Estamos en el Pabellón 1 de Ciudad Universitaria, por empezar la clase de la materia Superconductividad, y nos preguntamos:

Dónde está Santiago Maldonado?

Superconductores de tipo I y II

Table 6.3 - Experimental values of the GINZBURG-LANDAU parameter $\kappa = \lambda / \xi$

Note that its value is much less than 1 for pure metals, the majority of which are of type I, and much greater than 1 for alloys and compounds that are all of type II. This broad spectrum of κ is essentially due to the range of values for the coherence length ξ.

Material	T_c [K]	ξ [nm]	λ [nm]	$\kappa = \lambda/\xi$
Al	1.175	550	40	0.03
In	3.41	360	40	0.11
Ta	4.47	93	35	0.38
Pb	7.20	82	39	0.48
Nb	9.25	39	50	1.28
Pb-In	7	30	150	5
Nb-Ti	9.50	4	300	75
Nb_3Sn (A15)	18,1	3	65	22
$PbMo_6S_8$ (CHEVREL)	15	2	200	100
Rb_3C_{60}	29.60	2	247	124

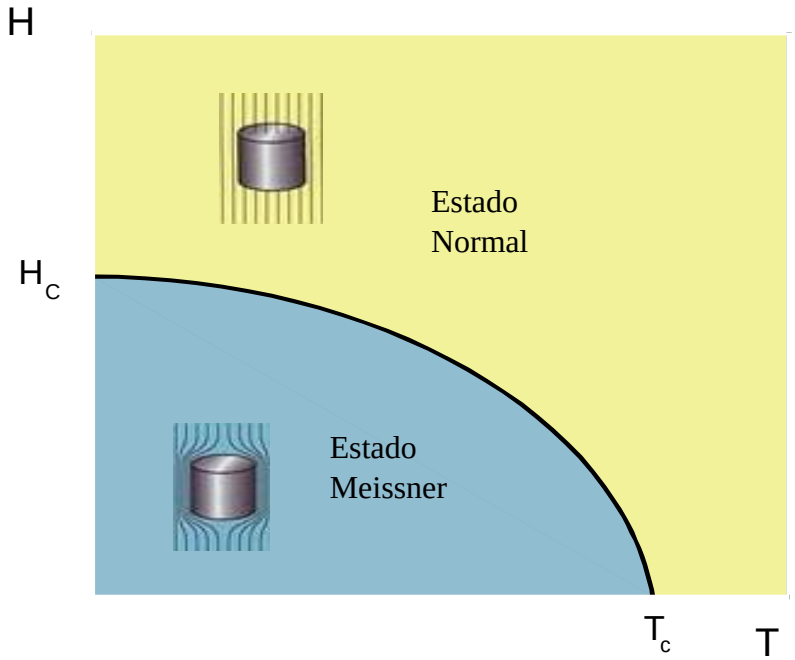
Table 12.1 Coherence Length ξ, Penetration Depth λ, and Ginzburg–Landau Parameter κ of Various Superconductors[a]

Material	T_c (K)	ξ (nm)	λ (nm)	κ (λ/ξ)	Source
Cd	0.56	760	110	0.14	Meservey and Schwartz (1969)
Al[a]	1.18	15.10	40	0.03	Table 9.2
In[a]	3.41	360	40	0.11	Table 9.2
Sn[a]	3.72	180	42	0.23	Table 9.2
Ta	4.4	93	35	0.38	Buckel (1991)
Pb[a]	7.20	82	39	0.48	Table 9.2
Nb[a]	9.25	39	52	1.28	Table 9.2
Pb–In	7.0	30	150	5.0	Orlando and Delin (1991)
Pb–Bi	8.3	20	200	10	Orlando and Delin (1991)
Nb–Ti	9.5	4	300	75	Orlando and Delin (1991)
Nb–N	16	5	200	40	Orlando and Delin (1991)
$PbMo_6S_8$ (Chevrel)	15	2	200	100	Orlando and Delin (1991)
V_3Ga (*A*15)	15	≈2.5	90	≈35	Orlando and Delin (1991)
V_3Si (*A*15)	16	3	60	20	Orlando and Delin (1991)
Nb_3Sn (*A*15)	18	3	65	22	Orlando and Delin (1991)
Nb_3Ge (*A*15)	23.2	3	90	30	Orlando and Delin (1991)
K_3C_{60}	19	2.6	240	92	Holczer *et al.* (1991)
Rb_3C_{60}	29.6	2.0	247	124	Sparn *et al.* (1992)
$(La_{0.925}Sr_{0.075})_2CuO_4$[b]	37	2.0	200	100	Poole *et al.* (1988)
$YBa_2Cu_3O_7$[b]	89	1.8	170	95	Poole *et al.* (1988)
HgBaCaCuO	126	2.3			Gao *et al.* (1993)
$HgBa_2Ca_2Cu_3O_{8+\delta}$	131			100	Schilling *et al.* (1994b)

