Under-compensation effect in Kondo insulator $(Yb,Tm)B_{12}$

Kirill Nemkovski

Jülich Centre for Neutron Science JCNS
Forschungszentrun Jülich GmbH
Outstation at MLZ

MLZ is a cooperation between:

JÜLICH FORSCHUNGSZENTRUM
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung
Technische Universität München

Phys. Rev. B **89**, 115121 (2014)

key collaborators

P.A. Alekseev *(NRC "Kurchatov Institute", Russia)*
J.-M. Mignot *(Laboratoire Léon Brillouin , France)*

local support

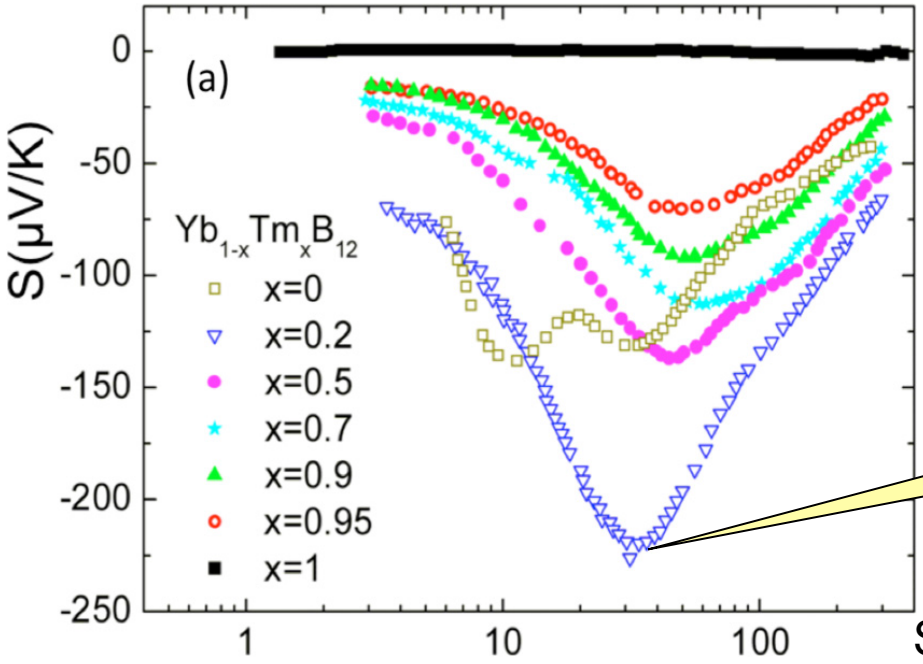
*A.S. Ivanov, S. Rols (*Institut Laue-Langevin*)*

samples

V.B. Filipov, N.Yu.Shitsevalova

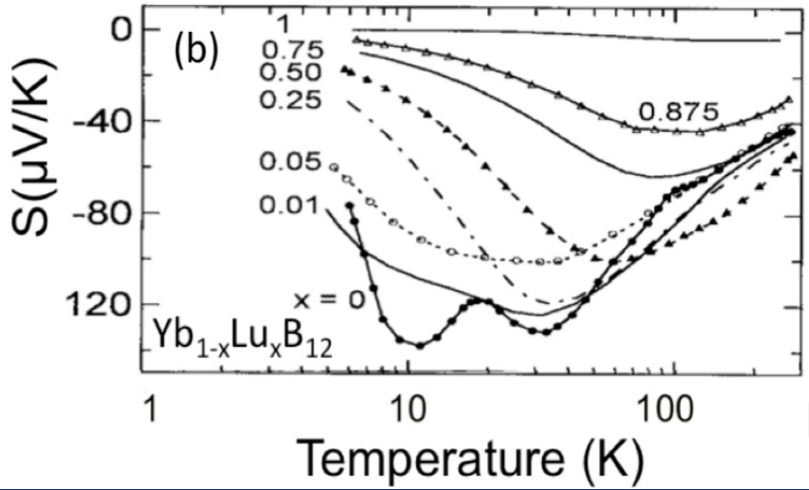
(Institute for Problems of Material Science, Ukraine)

Thermoelectric power in $Yb(Tm,Lu)B_{12}$



drastic enhancement
at low Tm concentration

Sluchanko et al., JETP Lett. 89, 256 (2009)



F. Iga et al., JMM 226-230, 137 (2001)

Experimental details for INS experiment

polycrystalline (powder) samples:

$Yb^{11}B_{12}$

$Yb_{0.92}Tm_{0.08}{}^{11}B_{12}$

$Yb_{0.85}Tm_{0.15}{}^{11}B_{12}$

$Lu_{0.92}Tm_{0.08}{}^{11}B_{12}$

measurements:

