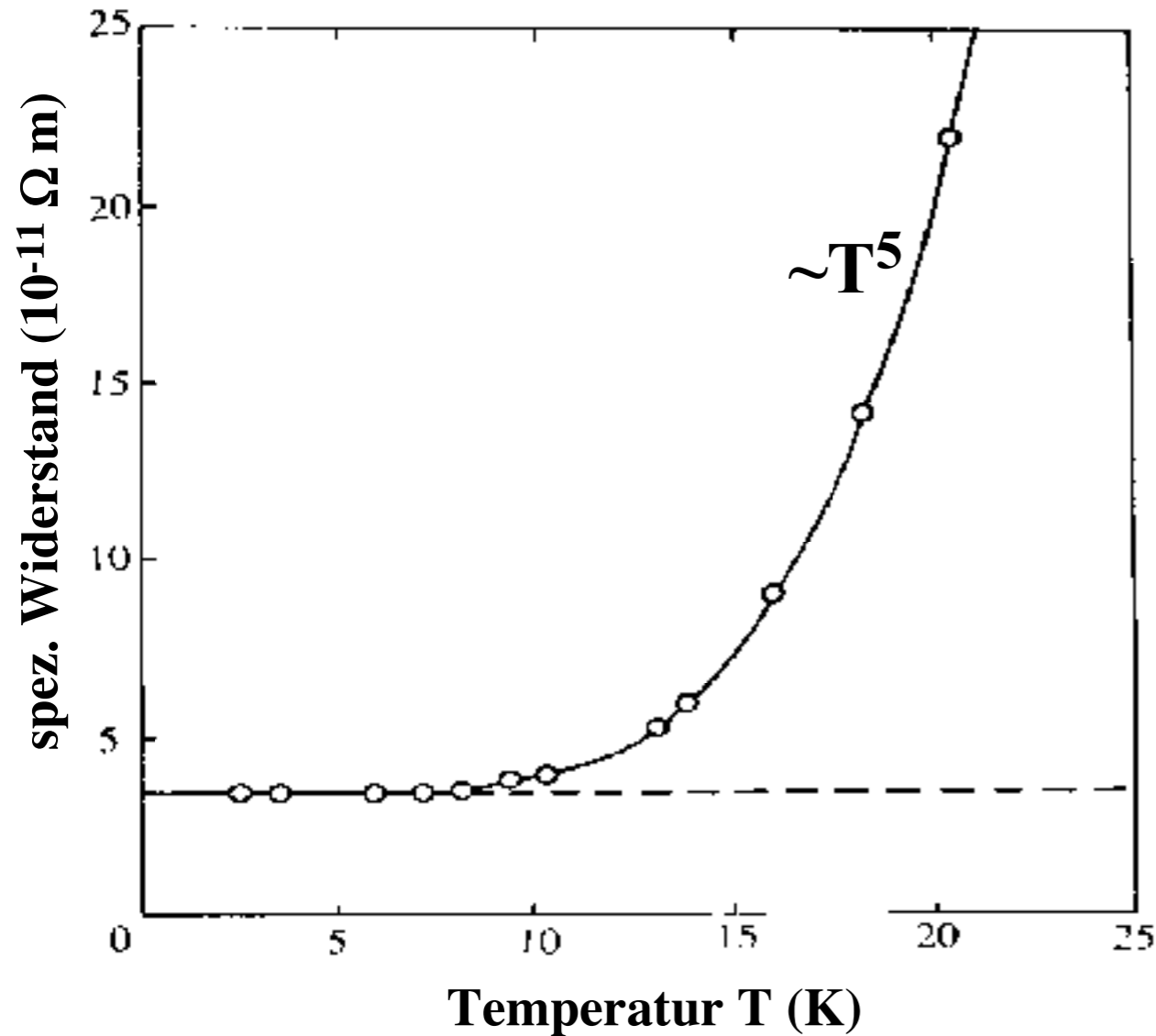
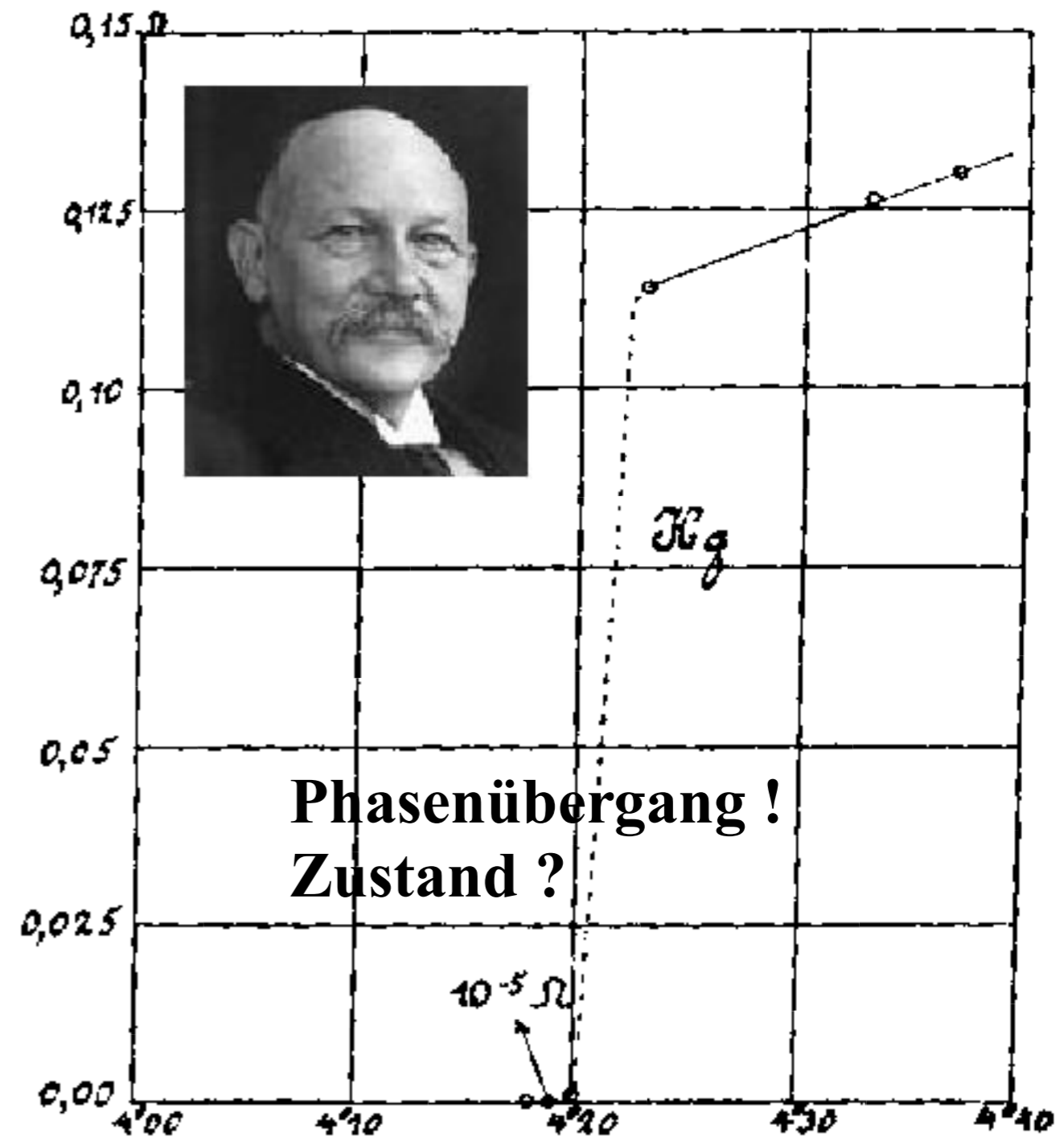


