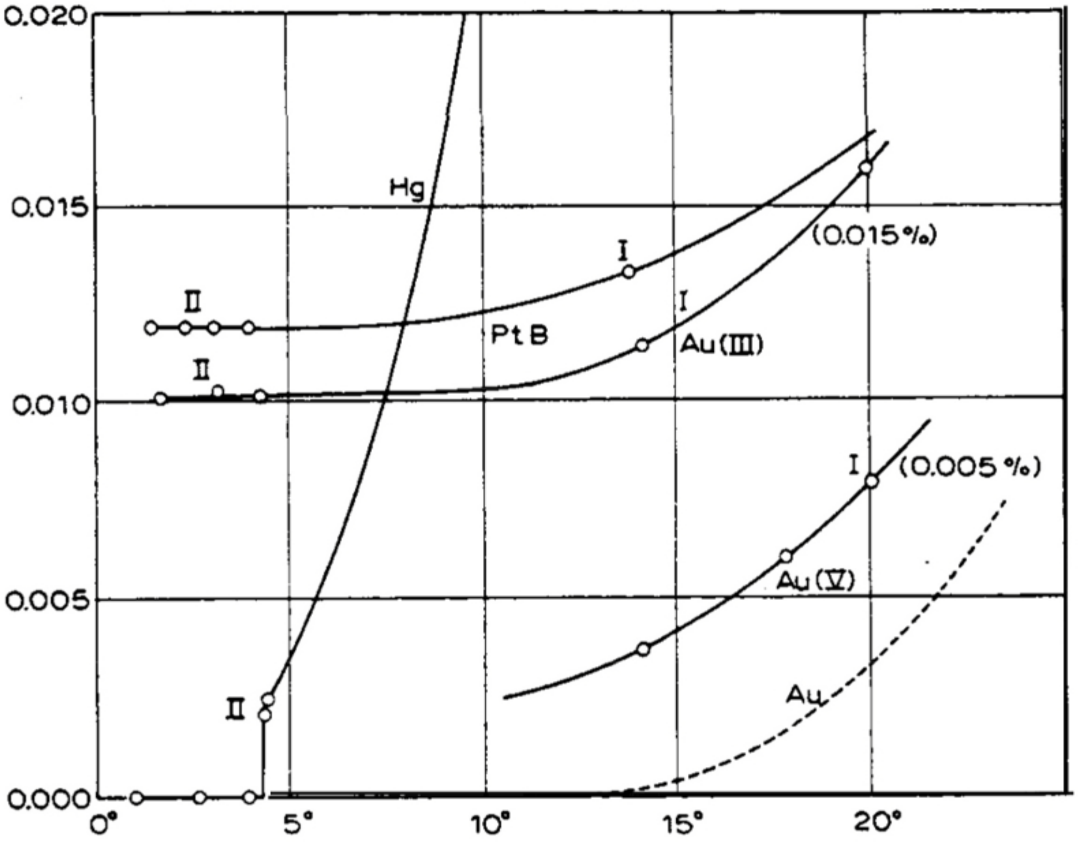
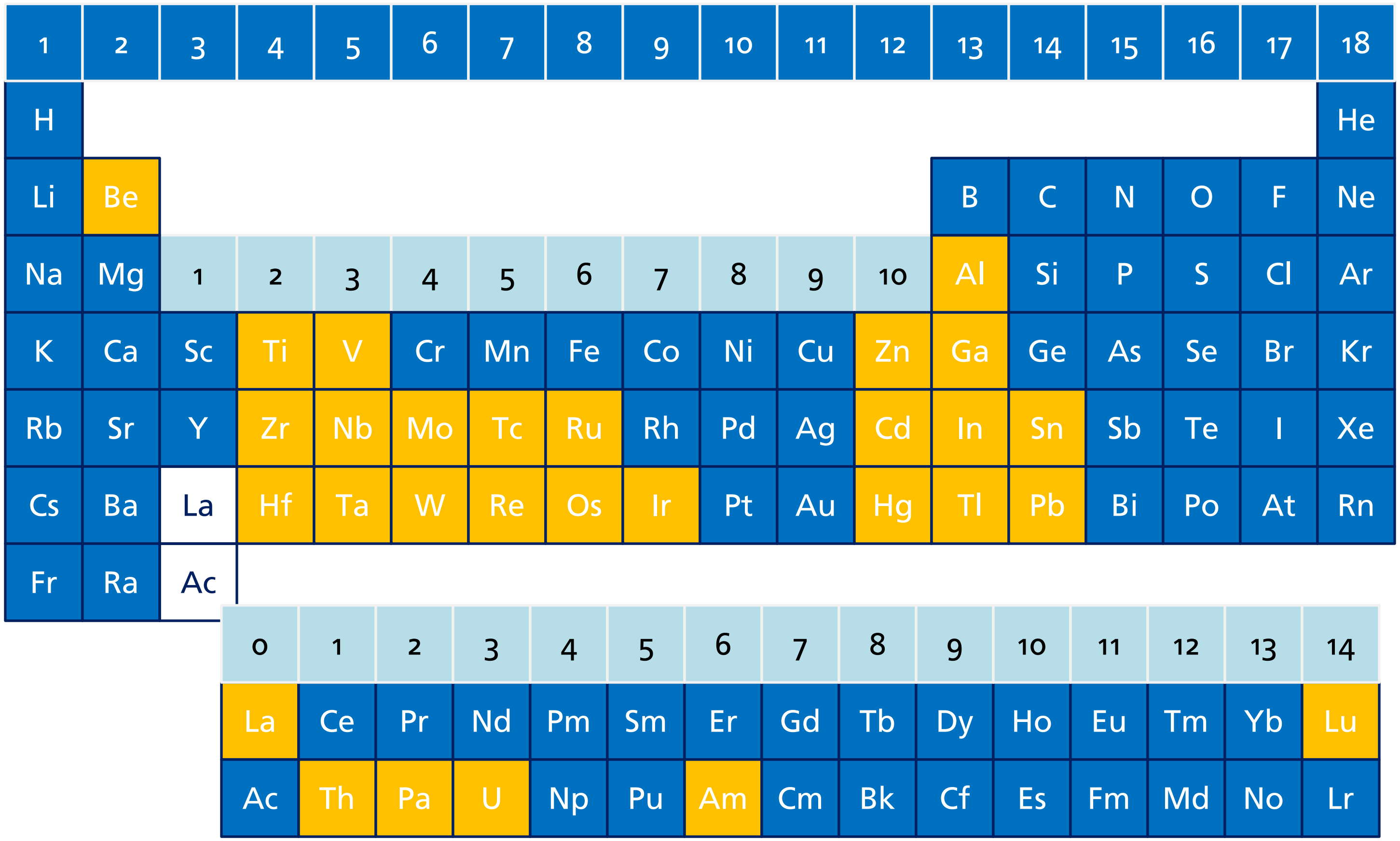
Class 1: Recent developments in superconductivity