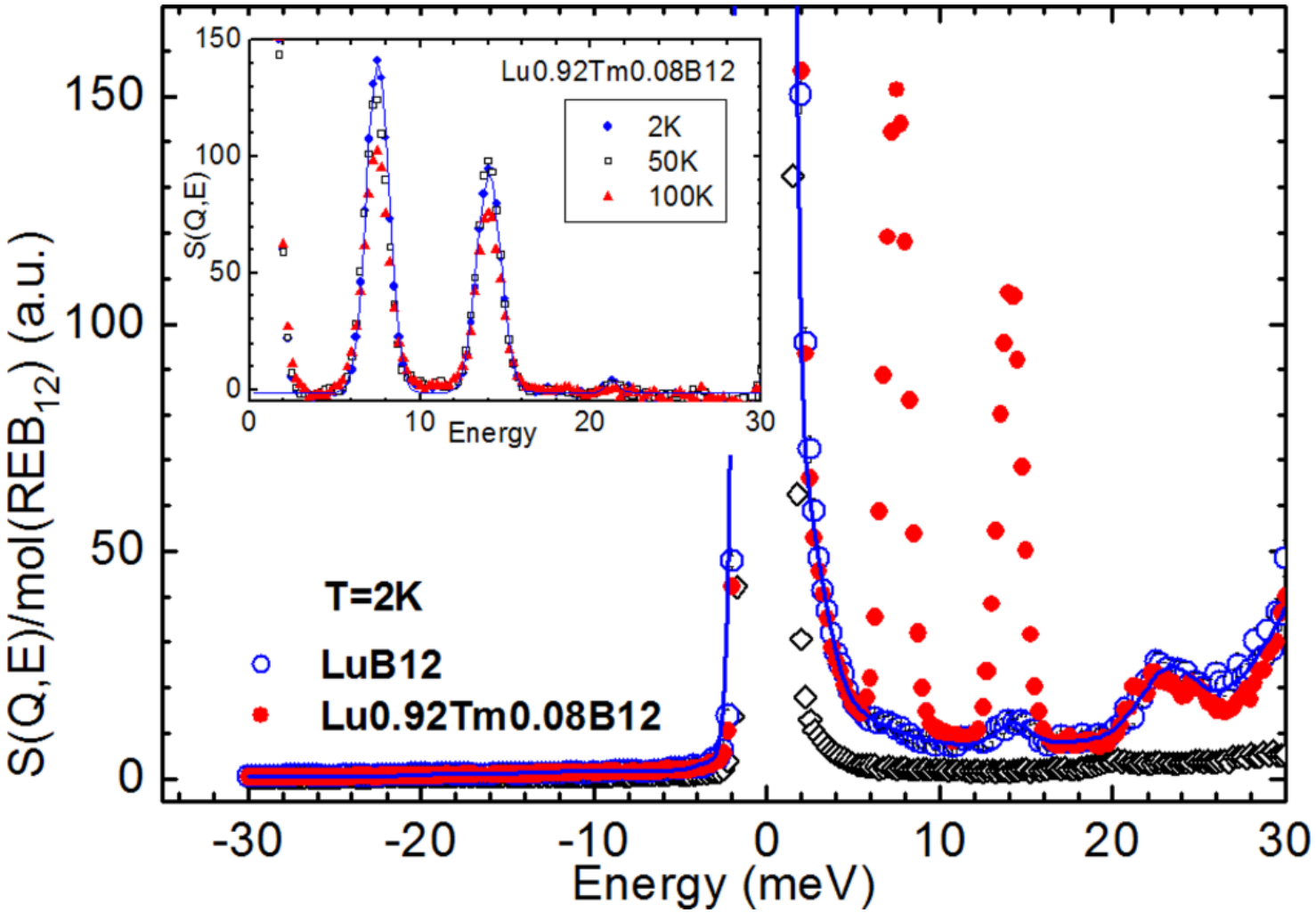
IN4 @ ILL

PG [002] monochromator

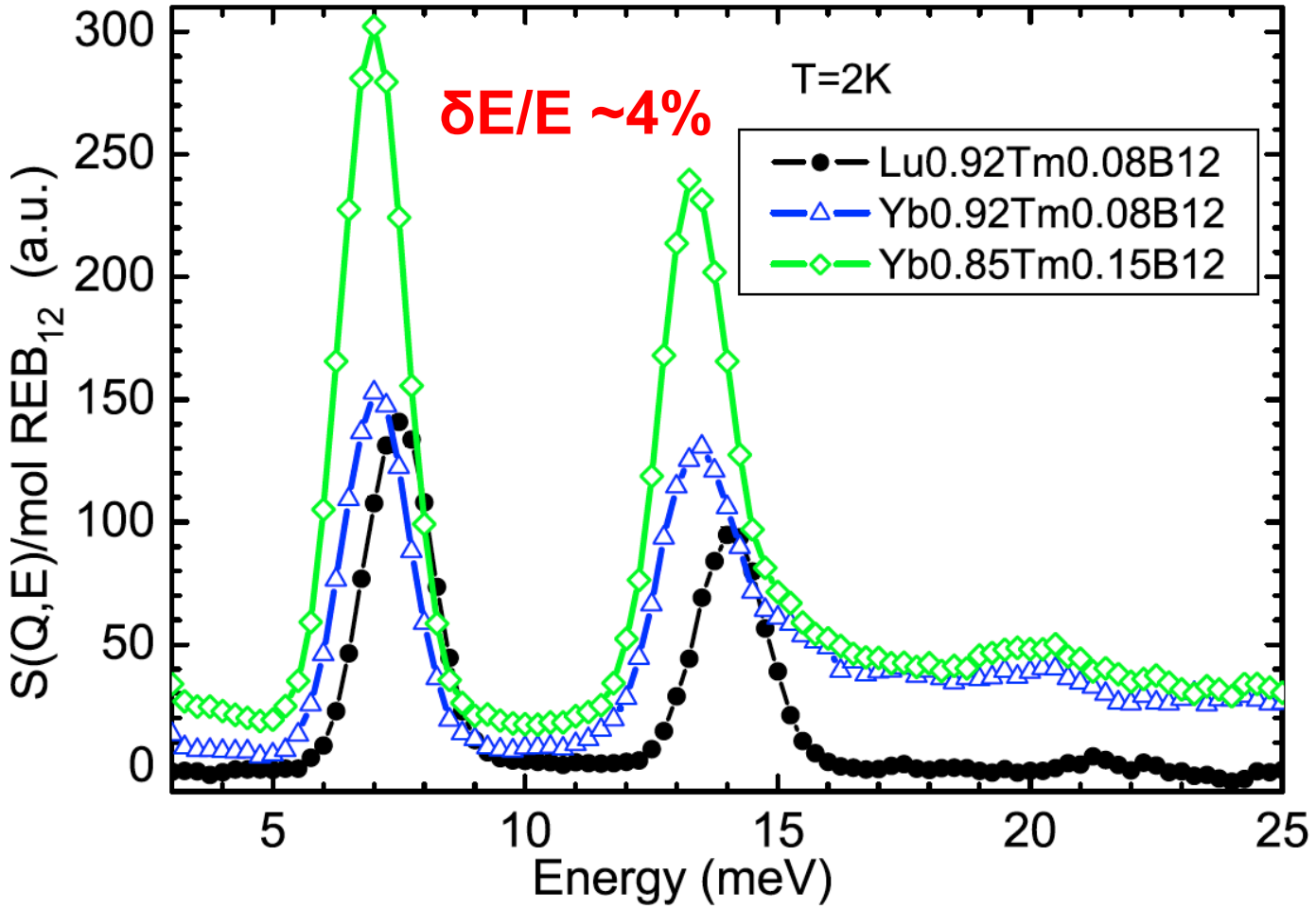
E_i=36 meV, δE=1.75 meV

T = 2…80K

Crystal Field excitations in $(Lu,Tm)B_{12}$



Shift of CF peaks in $(Yb,Tm)B_{12}$



CF parameters (LLW notation):