# Widerstand bei tiefen Temperaturen

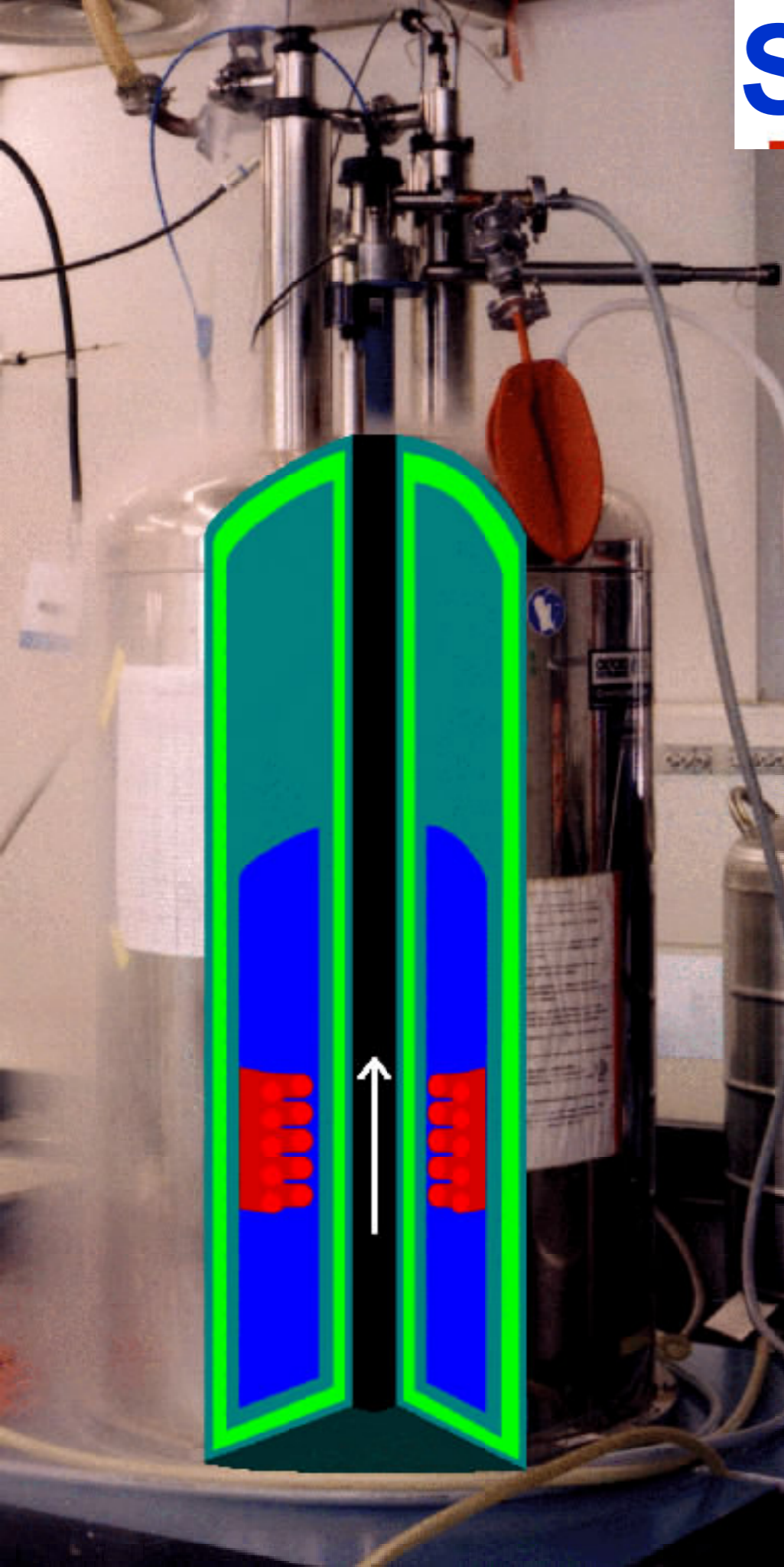
## Typisches Metall



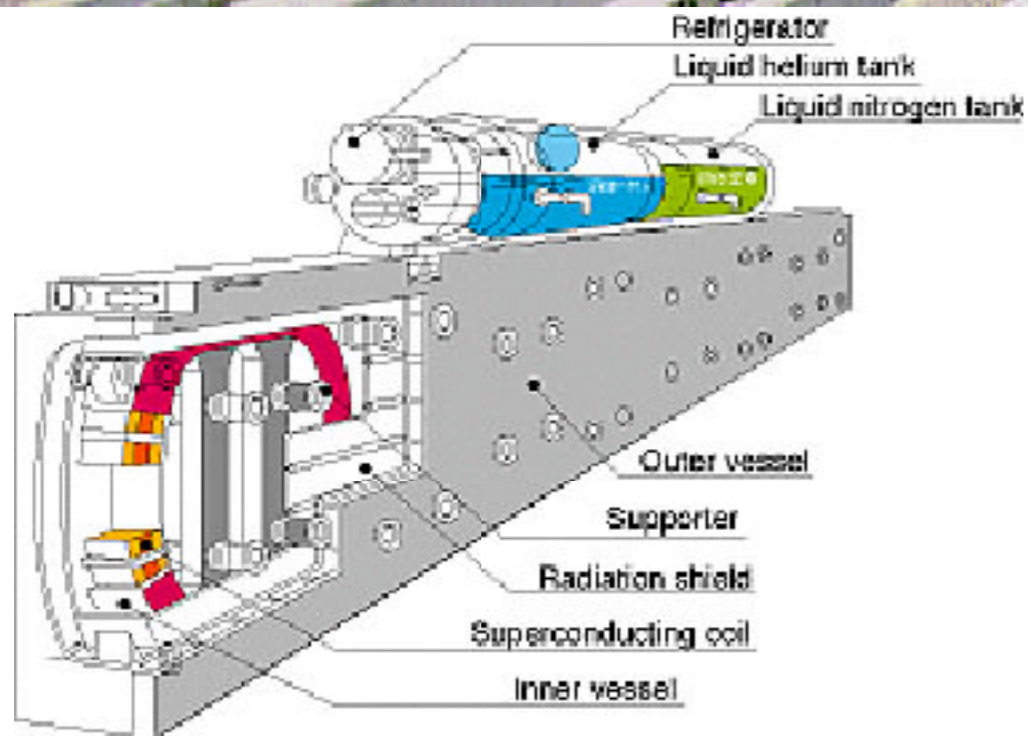
## Messung von Kammerlingh Onnes an Quecksilber (Leiden, 1911)