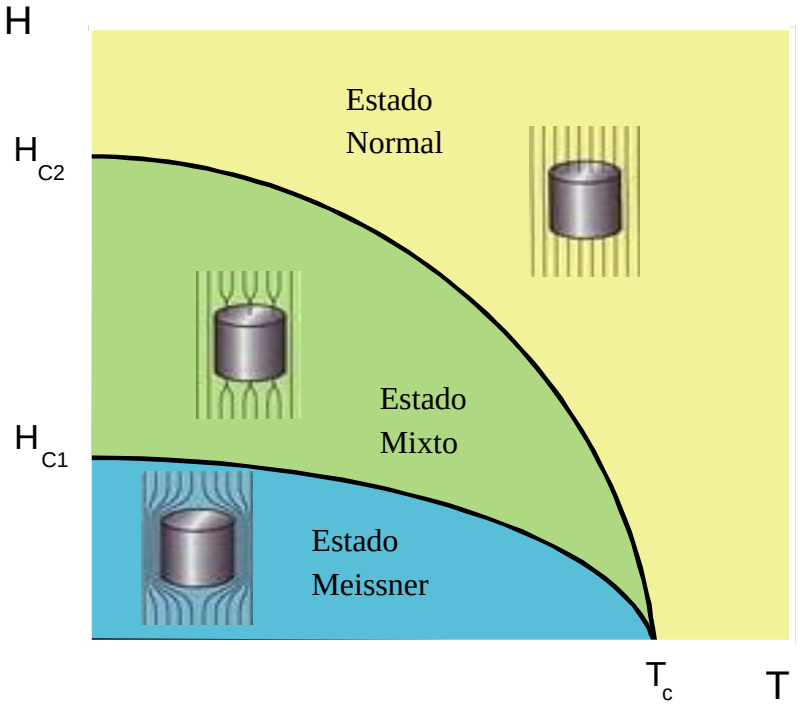
[a] Figures are rounded averages from Table 12.2.

[b] Averages of the polycrystalline data from our earlier Table III-1 (1988).