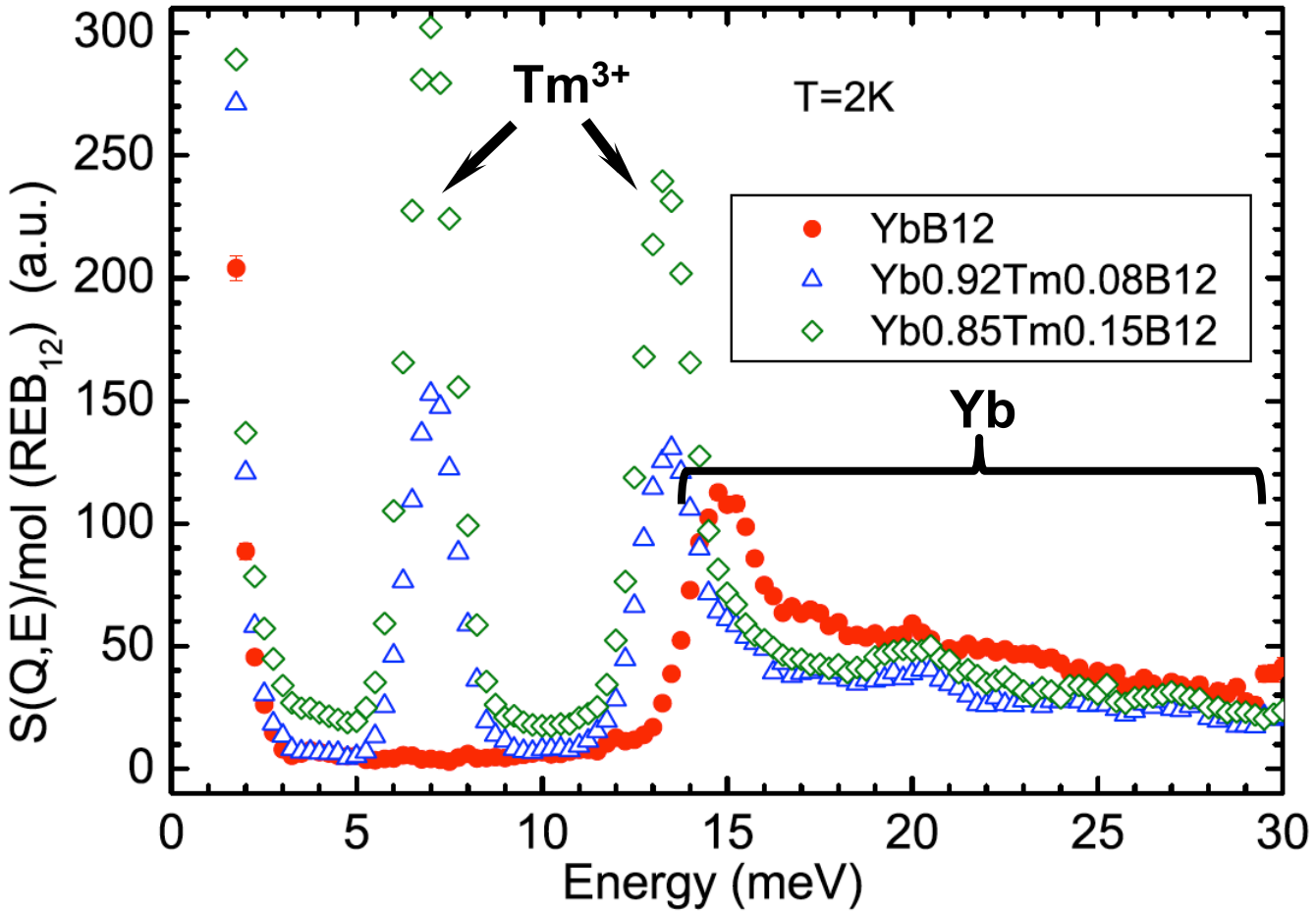
TmB_{12}*
x = -0.063
W = 0.102

$(Lu,Tm)B_{12}$
x = -0.060
W = 0.1016

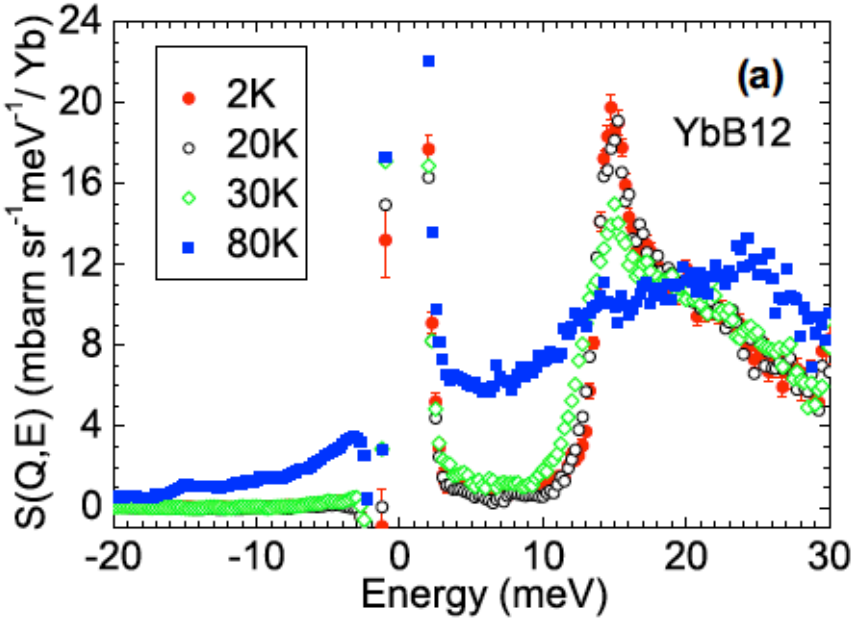
$(Yb,Tm)B_{12}$
x = -0.060
W = 0.0975

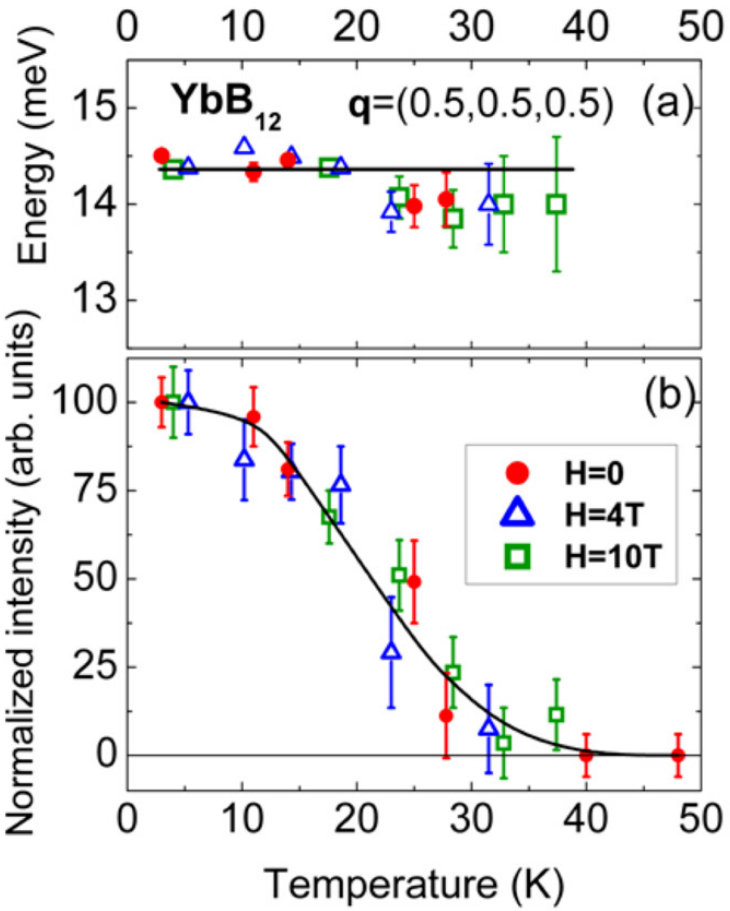
* Murasik et al., Report IAE -99 /A, (2003) Świerk, Poland