Investigations into the Properties of Substances at Low Temperatures, which Have Led, amongst Other Things, to the Preparation of Liquid Helium [1913 Physics Nobel, Heike Kammerlingh Onnes]

Hg becomes superconducting, *ie.* loses all at electrical resistance at a little above 4 K

The superconducting elements (bulk, ambient pressure)



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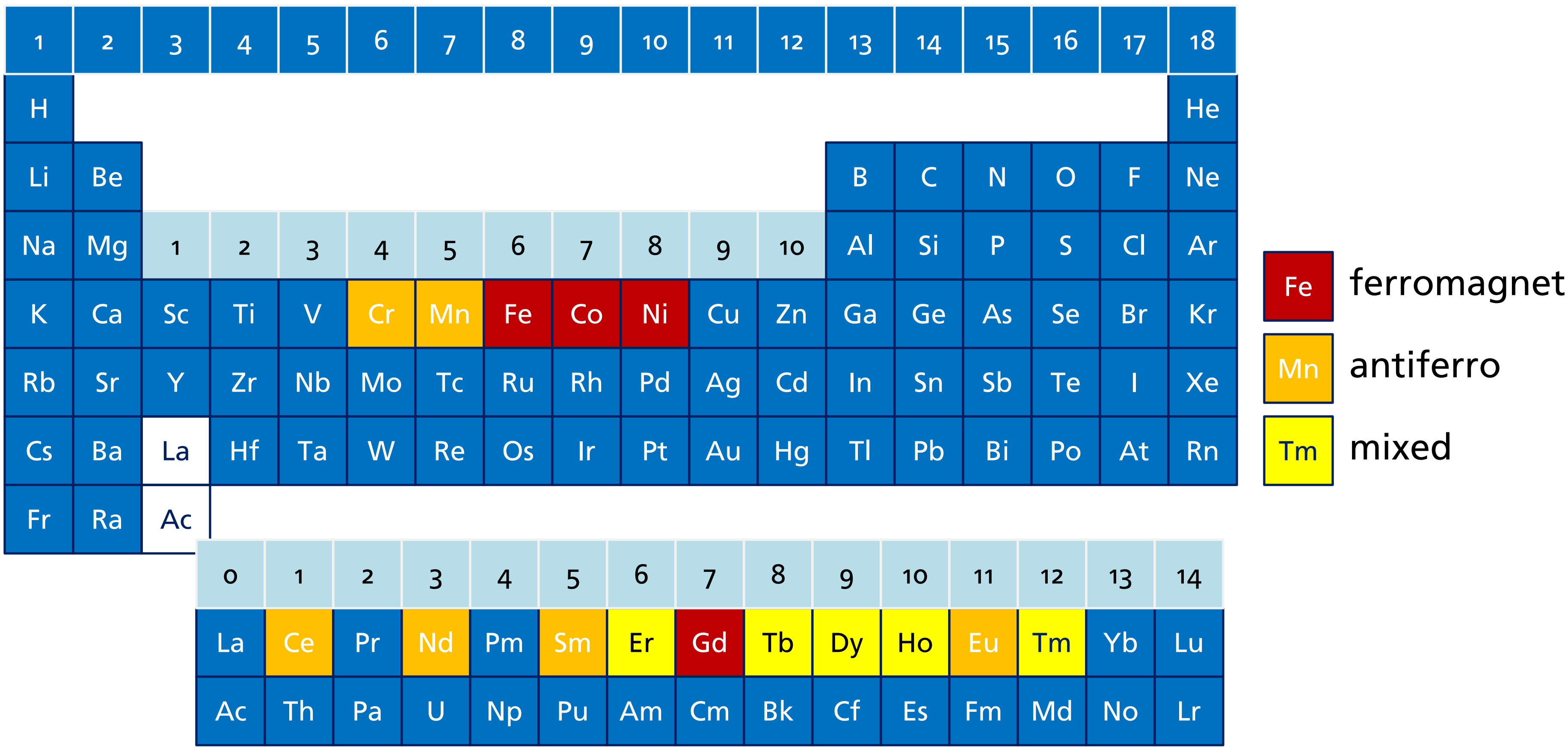
The magnetic(ally ordered) elements [Ferromagnetic or antiferromagnetic]



Magnetism and superconductivity are largely incompatible

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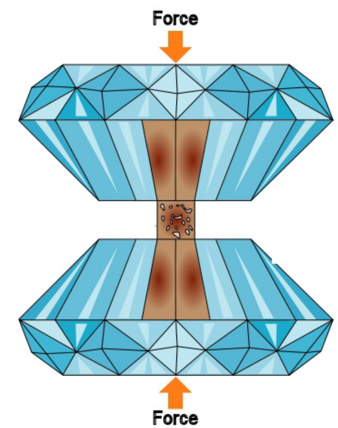
Some (new) superconducting elements (under pressure)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H																	He
Li	Be											**B**	C	N	**O**	F	Ne
Na	Mg	1	2	3	4	5	6	7	8	9	10	Al	**Si**	**P**	**S**	Cl	Ar
K	**Ca**	**Sc**	Ti	**V**	Cr	Mn	**Fe**	Co	Ni	Cu	Zn	Ga	**Ge**	**As**	**Se**	**Br**	Kr
Rb	**Sr**	**Y**	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	**Sb**	**Te**	**I**	Xe
Cs	**Ba**	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	**Bi**	Po	At	Rn
Fr	Ra	Ac															