Superconductores de Tipo I y Tipo II: estado mixto



Tipo I



Tipo II

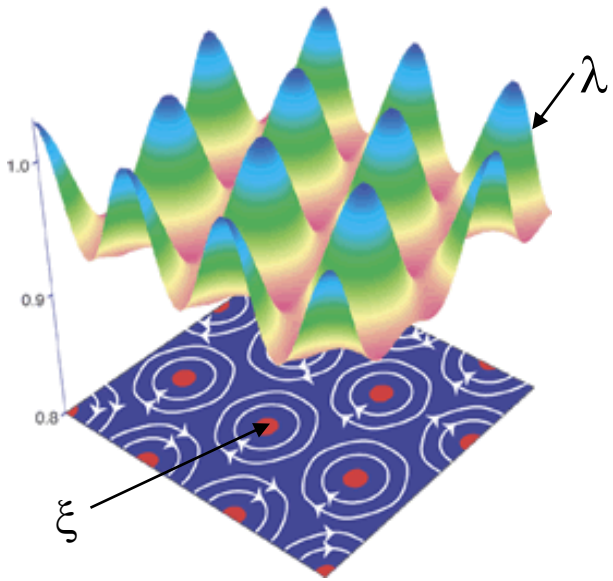
$$H_{c1} < H_c < H_{c2}$$

Campos crítico H_{c2}

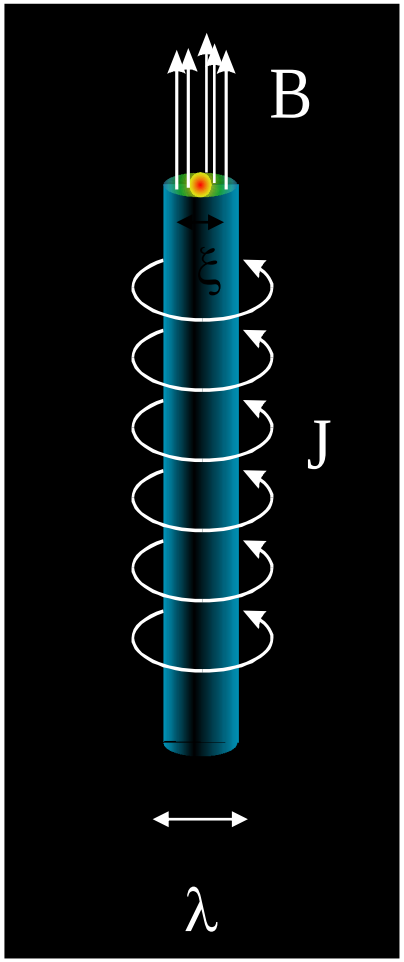
$$H_{c2} = \frac{\Phi_0}{2\pi\xi^2(T)\mu_0} = \sqrt{2}\kappa H_c$$

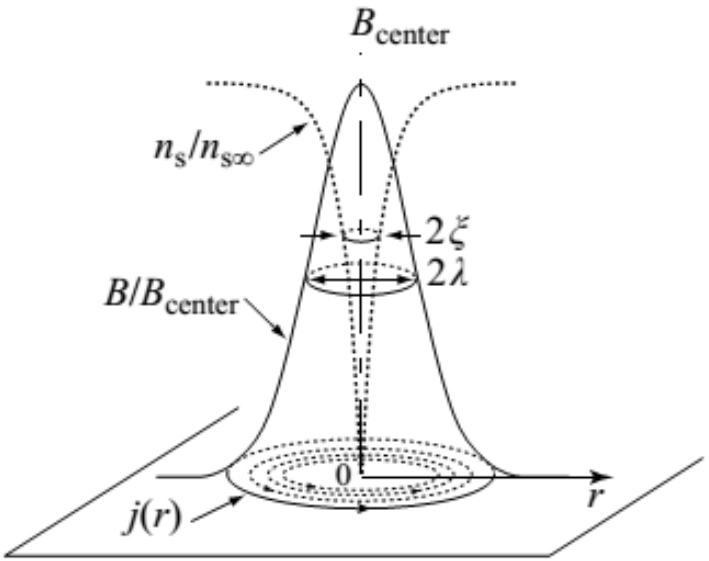
En H_{c2} es energéticamente favorable la nucleación de regiones superconductoras.

Abrikosov mostró que la solución de GL para $\psi/\psi_\infty << 1$, cerca de H_{c2}, es un arreglo periódico de vórtices.



Vórtices; Campos crítico H_{c1}





En H_{c1} un vórtice es estable.

G (1 vórtice) = G (Meissner)

$$H_{c1} \approx \frac{\Phi_0}{4\pi\lambda^2\mu_0}\ln\kappa = \frac{H_c}{\sqrt{2}\kappa}\ln\kappa$$

$\kappa >> 1$

VOLUME 7, NUMBER 2 PHYSICAL REVIEW LETTERS JULY 15, 1961

EXPERIMENTAL EVIDENCE FOR QUANTIZED FLUX IN SUPERCONDUCTING CYLINDERS*

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(Received June 16, 1961)