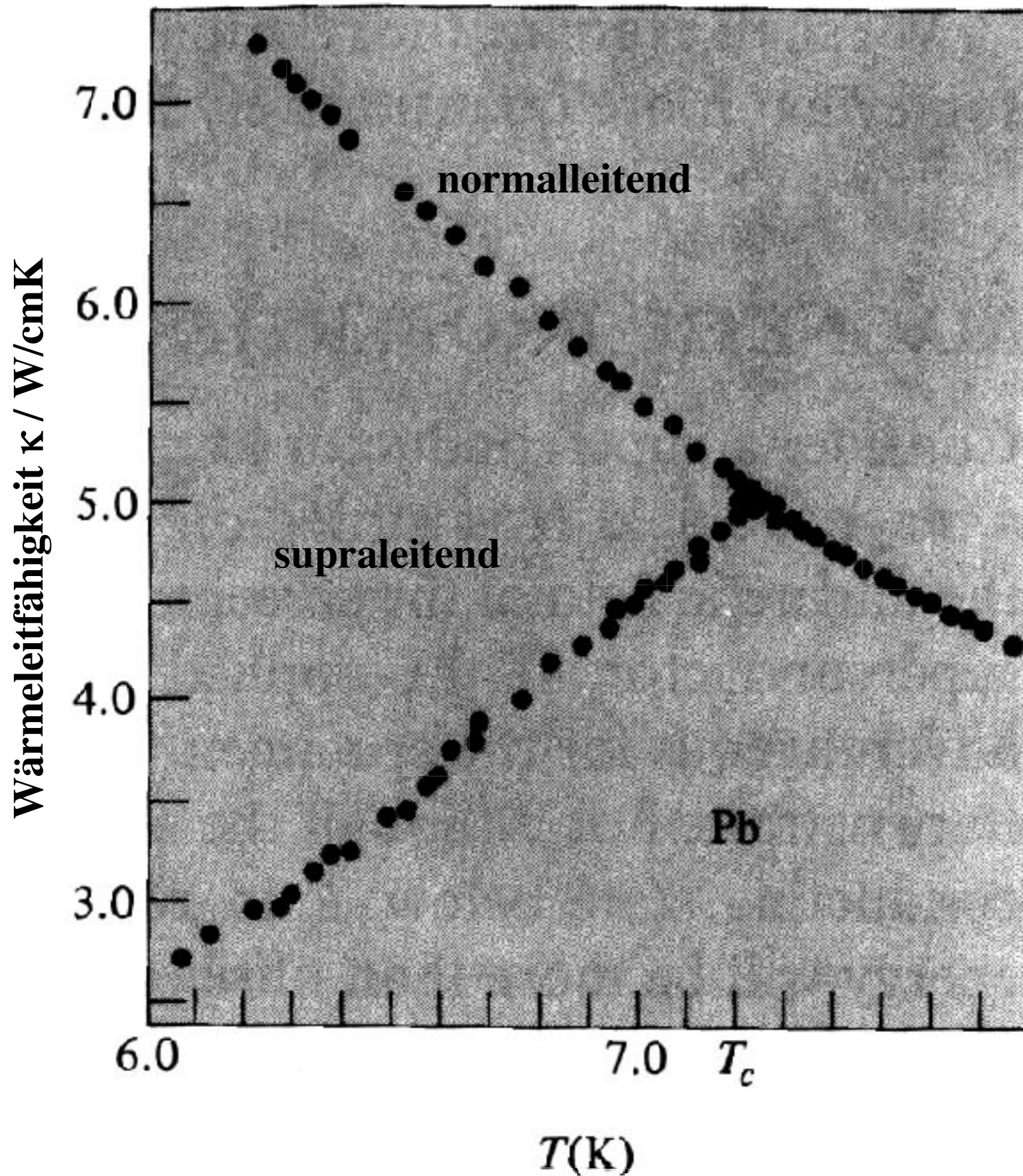
# Supraleitender Magnet



# Supraleiter für Transport



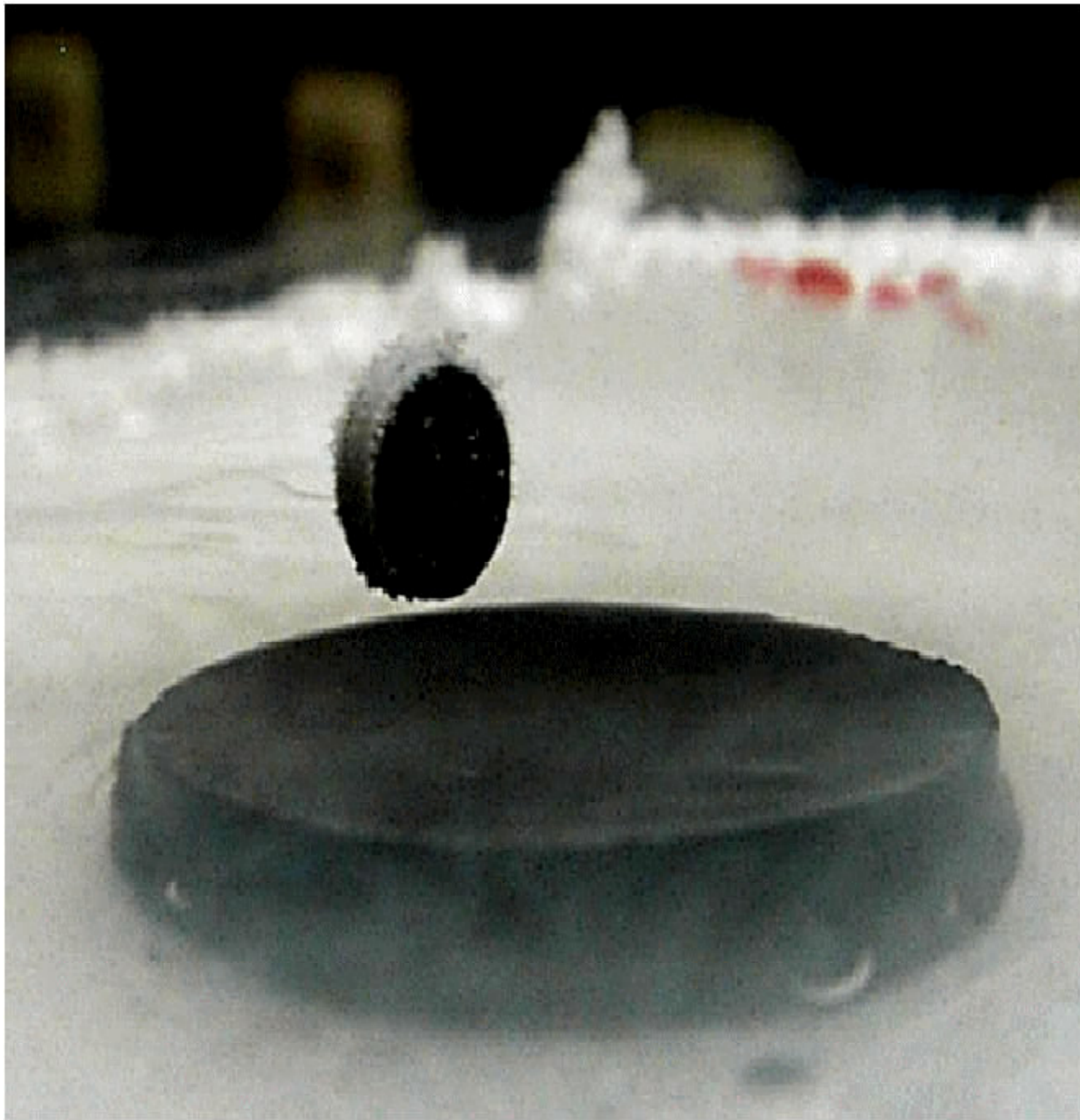
# Thermische Leitfähigkeit



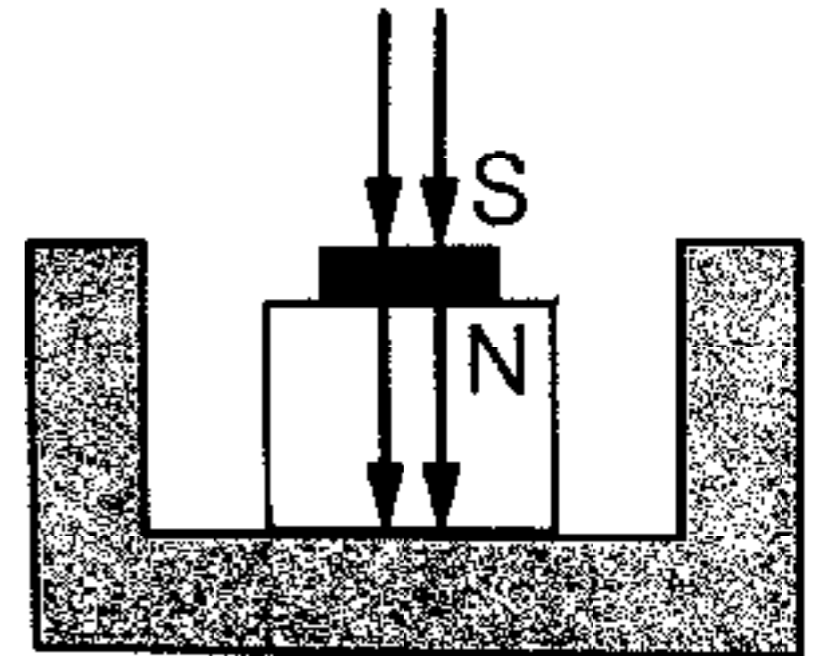
N.W. Ashcroft and N.D. Mermin, 'Solid state physics', Holt, Rinehart and Winston, New York (1976).

# Meißner Effekt

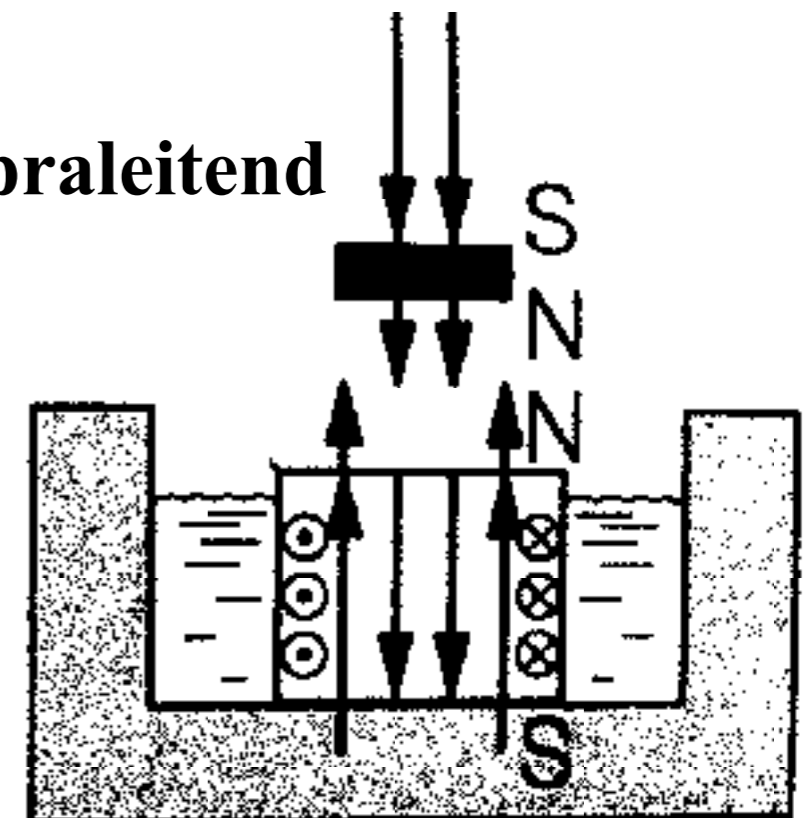
Magnet schwebt über Supraleiter



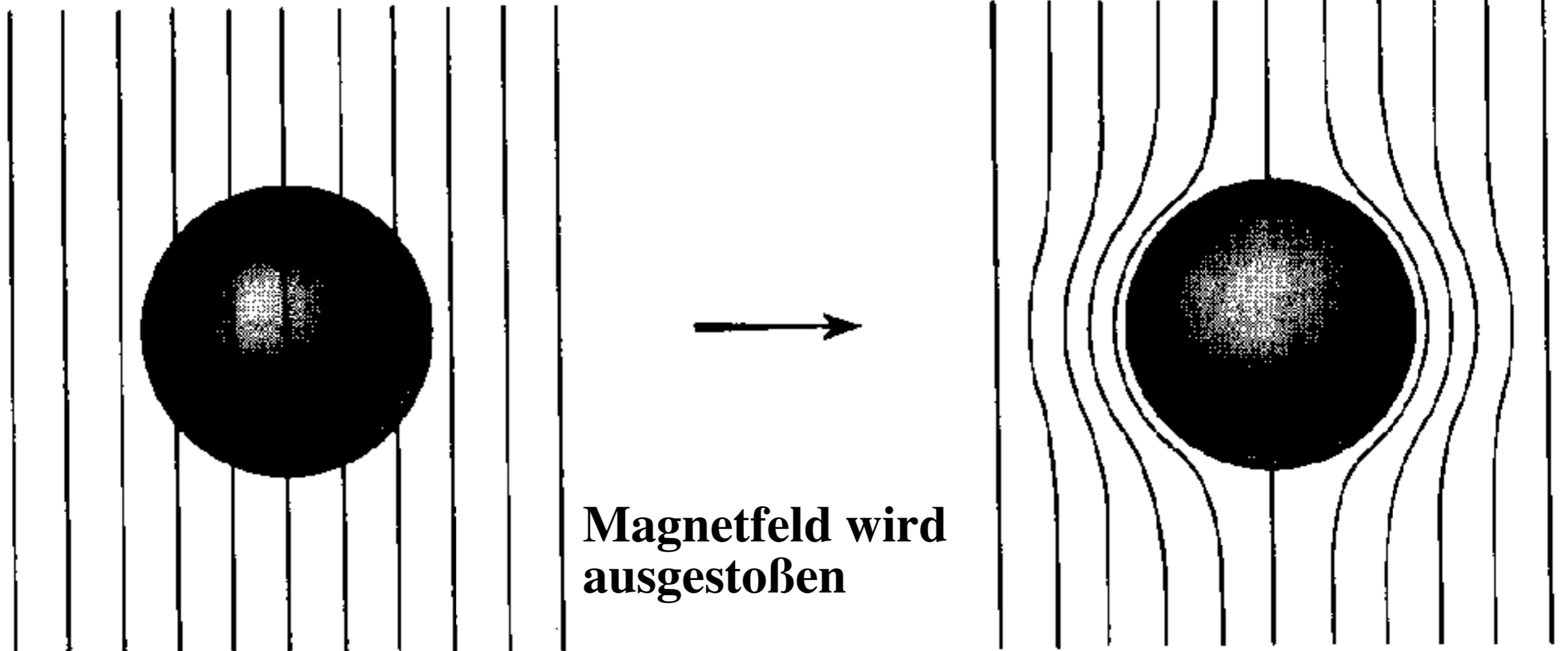
normal leitend



supraleitend



# Meißner Effekt



Magnetfeld wird  
ausgestoßen

$$\vec{M} = -\vec{H}$$

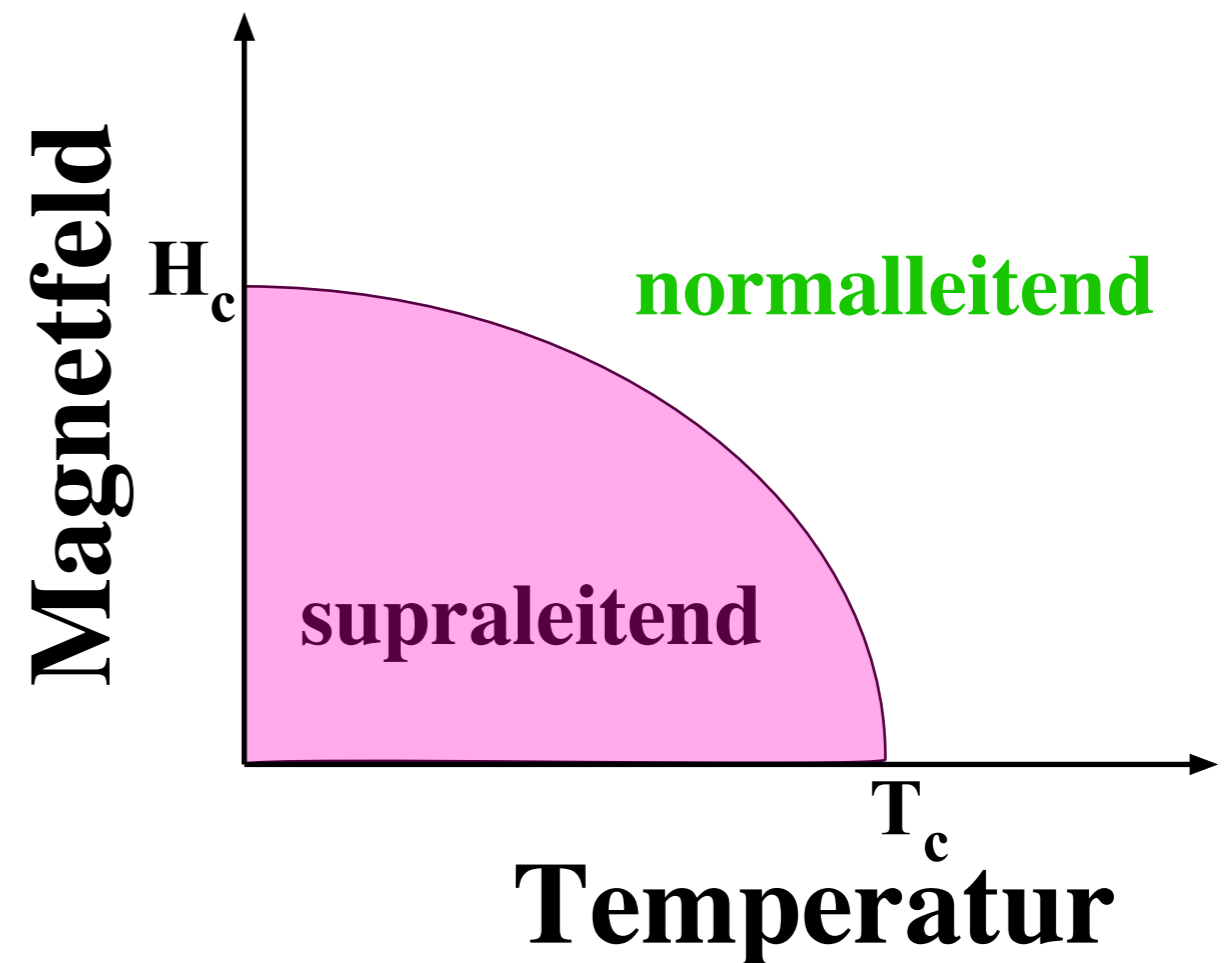
$$\chi_m = -1/\mu_0$$

“perfekter Diamagnetismus”