YbB_{12} vs. $(Yb,Tm)B_{12}$



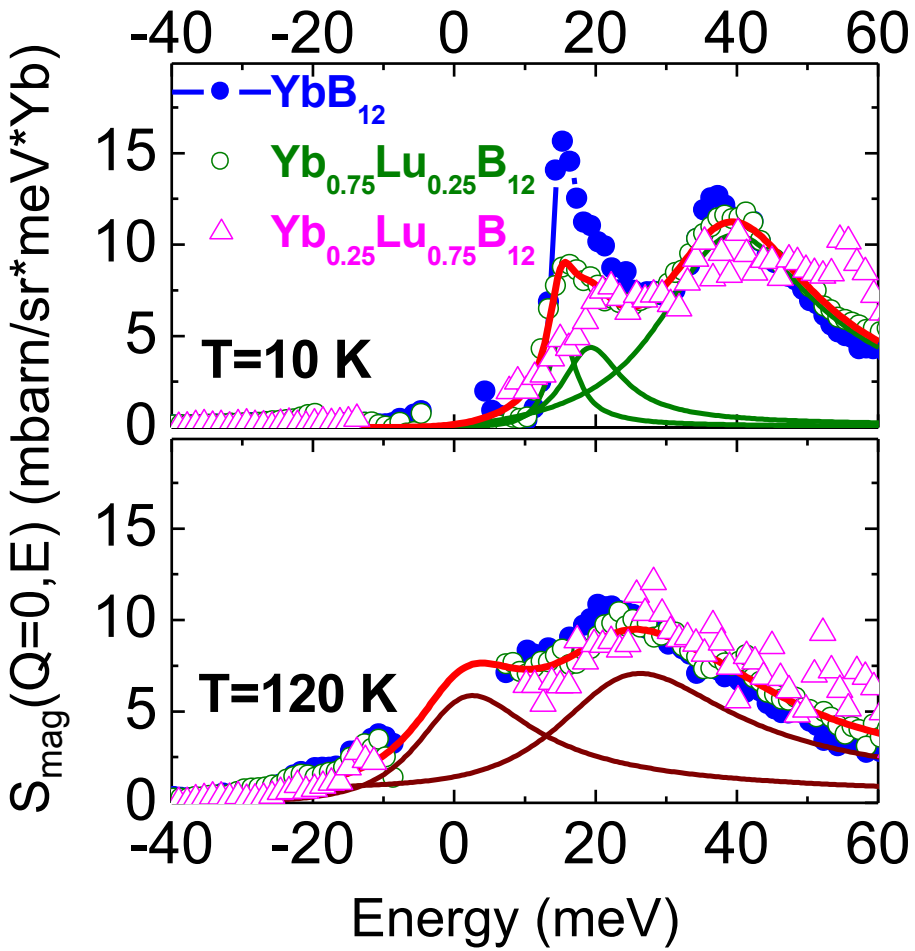
Summary of spin dynamics in YbB_{12}





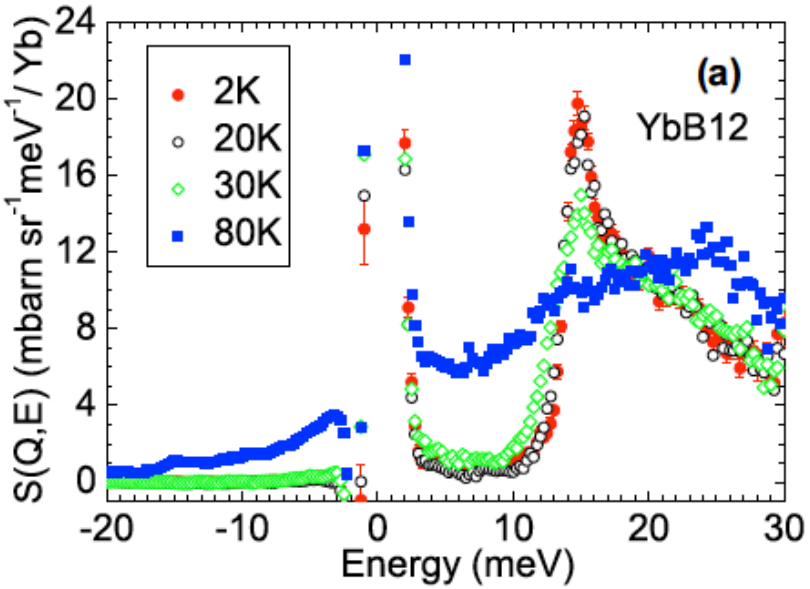
Phys. Proc. **42**, 18 (2013)