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
La	**Ce**	Pr	Nd	Pm	Sm	Er	Gd	Tb	Dy	Ho	Eu	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

High pressures (above ~10 GPa) generated with a diamond anvil cell.



Pressure can drastically change electronic structure (for *eg.* Ba behaves like a transition metal)

impetus mutat res

Buzea, Robbie, *Supercond. Sci. Technol.* **18** (2005) R1-R8.

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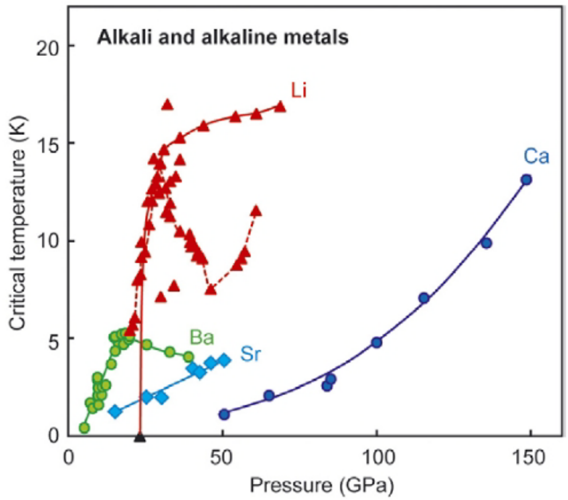

Figure 4. Critical temperature dependence on pressure for alkali and alkaline metals: Li [2, 28, 29], Ca [36], Ba [37–43], and Sr [37].

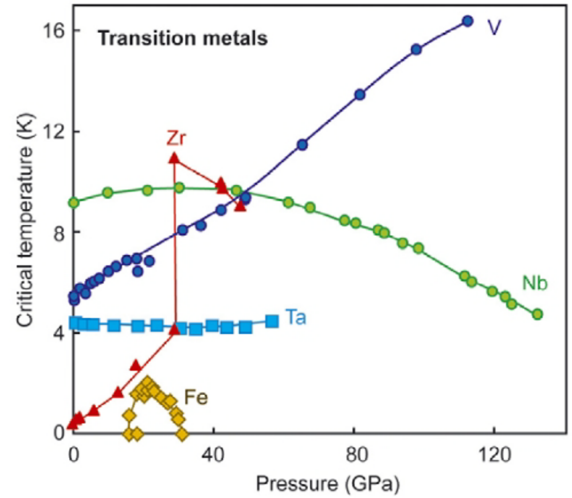

Figure 6. Critical temperature dependence on pressure for transition metals: Zr [52, 53], V [48–50], Nb [45], Ta [45, 67], and Fe [7].

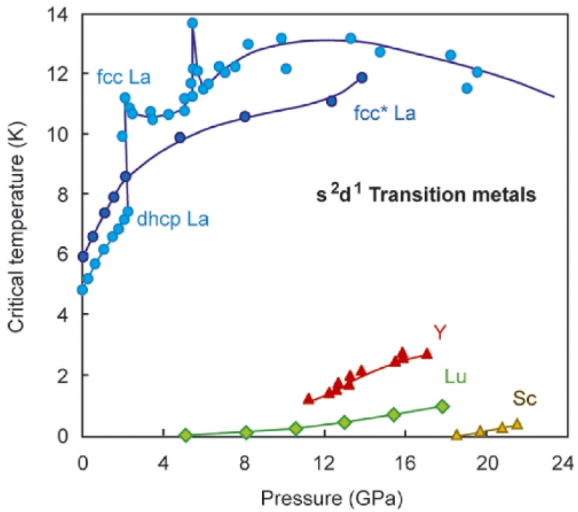

Figure 5. Critical temperature dependence on pressure for s^2d^1 transition metals: La [16], Lu [44], Sc [44], and Y [30].