VOLUME 7, NUMBER 2 PHYSICAL REVIEW LETTERS JULY 15, 1961

EXPERIMENTAL PROOF OF MAGNETIC FLUX QUANTIZATION IN A SUPERCONDUCTING RING*

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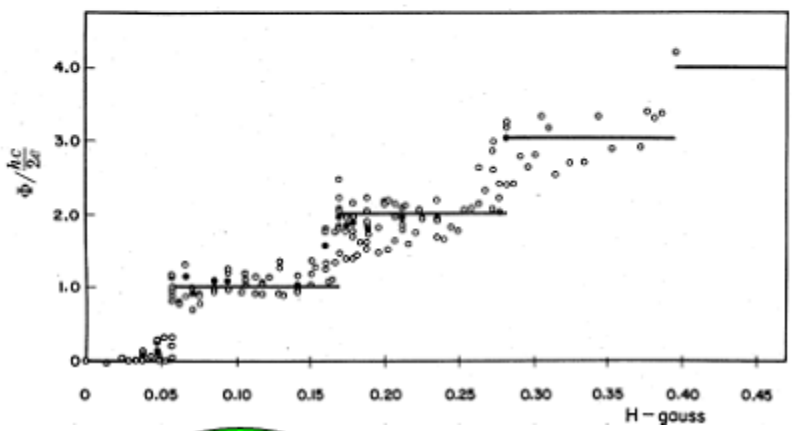
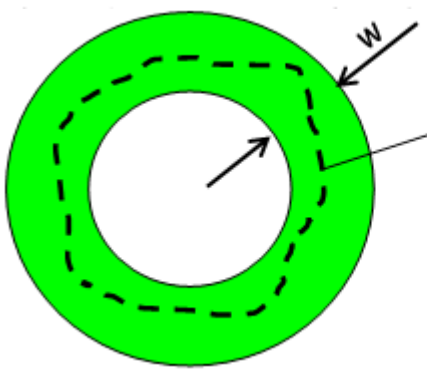
(Received June 19, 1961)





$$J = 0$$

$$\lambda^2 \oint J \cdot dl + \Phi = n\phi_0$$

$$\Phi = n\phi_0$$

OBSERVATION OF QUANTUM PERIODICITY IN THE TRANSITION TEMPERATURE OF A SUPERCONDUCTING CYLINDER*

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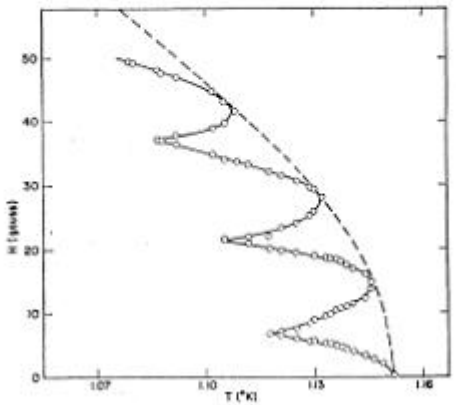
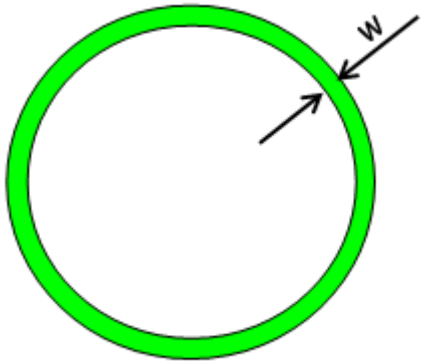
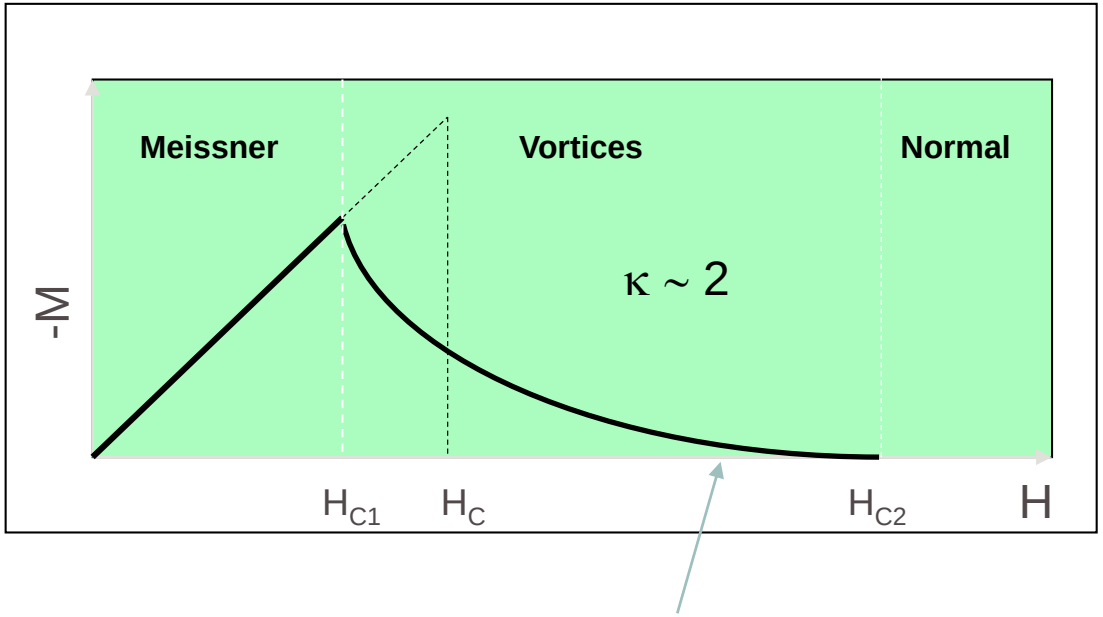
(Received May 10, 1962; revised manuscript received June 15, 1962)