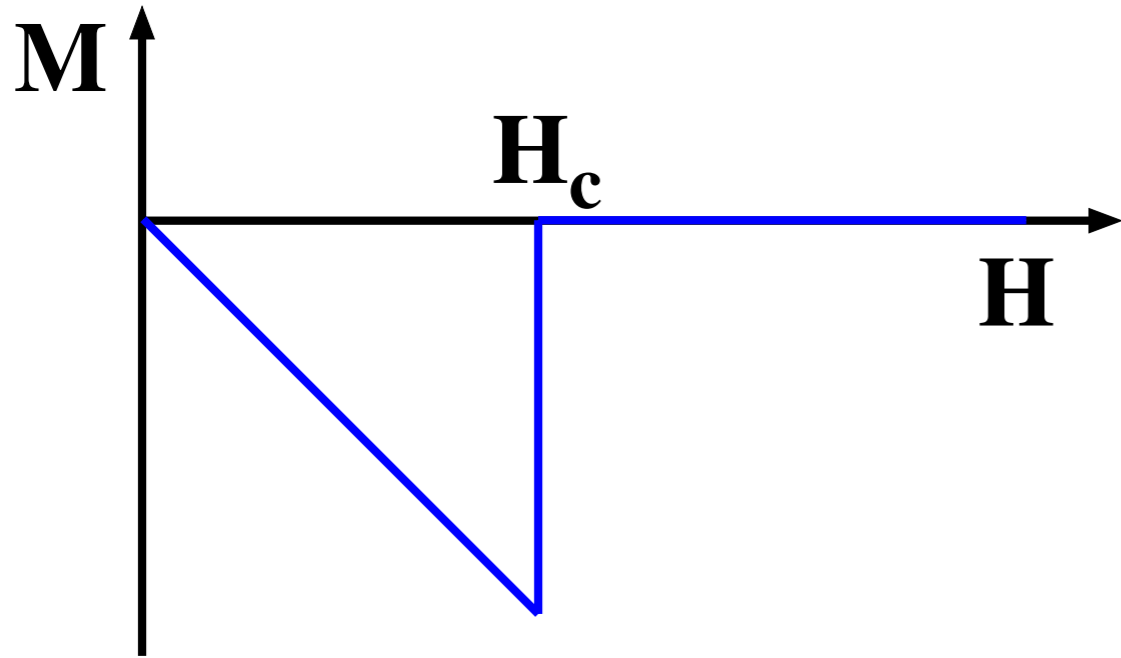
# Kritisches Verhalten

## kritische Temperaturen

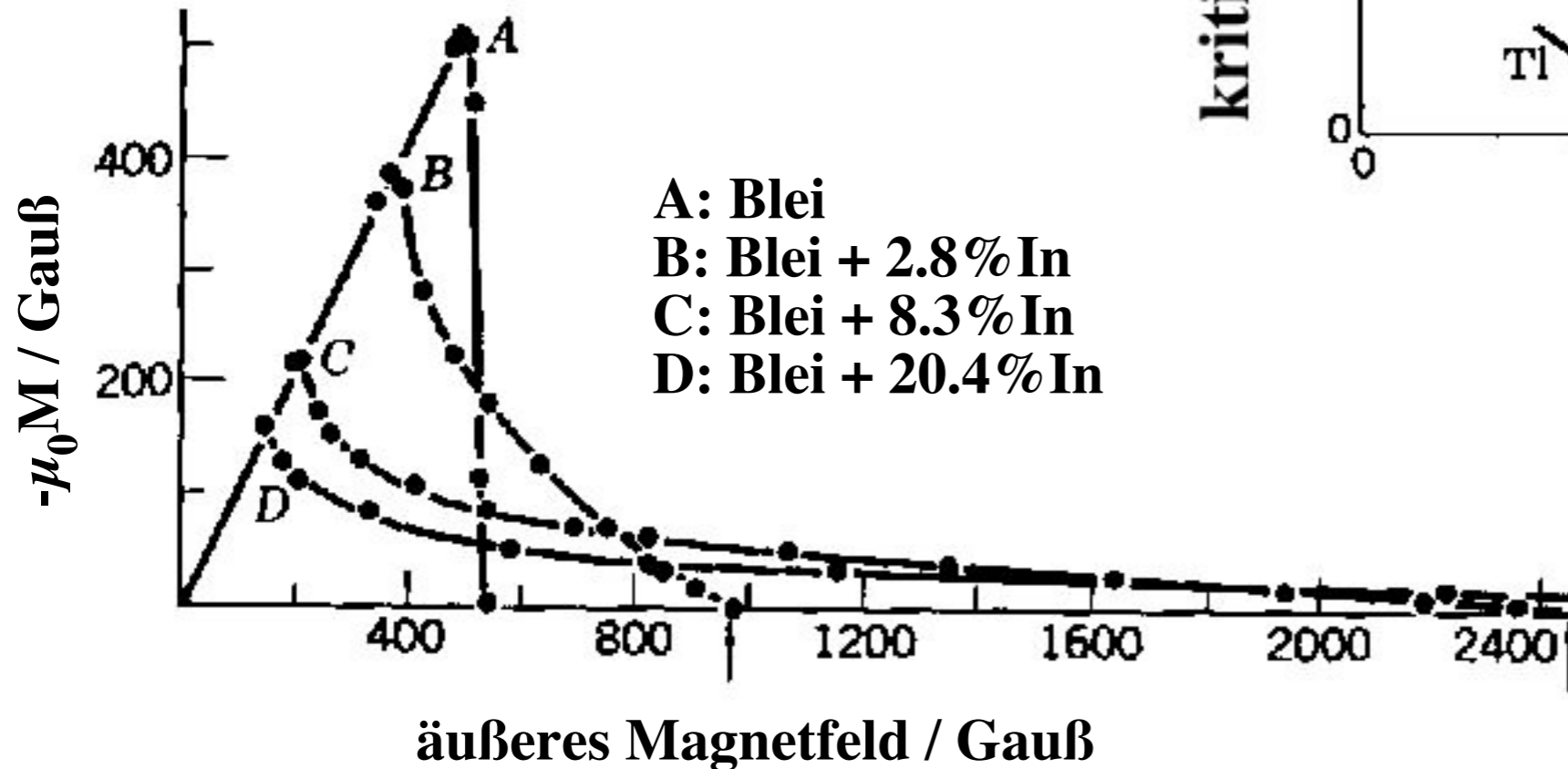
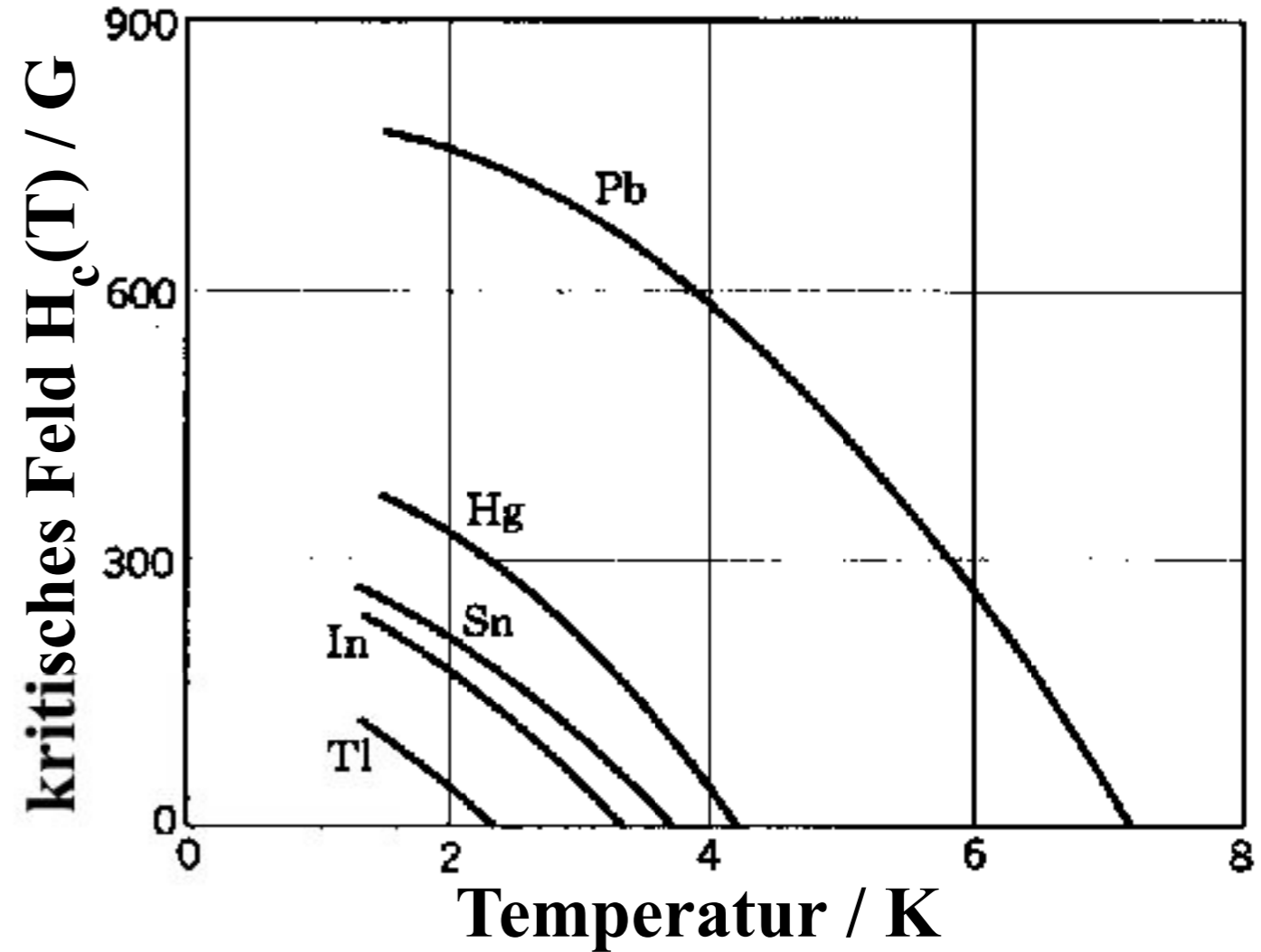
Stoff	$T_C/K$
Al	1.19
Be	0.026
Hg	4.15
Zn	0.9
Wo	0.012
Pb	7.2
$V_3Si$	17.1
$Nb_3Sn$	18.0
$Nb_3Al_8Ge_{0.2}$	20.7
$YBa_2Cu_3O_{6+x}$	90
$HgBa_2CuO_{4+\delta}$	133
$CsRb_2C_{60}$	31



