Crystal-field Excitations in CePtSn Studied by Polarized Neutrons

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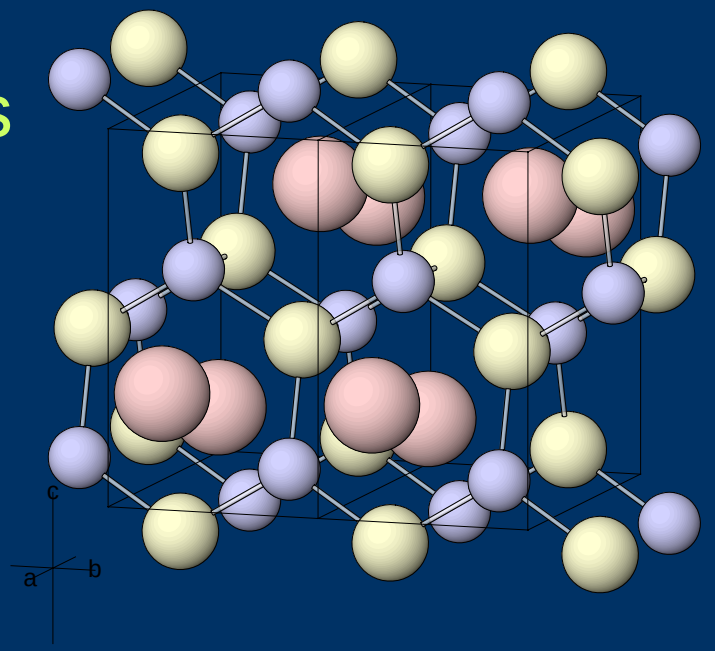
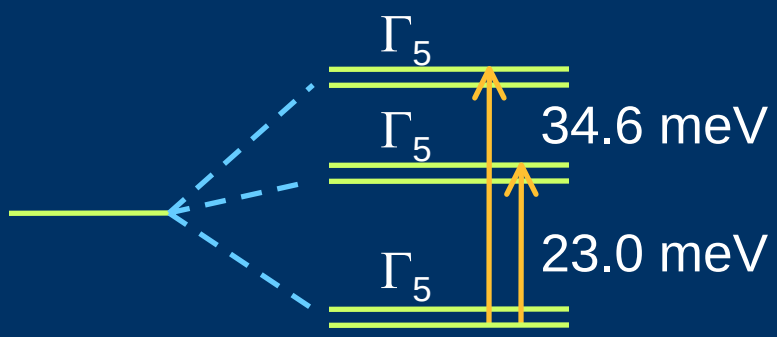
CePtSn

- crystal structure: orthorhombic, space group *Pnma*
- antiferromagnetic Kondo compound (T_K ~ 10 K)
- magnetic properties:
  - AF – T_N = 7.5 K, T_M = 5 K
  - strong magnetocrystalline anisotropy
  - complex magnetic phase diagram
  - GMR effect for B = 3 T || b-axis (almost 40% at 2K)

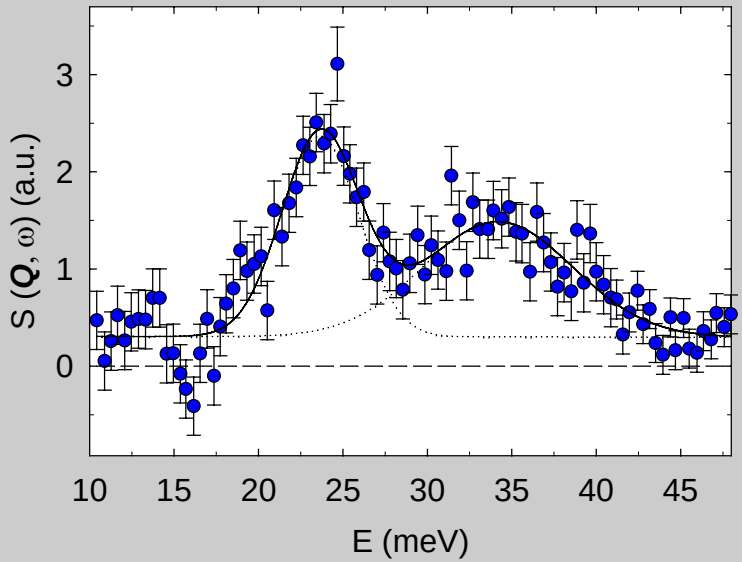


Crystal field in CePtSn

- Ce: J = 5/2



free ion with CF interaction



INS of CePtSn on HET (polycrystalline sample) after Adroja et al., 1994

monoclinic site symmetry ⇨

$$H_{CF} = B_2^0 O_2^0 + B_4^0 O_4^0 + B_2^2 O_2^2 + B_4^2 O_4^2 + B_4^4 O_4^4 + C_2^2 \Omega_2^2 + C_4^2 \Omega_4^2 + C_4^4 \Omega_4^4$$