Magnetización de equilibrio



Para $\kappa >> 1$ $M \sim 0$ y $B \sim \mu_0 H$

Table 12.3 Critical Fields of Selected Type II Superconductors[a]

Material	T_c (K)	B_{c1} (mT)	B_c (mT)	B_{c2} (T)	Reference
Nb wire, RRR = 750	9.3	181.0	0.37	2.0	Roberts (1976)
Nb wire, cold-drawn	9.3	248.0		≈10.0	Roberts (1976)
$In_{0.95}Pb_{0.05}$ (alloy)	3.7	31.8	37.5	0.049	Roberts (1976)
$Mo_{\approx 0.1}Nb_{\approx 0.9}$ (alloy)	6.4	29.0	78.5	0.414	Roberts (1976)
$Mo_{0.66}Re_{0.34}$ (alloy)	11.8	38.1	0.113		Roberts (1976)
$Nb_{0.99}Ta_{0.01}$ (alloy)	8.8	173.0	20.4	0.445	Roberts (1976)
Nb–Ti	9.5			13.0	Orlando and Delin (1991); Van Duzer and Turner (1981)
CTa (NaCl Structure)	≈10.0	22.0	81.0	0.46	Roberts (1976)
Nb–N (NaCl Structure)	16.0	9.3		15.0	Orlando and Delin (1991); Roberts (1976)
Cr_3Ir (*A*15)	0.75	16.8		1.05	Roberts (1976)
V_3Ge (*A*15)	6.8			≈5.0	Roberts (1976)
V_3Ga(*A*15)	15.0			23.0	Orlando and Delin (1991); Van Duzer and Turner (1981)
V_3Si (*A*15)	16.0	55.0	670.0	23.0	Roberts (1976)
Nb_3Sn (*A*15)	18.2	35.0	440.0	23.0	Roberts (1976)
Nb_3Ge (*A*15)	23.1			37.0	Orlando and Delin (1991); Van Duzer and Turner (1981)
HfV_2 (Laves)	9.2	187.0		21.7	Vonsovsky *et al.* (1982, p. 376)
$(Hf_{0.5}Zr_{0.5})V_2$ (Laves)	10.1	197.0		28.3	Vonsovsky *et al.* (1982, p. 376)
ZrV_2 (Laves)	8.5	219.0		16.5	Vonsovsky *et al.* (1982, p. 376)
$NbSe_2$	7.2	7.2	204.0	17.4	Roberts (1976)