# Kritisches Feld

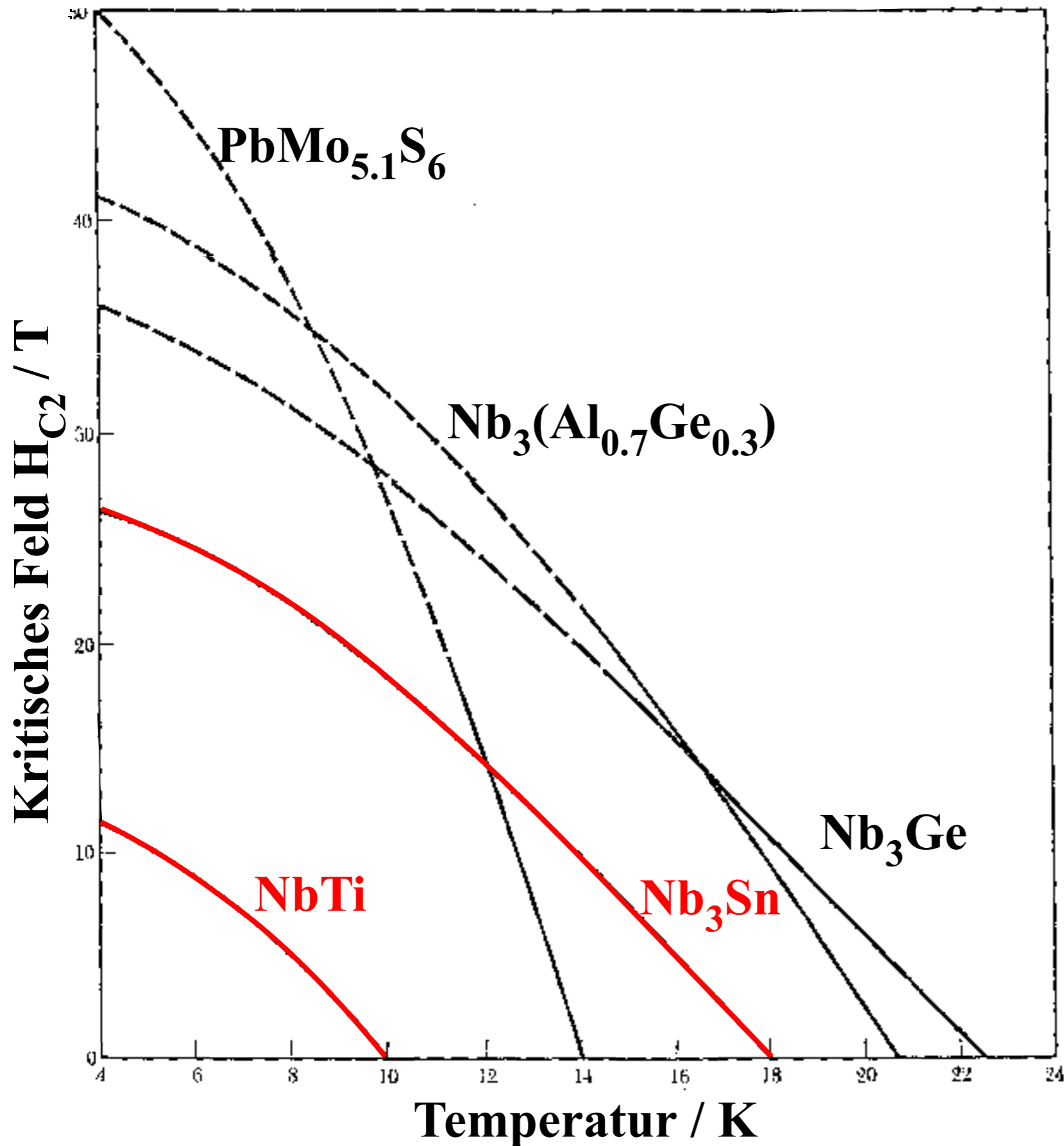


Kritisches Verhalten (T, H)

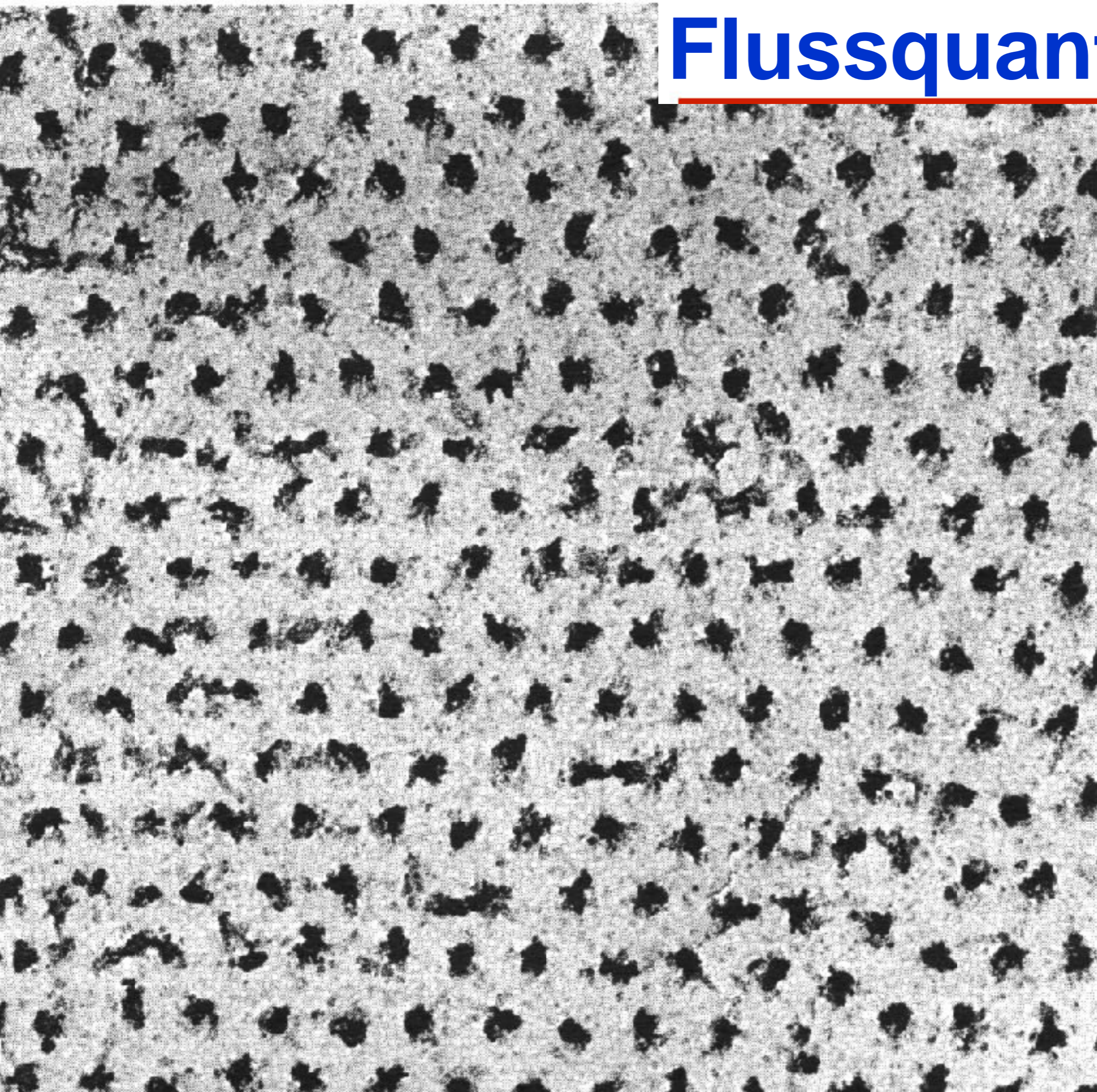




# Typ II Supraleiter: kritische Felder



# Flussquantengitter



# Elementare Supraleiter

1	IA	1	H	IIA	<div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; background-color: blue; margin-right: 5px;"></div> <div style="margin-right: 10px;">Normaldruck</div> </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 15px; height: 15px; background-color: green; margin-right: 5px;"></div> <div>Druck</div> </div>																0	2	He														
2		3	Li	4	Be								5	B	6	C	7	N	8	O	9	F	10	Ne													
3		11	Na	12	Mg	III B	IV B	V B	VI B	VII B	VIII B	IX B	X B	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar												
4		19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
5		37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
6		55	Cs	56	Ba	57	*La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
7		87	Fr	88	Ra	89	+Ac	104	Rf	105	Ha	106	106	107	107	108	108	109	109	110	110	111	111	112	112												