"orthorhombic" terms

"monoclinic" terms

Polarized INS studies on IN20

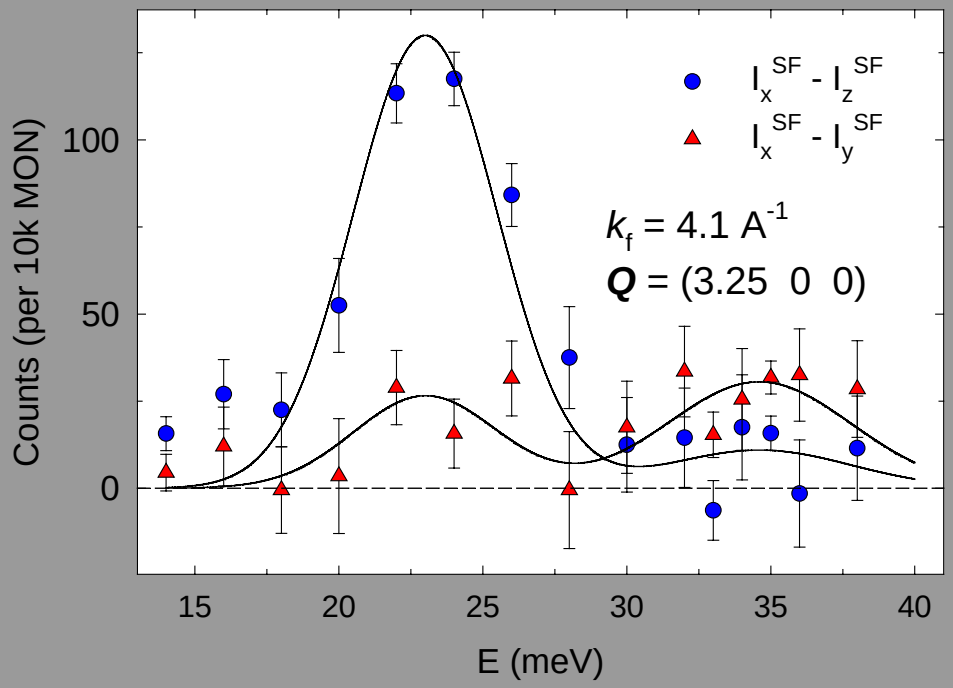
- polarized neutrons from horizontally and vertically focusing Heusler alloy monochromator and analyser
- constant ***Q*** scans with k_f = 4.1 Å^{-1}
- magnetic field at sample position can be applied in any direction: XYZ polarization analysis

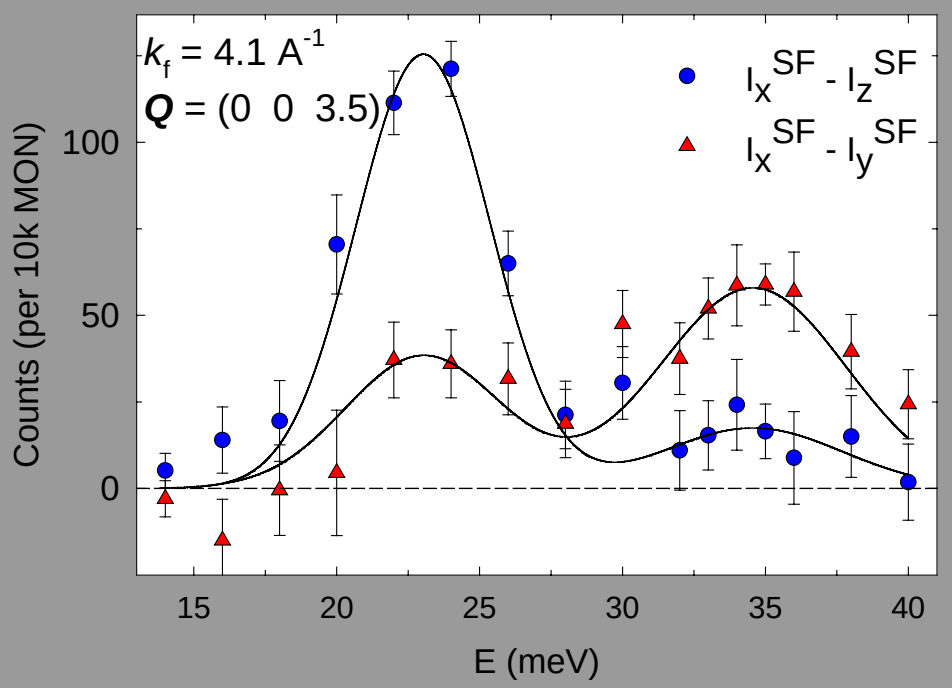
- CF signal extracted from the difference in the spin-flip scattering intensities:

$$I_x^{SF} - I_{y,z}^{SF} \approx F^2(Q)\exp(-2W)\sum_{ij}\frac{k_f}{k_i} n_i \left|\langle j|J_{y,z}|i\rangle\right|^2 \delta(\omega_j - \omega_i - \omega)$$

Polarized INS

T = 15 K, sample mounted with b-axis vertical (z direction)





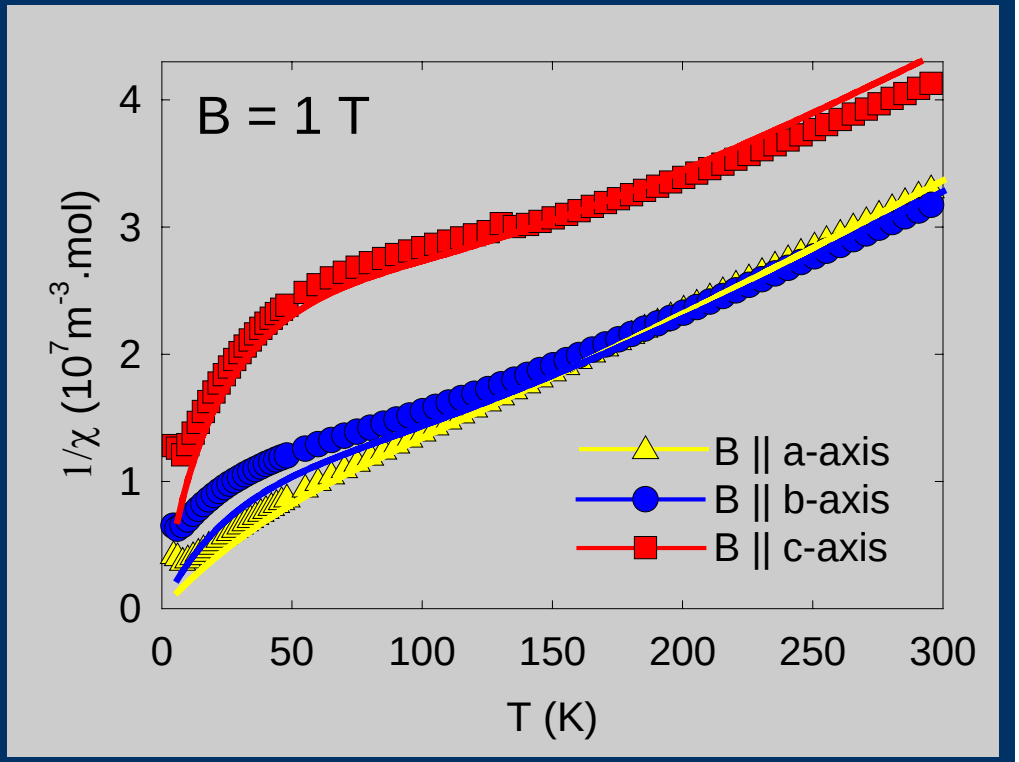
⇨ J_b, J_c

⇨ J_a, J_b

Theory vs. Experiment

- Monte Carlo method used to find the correct set of CF parameters that would reproduce BOTH bulk magnetic AND INS data (with polarisation analysis)

	Experiment	This work	Divis et al.
Δ_1 (K)	273	289	264
Δ_2 (K)	425	425	425
Intensities	1.45	1.36	0.76
$\|\langle 1\|J_a\|2\rangle\|^2$	262(71)	280	323
$\|\langle 1\|J_b\|2\rangle\|^2$	777(54)	732	385
$\|\langle 1\|J_c\|2\rangle\|^2$	166(40)	159	168
$\|\langle 1\|J_a\|3\rangle\|^2$	474(69)	499	20
$\|\langle 1\|J_b\|3\rangle\|^2$	113(56)	91	405
$\|\langle 1\|J_c\|3\rangle\|^2$	245(32)	269	730



Conclusions

- polarisation analysis of crystal-field excitations is FEASIBLE even with very small (< 1 cm^3) samples
- the method
  - gives a direct information on the anisotropy of the CF transition matrix elements
  - is very sensitive to local symmetry of the studied site