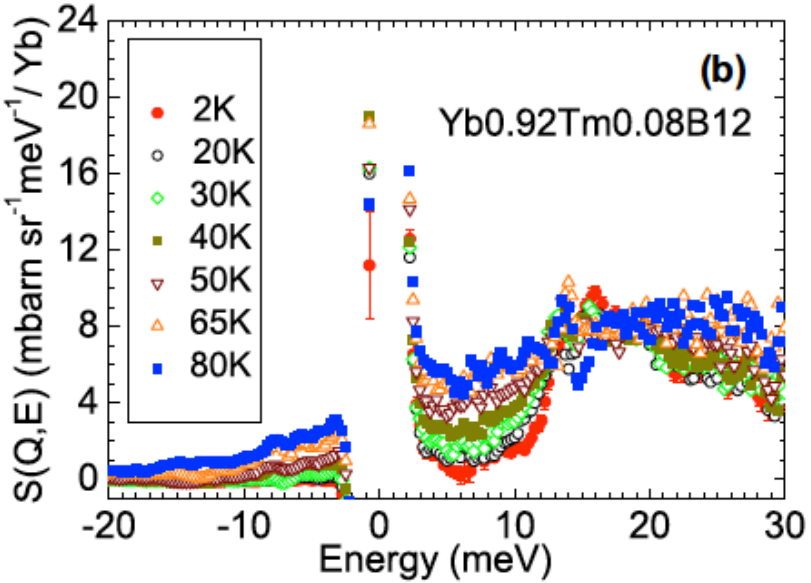
Substitution by non-magnetic Lu

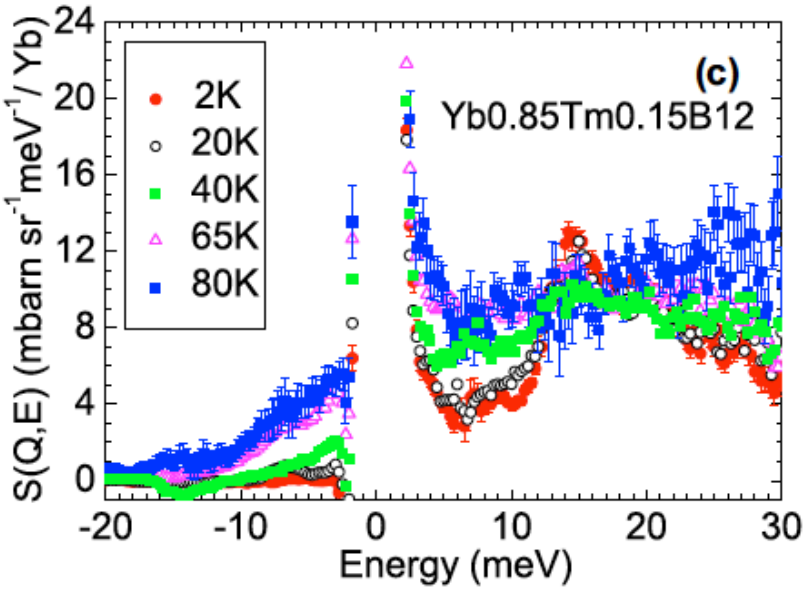


J.Phys.:Cond.Mat. **16** (2004) 2631,
J. Sol. Stat. Chem. **179** (2006) 2858

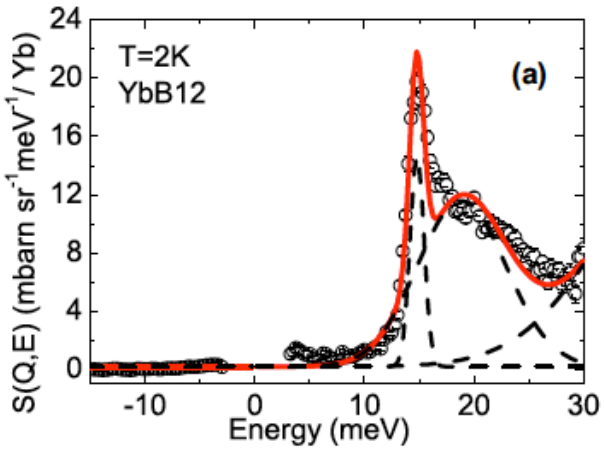
Effect of Tm substitution

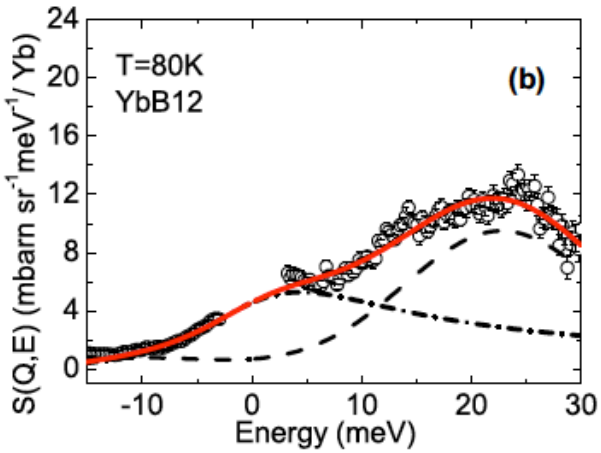