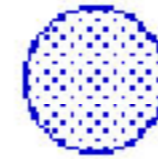
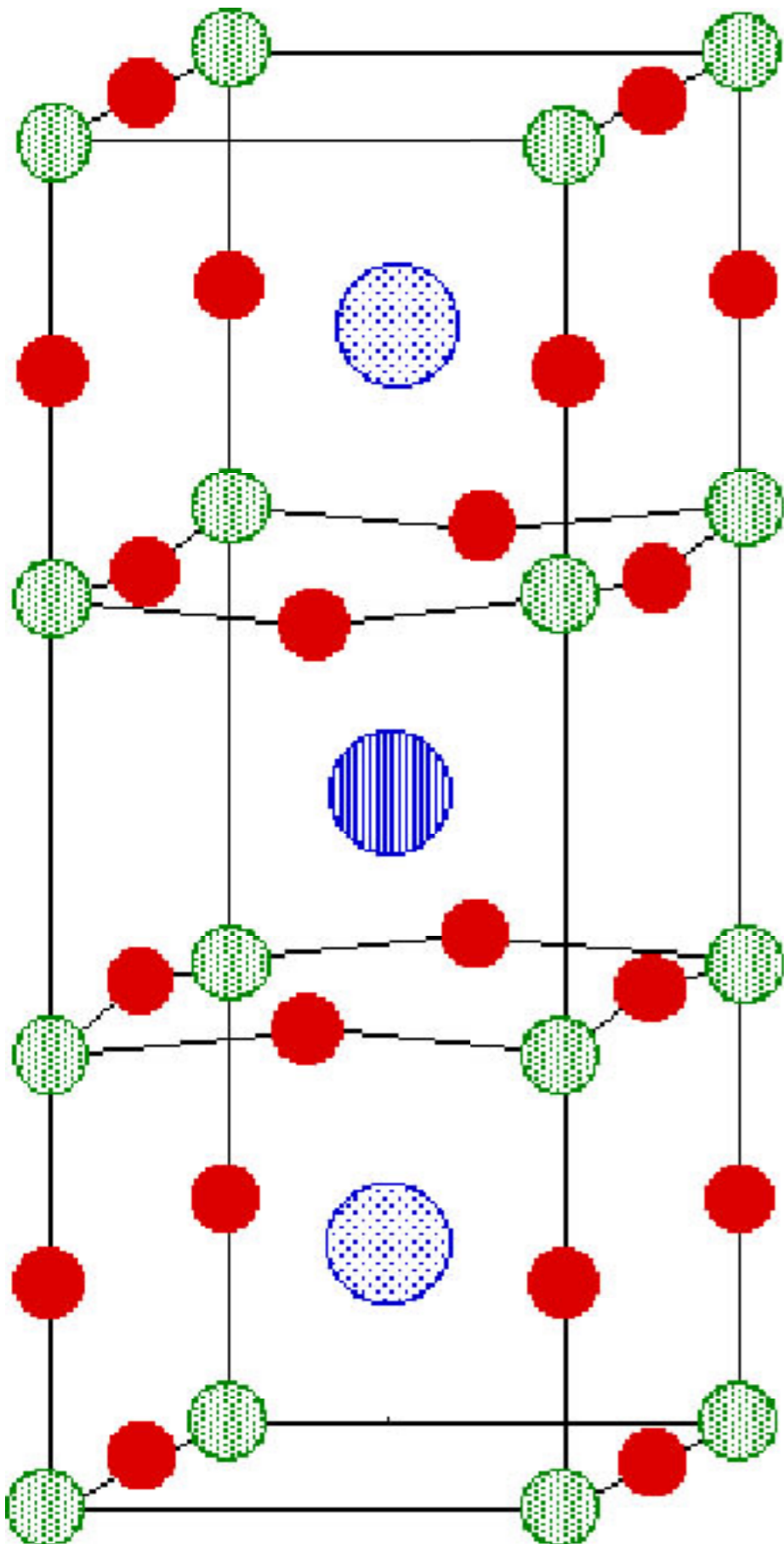
\* Lanthanide Series

+ Actinide Series

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

# Struktur von HTC's

## Einheitszelle von $\text{YBa}_2\text{Cu}_3\text{O}_7$



Barium



Yttrium

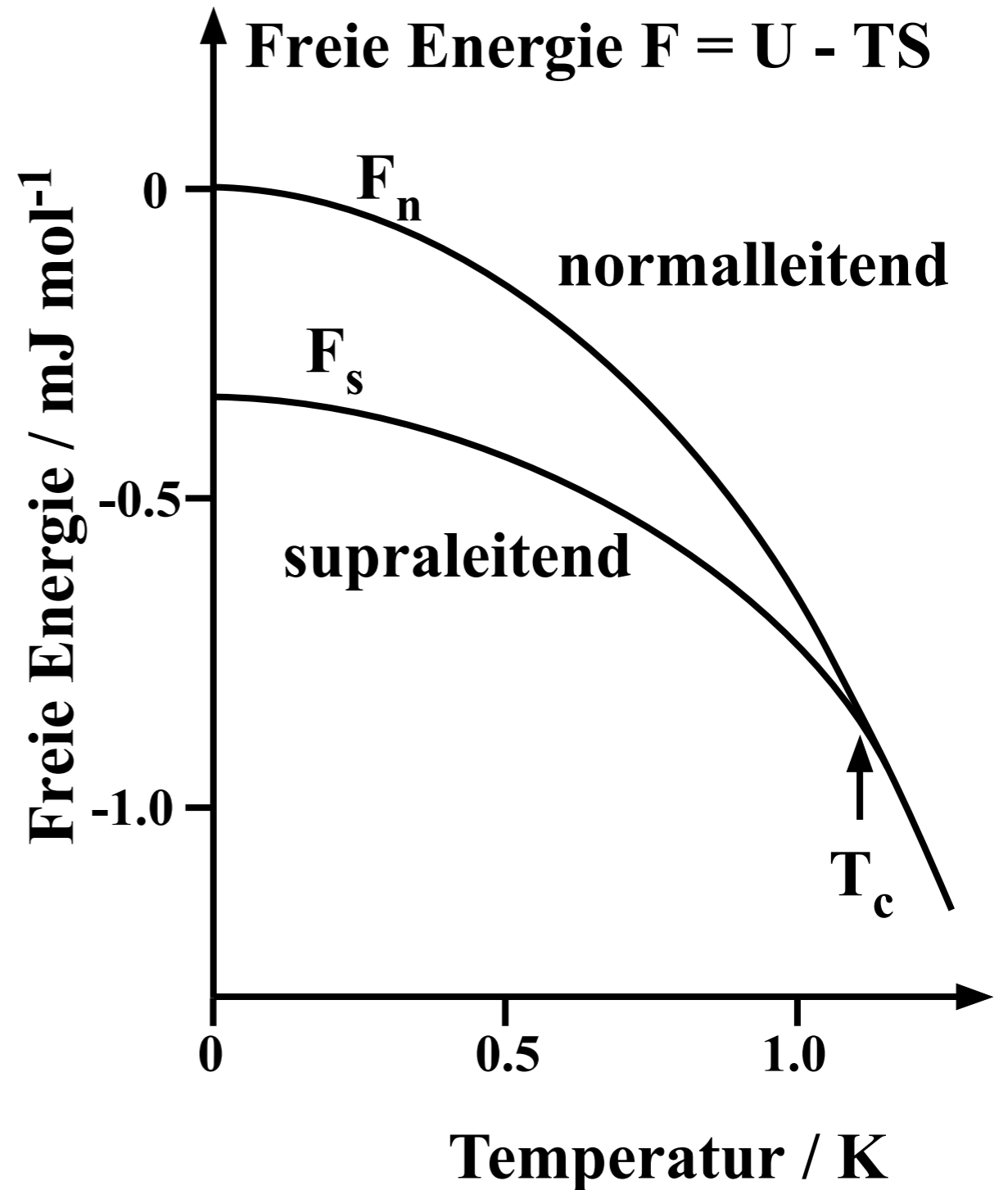
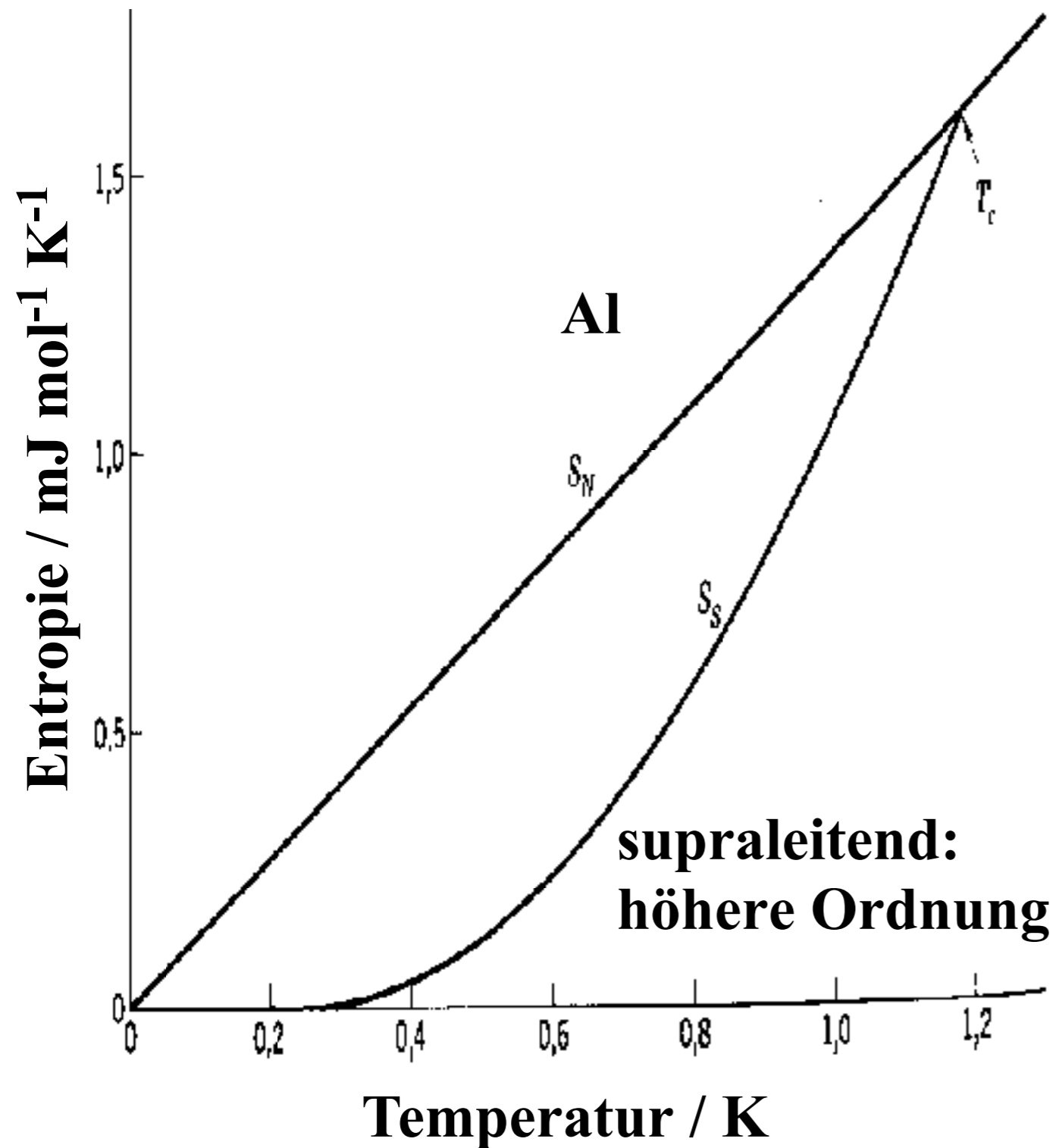