Table 12.5 Critical Fields of Selected Anisotropic Type II Superconductors

Material	T_c (K)	B_{c1}^{ab} (mT)	B_{c1}^{c} (mT)	B_c (T)	B_{c2}^{ab} (T)	B_{c2}^{c} (T)	$-dB_{c2}^{ab}/dT$ (T/K)	$-dB_{c2}^{c}/dT$ (T/K)	Reference
$CeCu_2Si_2$ (heavy fermion)	0.63				2.0	2.4			Assmus *et al.* (1984)
β-$(ET)_2I_3$ (organic)	1.5	7[a]	36		1.74[b]	0.08			Ishiguro and Yamaji (1990)
β-$(ET)_2I_3$ 1.6 kbar	7.2				25	2.7			Ishiguro and Yamaji (1990)
β-$(ET)_2IBr_2$ (organic)	2.3	390	1600		3.48[c]	1.5			Ishiguro and Yamaji (1990)
β-$(ET)_2AuI_2$ (organic)	4.2	400	2050		≈6.35	≈0.8			Ishiguro and Yamagi (1990)
K-$(ET)_2Cu[N(CN)_2]Br$	11.6						20	2.2	Kwok *et al.* (1990b)
$(Sm_{0.925}Ce_{0.05})_2CuO_4$ (electron type)	11.4				28.2	5.2	3.6	0.1	Dalichaouch *et al.* (1990b)
$(La_{0.95}Ca_{0.05})_2CuO_4$	≈14.0				>20	>13	4	0.3	Hidaka *et al.* (1987)
$(La_{0.9}Ca_{0.1})_2CuO_4$	30			0.2		32		1.5	Li *et al.* (1993)
$(La_{0.93}Ca_{0.07})_2CuO_4$[d]	≈34.0	7	30						Naito *et al.* (1990)
$YBa_2Cu_3O_{6.5}$	62	2.5	8.3	0.38	380	87	8.7	2.0	Vandervoort *et al.* (1991)
$YBa_2Cu_3O_{6.94}$	91.2		32			115		1.8	Ossandon *et al.* (1992a)
$YBa_2Cu_3O_{7-\delta}$		53	520						Dinger *et al.* (1987)
$YBa_2Cu_3O_{7-\delta}$		70	130				≈1.0	0.65	Song *et al.* (1987)
$YBa_2Cu_3O_{7-\delta}$	88.8	≲5	500	2.65	140	29	2.3	0.46	Worthington *et al.* (1987)
$YBa_2Cu_3O_{7-\delta}$	92.4	≲5	500	1.93	240	34	3.8	0.54	Gallagher (1988)
$YBa_2Cu_3O_{7-\delta}$	24	103	≈1.7				14		Salamon (1989)
$YBa_2Cu_3O_{7-\delta}$					110	40	3.4	1.0	Nakao *et al.* (1989)
$YBa_2Cu_3O_{7-\delta}$	90	18	53	≈1.8					Krusin-Elbaum *et al.* (1989)
$YBa_2Cu_3O_{7-\delta}$	92						10.5	1.9	Welp *et al.* (1989)
$EuBa_2Cu_3O_{7-\delta}$	95				190	45	3.0	0.7	Hikita *et al.* (1987)
$EuBa_2Cu_3O_{7-\delta}$	94.8				245	28	3.8	0.41	Y. Tajima *et al.* (1988)
$Y_{0.8}Pr_{0.2}Ba_2Cu_3O_{7-\delta}$	73				174	56	3.4	1.1	Jia *et al.* (1992)
$Bi_2Sr_2CaCu_2O_{8+\delta}$	90	85							Maeda *et al.* (1992)
$(Bi, Pb)_2Sr_2CaCu_2O_8$	91			0.65		≈89		1.4	L. Zhang *et al.* (1992)
$Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$	109						16	0.5	Matsubara *et al.* (1992)
$Pb_2Sr_2(Y, Ca)Cu_3O_8$	76	9.5	50.5	0.80	590	96	11	1.75	Reedyk *et al.* (1992b)
$HgBa_2Ca_2Cu_3O_{8+\delta}$	131		45			190		2.0	Schilling *et al.* (1994b)

Note: Some of the thermodynamic critical fields B_c were calculated from Eq. (12.53) using data from Table 12.4.
[a] Average of $B_{c1}^{a} = 5$ mT, $B_{c1}^{b} = 9$ mT; [b] Average of $B_{c2}^{a} = 1.78$ T, $B_{c2}^{b} = 1.70$ T; [c] Average of $B_{c2}^{a} = 3.36$ T, $B_{c2}^{b} = 3.60$ T; [d] $-dB_{c1}^{ab}/dT = 1.8$ mT/K, $-dB_{c1}^{c}/dT = 5.5$ mT/K.