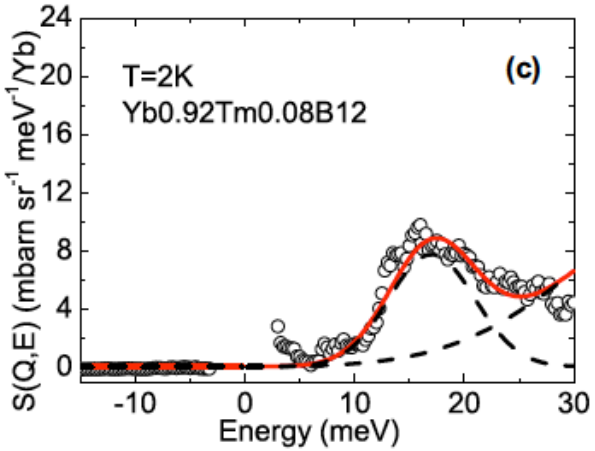


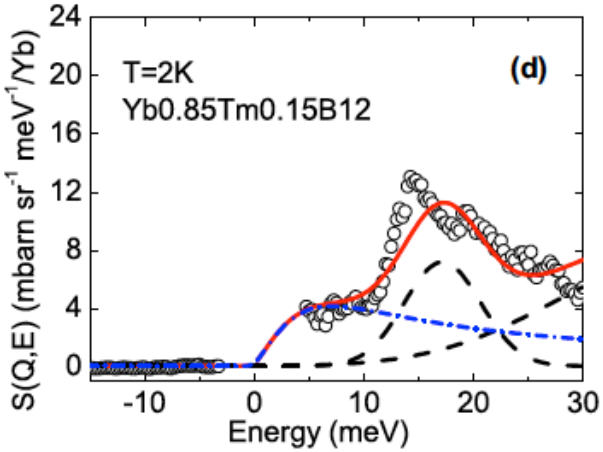


Spin gap and quasielastic signal

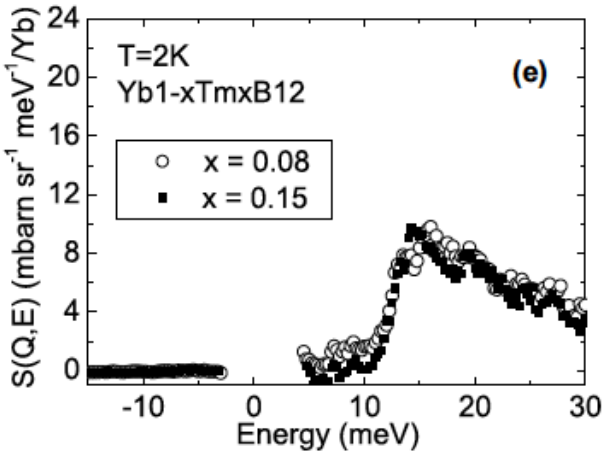




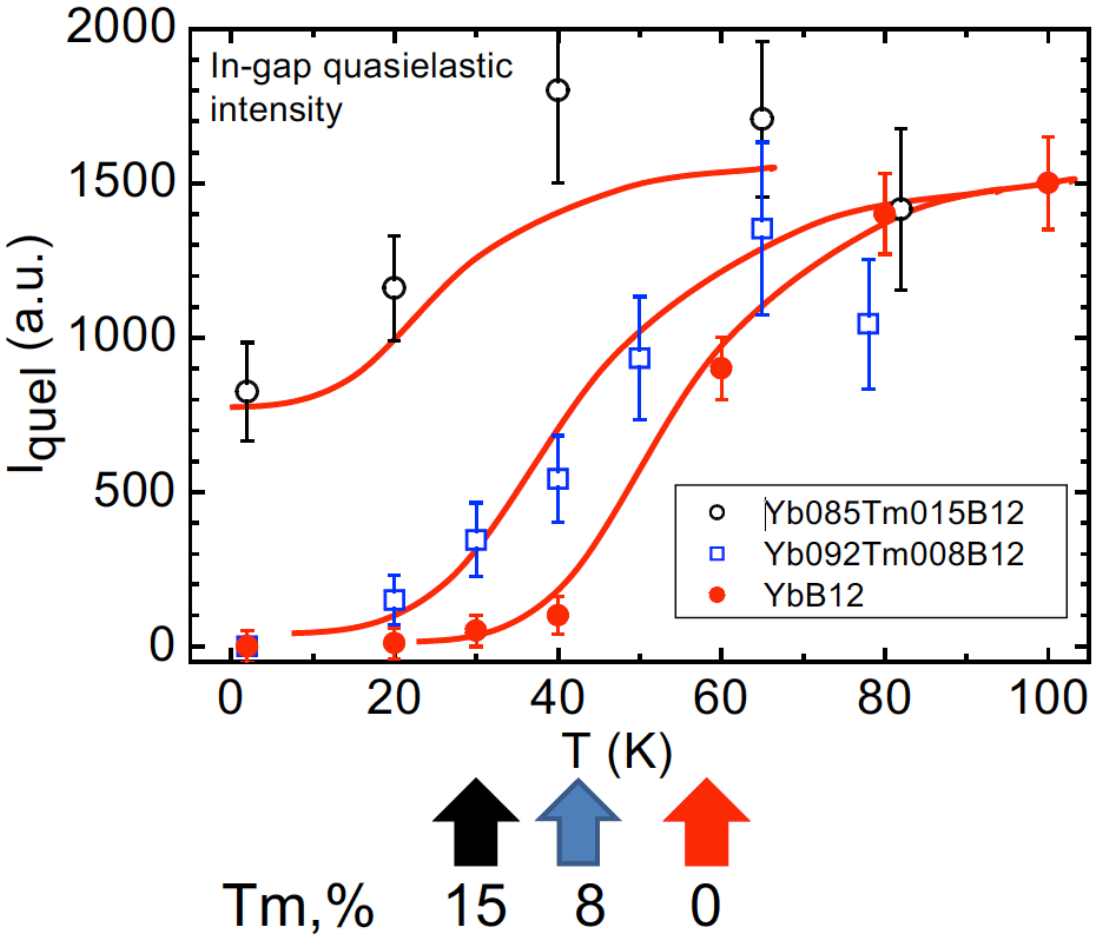




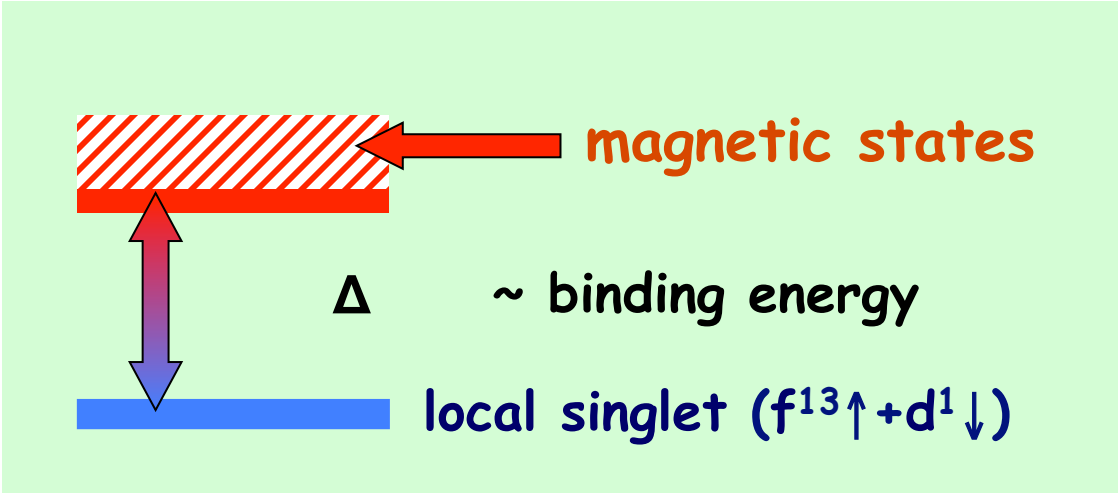
QE peak subtracted:



