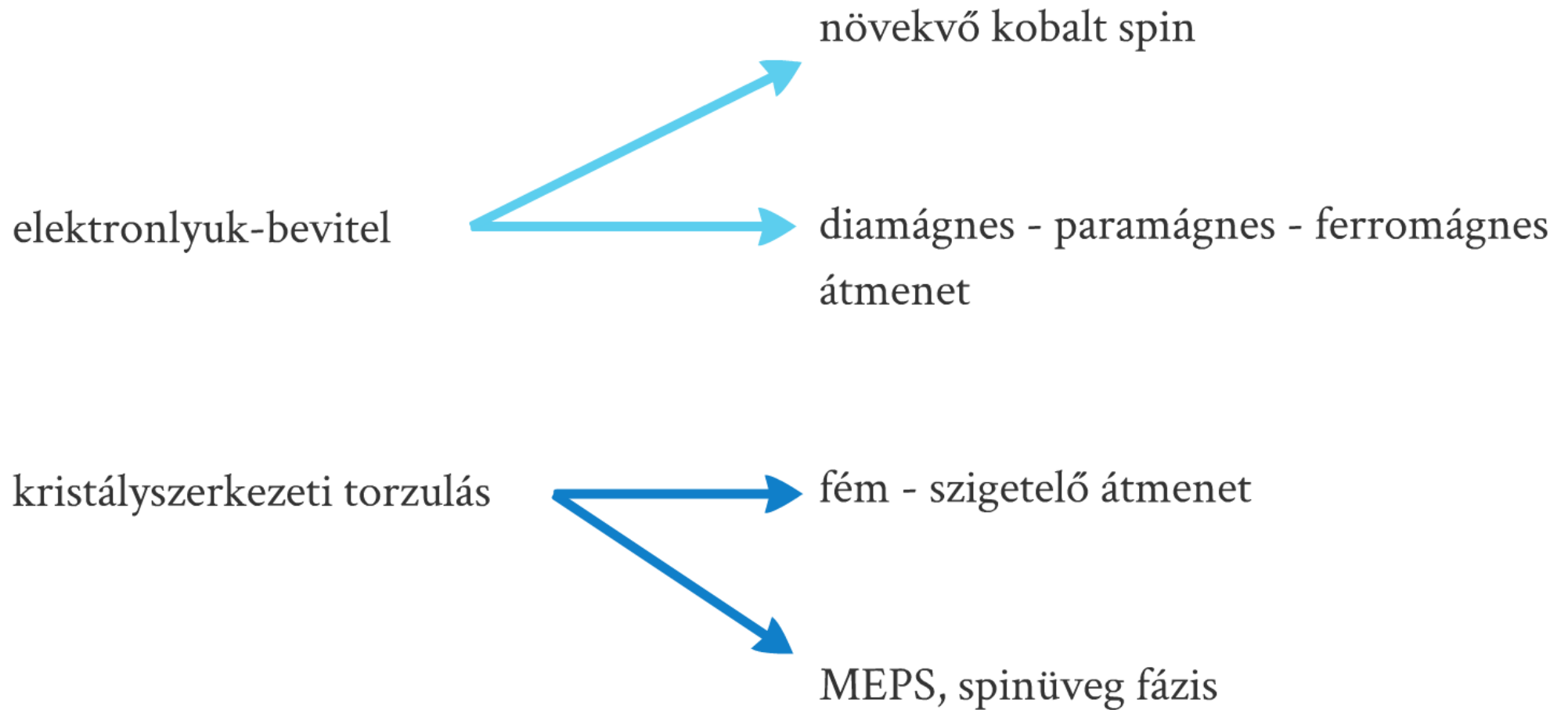


Ca vs. Sr:

- makroszkópikus fázisszétválás van
- mikroszkópikus fázisszétválás (MEPS) nincs



Ca vs. Sr: kobaltionok spinje hasonlóan változik



Köszönöm a figyelmet!