Copper

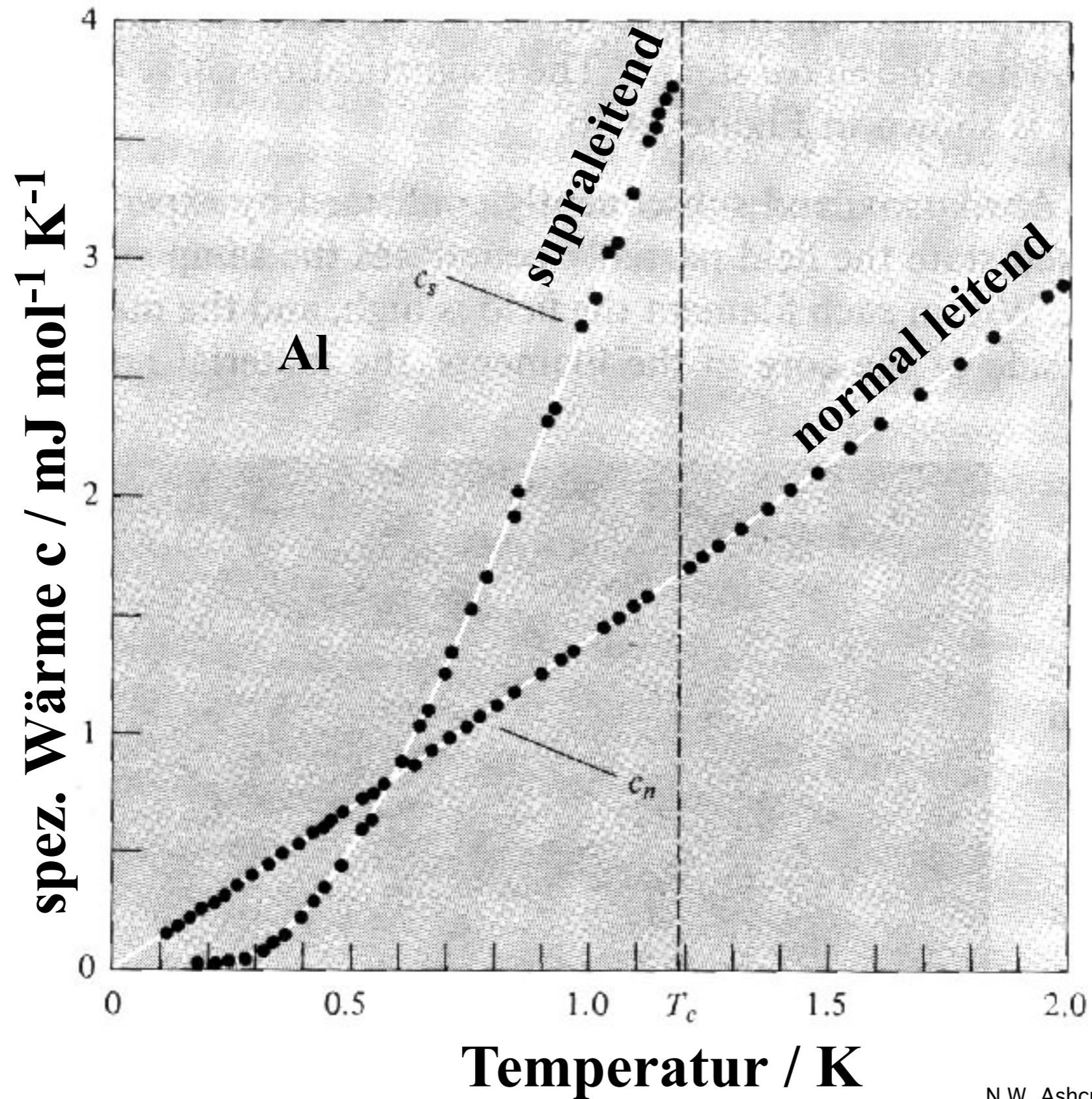


Oxygen

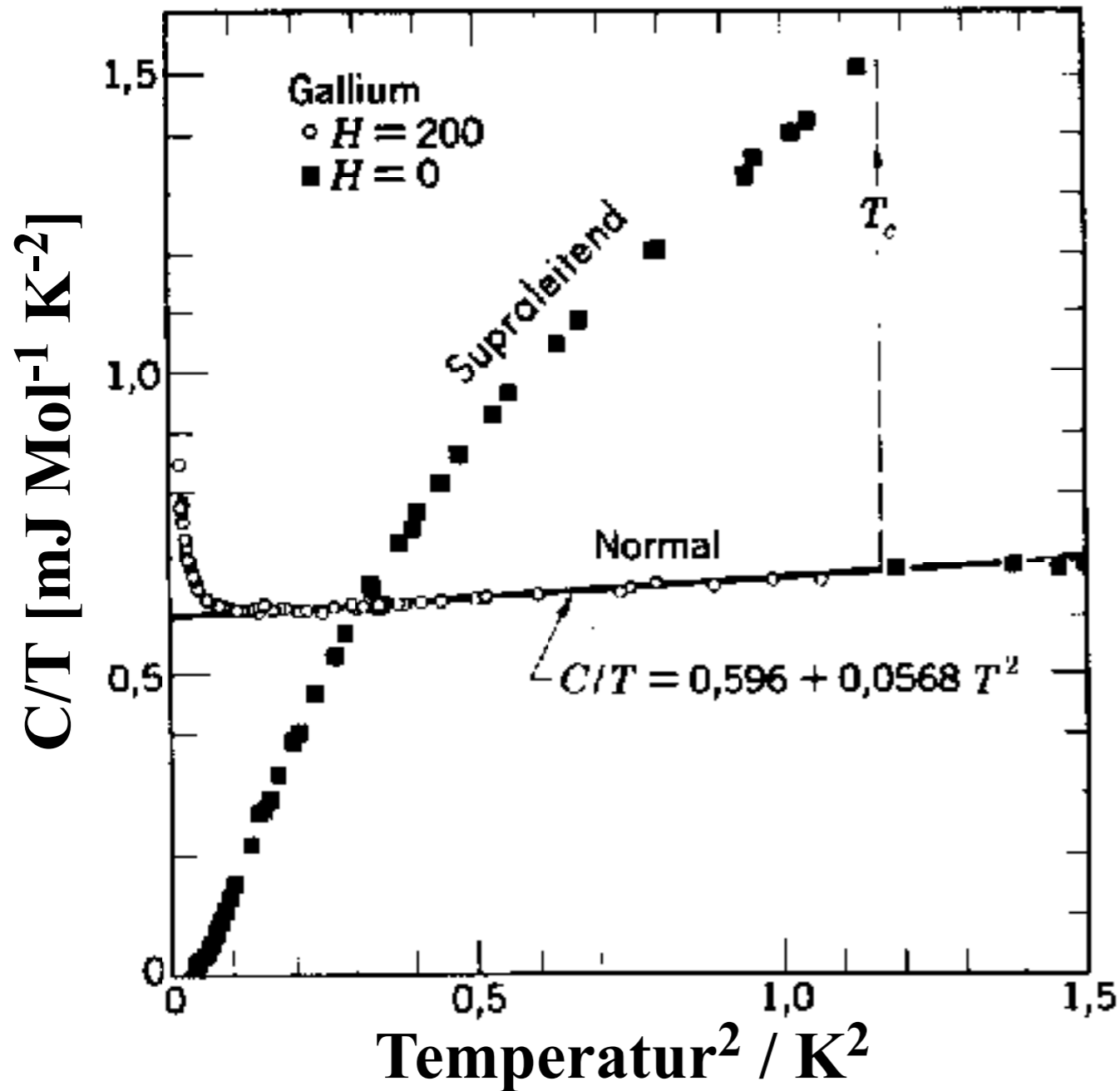
# Entropie und Energie



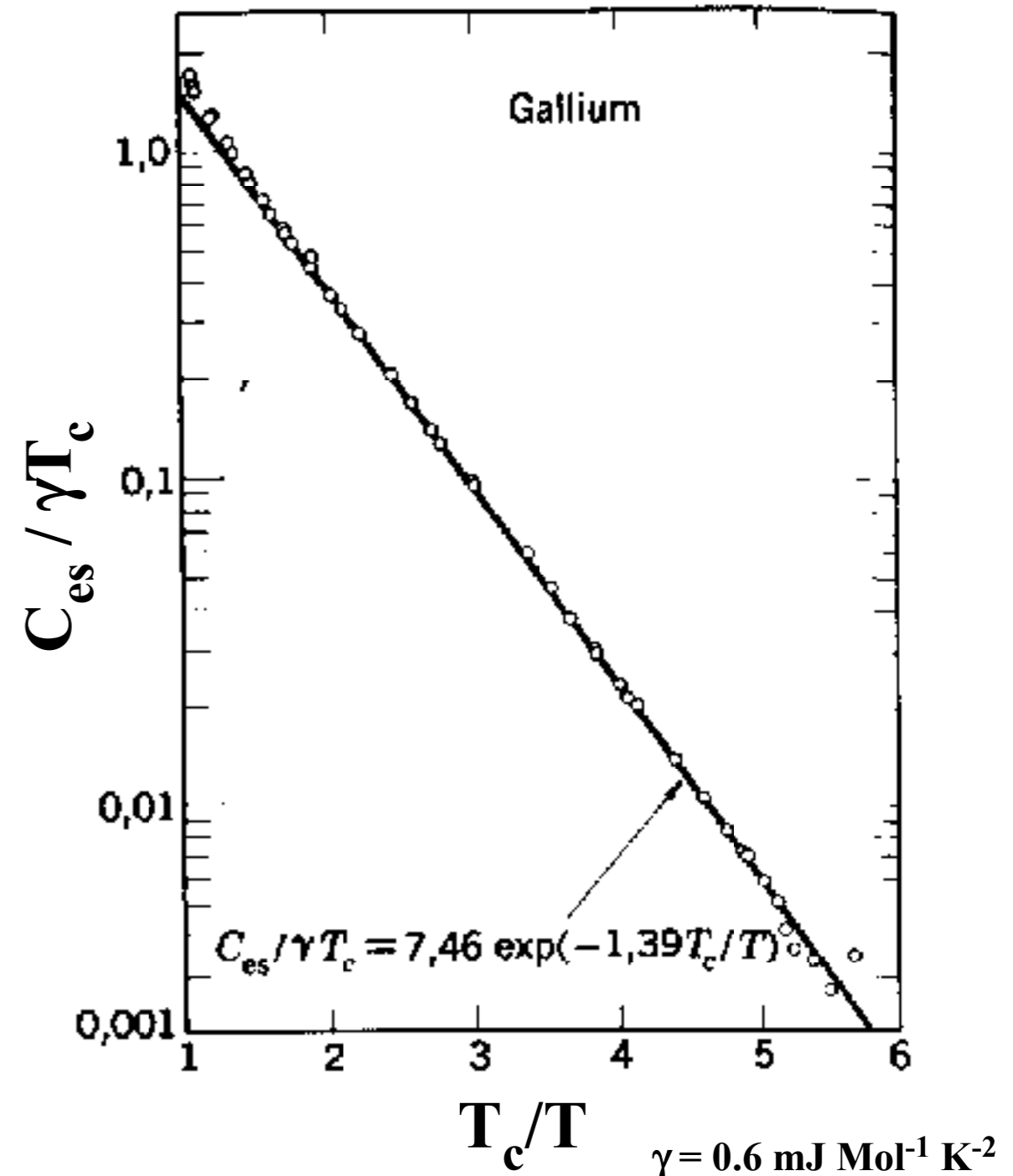
# Wärmekapazität



# Spezifische Wärme

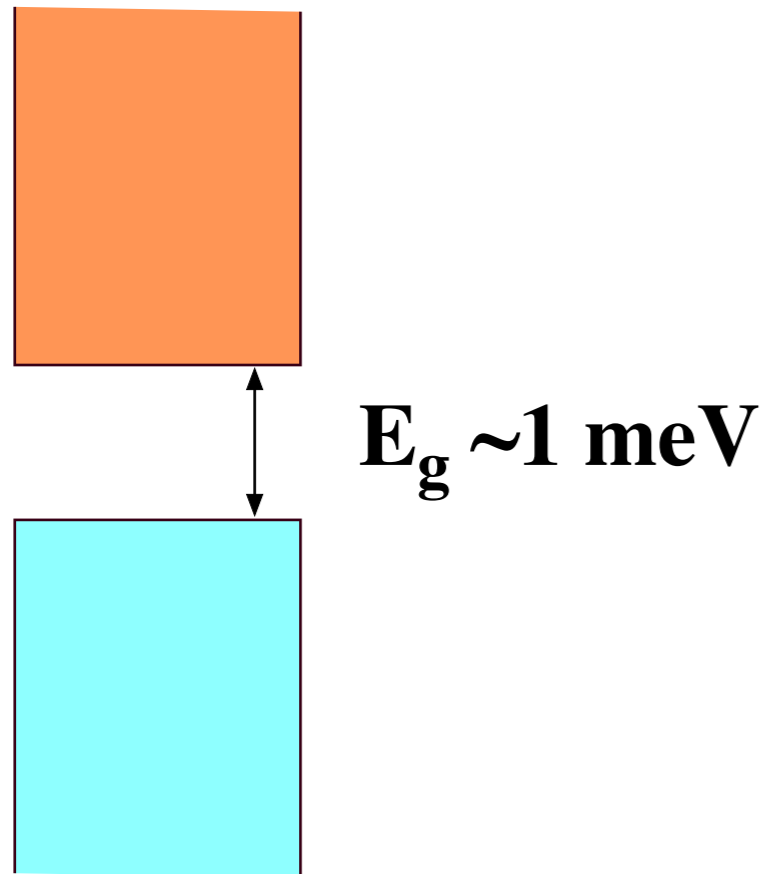


nur elektronischer Beitrag

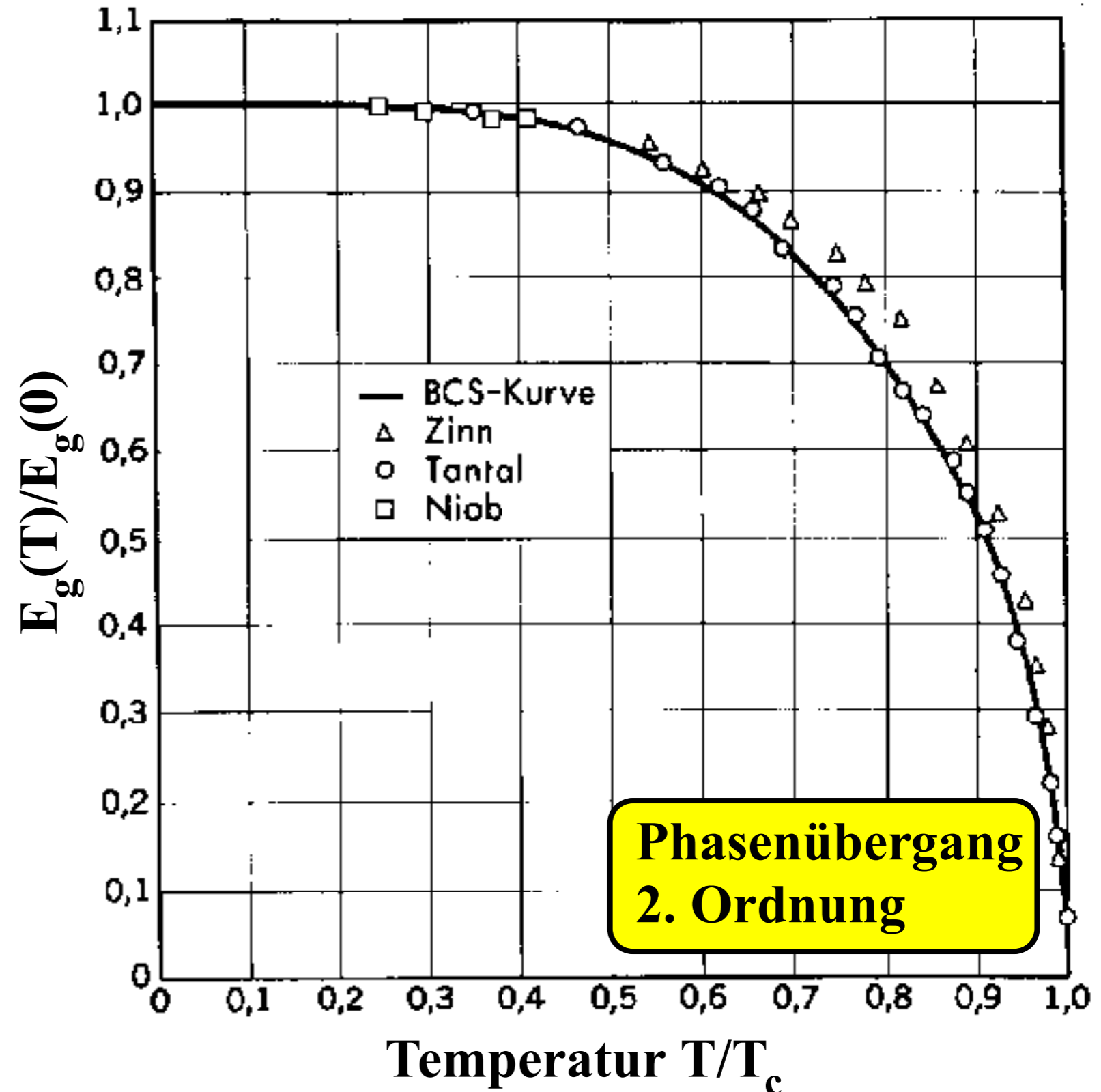
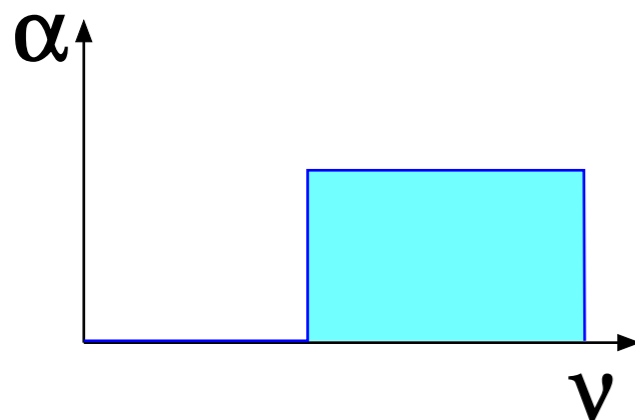