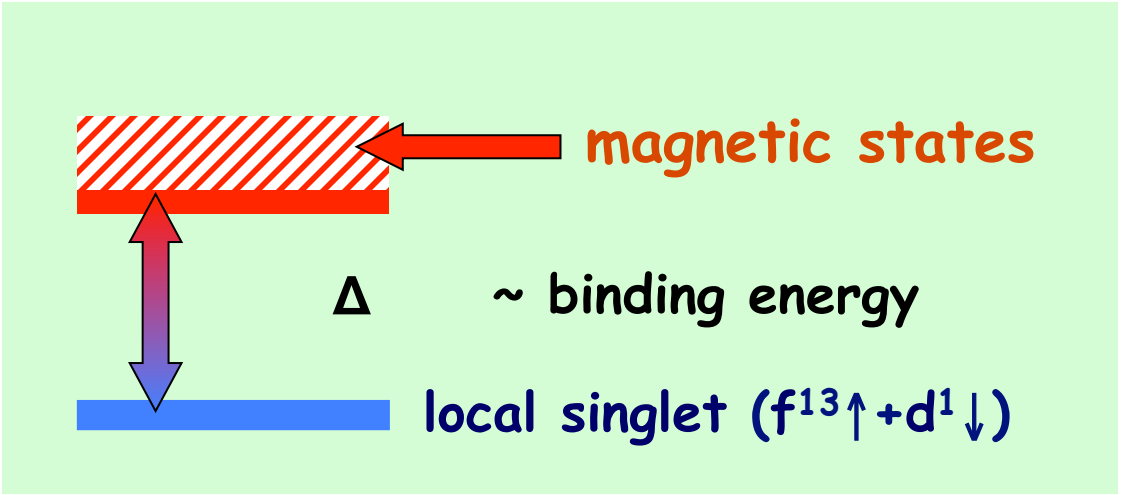
Filling the spin gap in (Yb,Tm)B_{12}



Local gap state in YbB_{12}



Local gap state in YbB_{12}



Undercompensation in $(Yb,Tm)B_{12}$

Strong inelastic scattering of carriers at Tm magnetic moments

↓

breaking the coherence of d-band

↓

incomplete screening of Yb magnetic moments

Thermoelectric power in Kondo systems

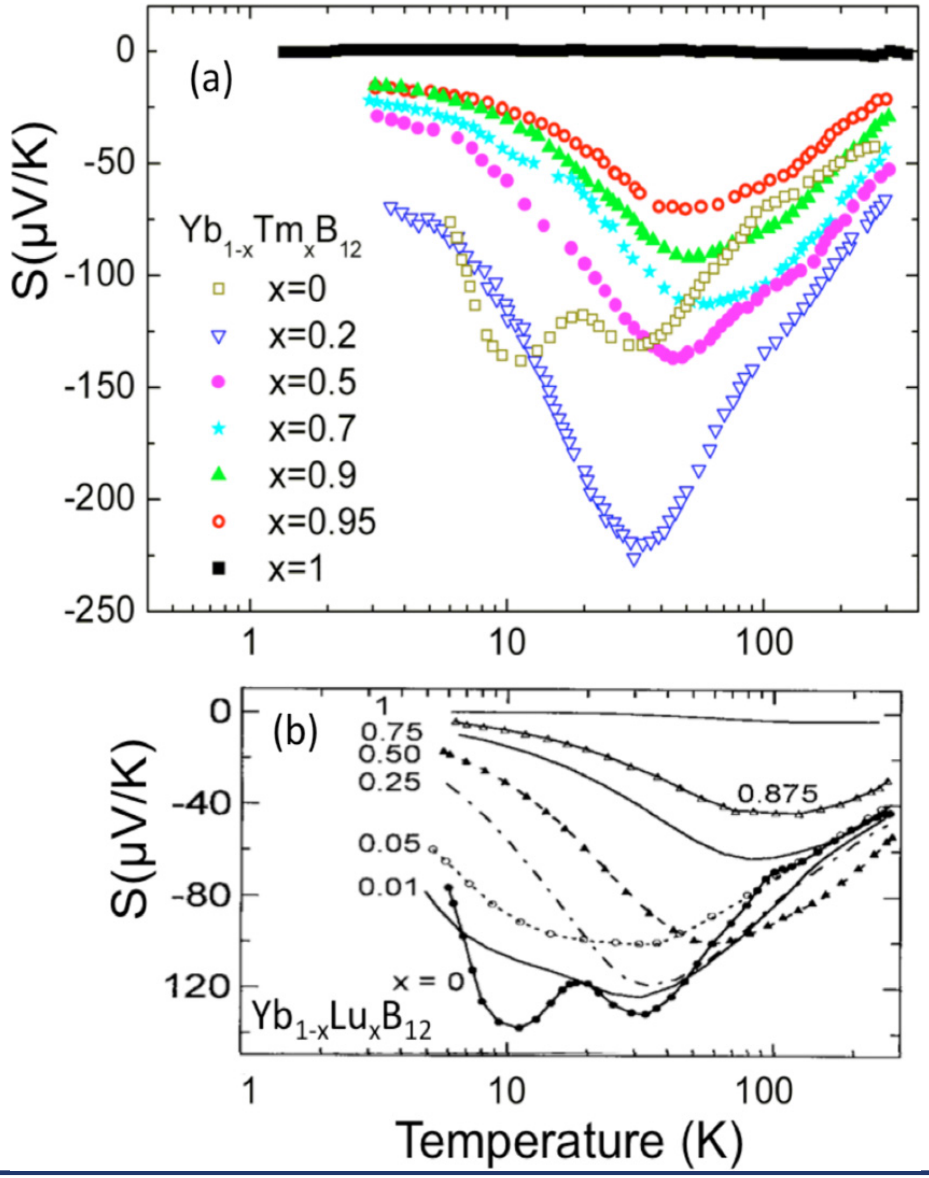
(B. Coqblin et al, 2009)

$$\Delta_{CF} >> T_K$$

two peaks in Seebeck coefficient at:

$$T_1 \sim \Delta_{CF}$$
$$T_2 \sim T_K/2$$

Analysis of thermoelectric power in $Yb(Tm,Lu)B_{12}$

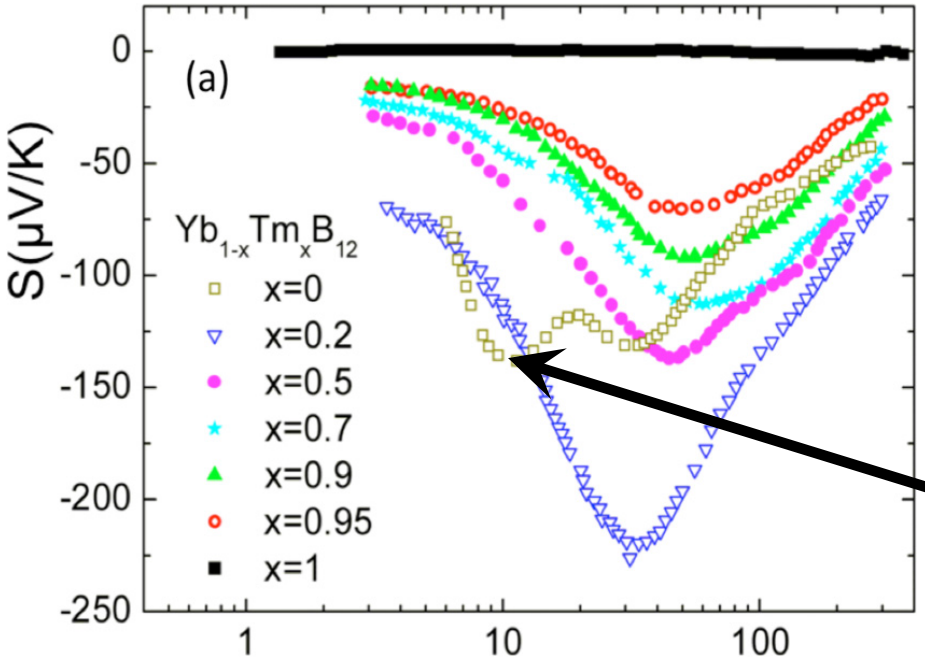


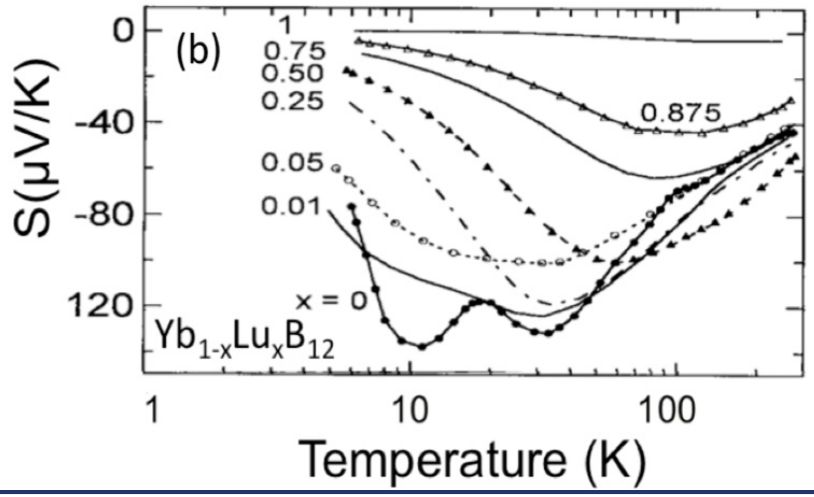
$T_1 \sim \Delta_{CF} = 200K$

$T_2 \sim T_K/2 = 50K$

$T_3 \sim 10K$

Analysis of thermoelectric power in $Yb(Tm,Lu)B_{12}$





$T_1 \sim \Delta_{CF} = 200K$

$T_2 \sim T_K/2 = 50K$

$T_3 \sim 10K$

RM-related?
(RM develops below 30K)

Thank you for attention