# Energielücke

## Temperaturabhängigkeit

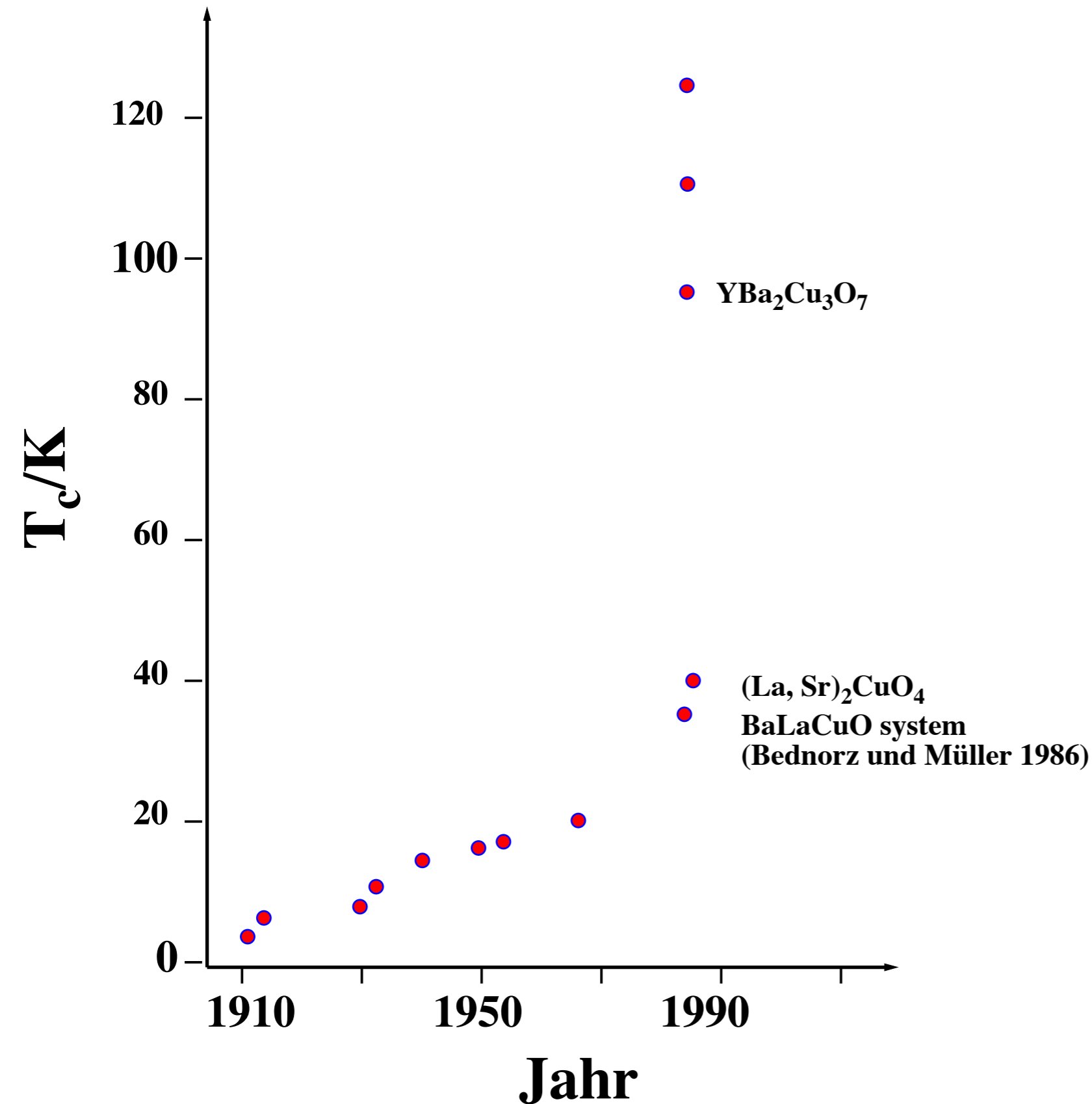


## Absorption von Photonen





# Kritische Temperaturen



1988

Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>2</sub>O<sub>10</sub> 110 K

Tl<sub>2</sub>Ba<sub>2</sub>Ca<sub>2</sub>Cu<sub>2</sub>O<sub>10</sub> 122 K

1993

HgBa<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O<sub>8-δ</sub> 135 K



Müller



Bednorz