Buzea, Robbie, *Supercond. Sci. Technol.* **18** (2005) R1-R8.

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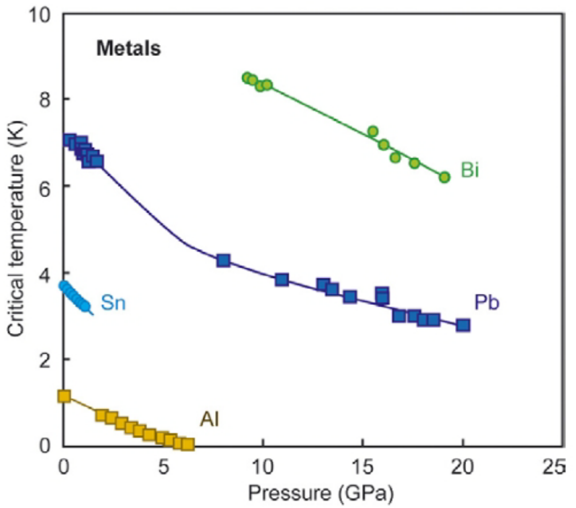

Figure 8. Critical temperature dependence on pressure for metals: Al [62], Sn [63], Pb [40, 64–67], and Bi [39, 40].

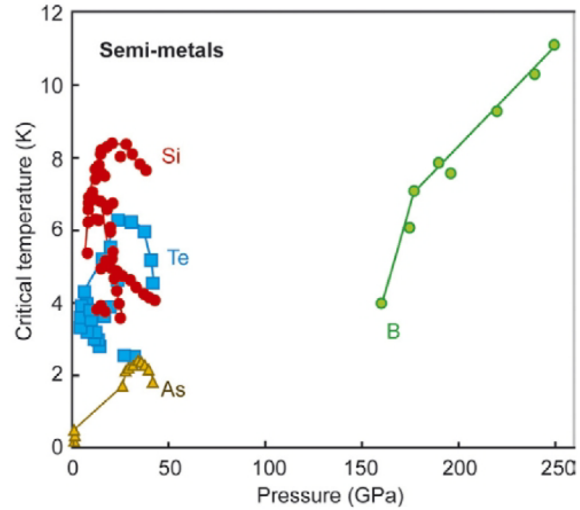

Figure 9. Critical temperature dependence on pressure for semi-metals: B [8], Si [72–74], As [75, 76], and Te [77–79].

Buzea, Robbie, *Supercond. Sci. Technol.* **18** (2005) R1-R8.

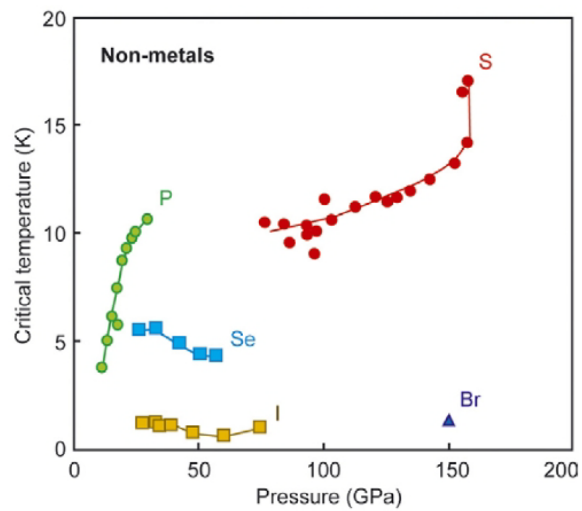

Figure 10. Critical temperature dependence on pressure for non-metals: P [86], S [3, 93], Se [77], Br [93], and I [92].

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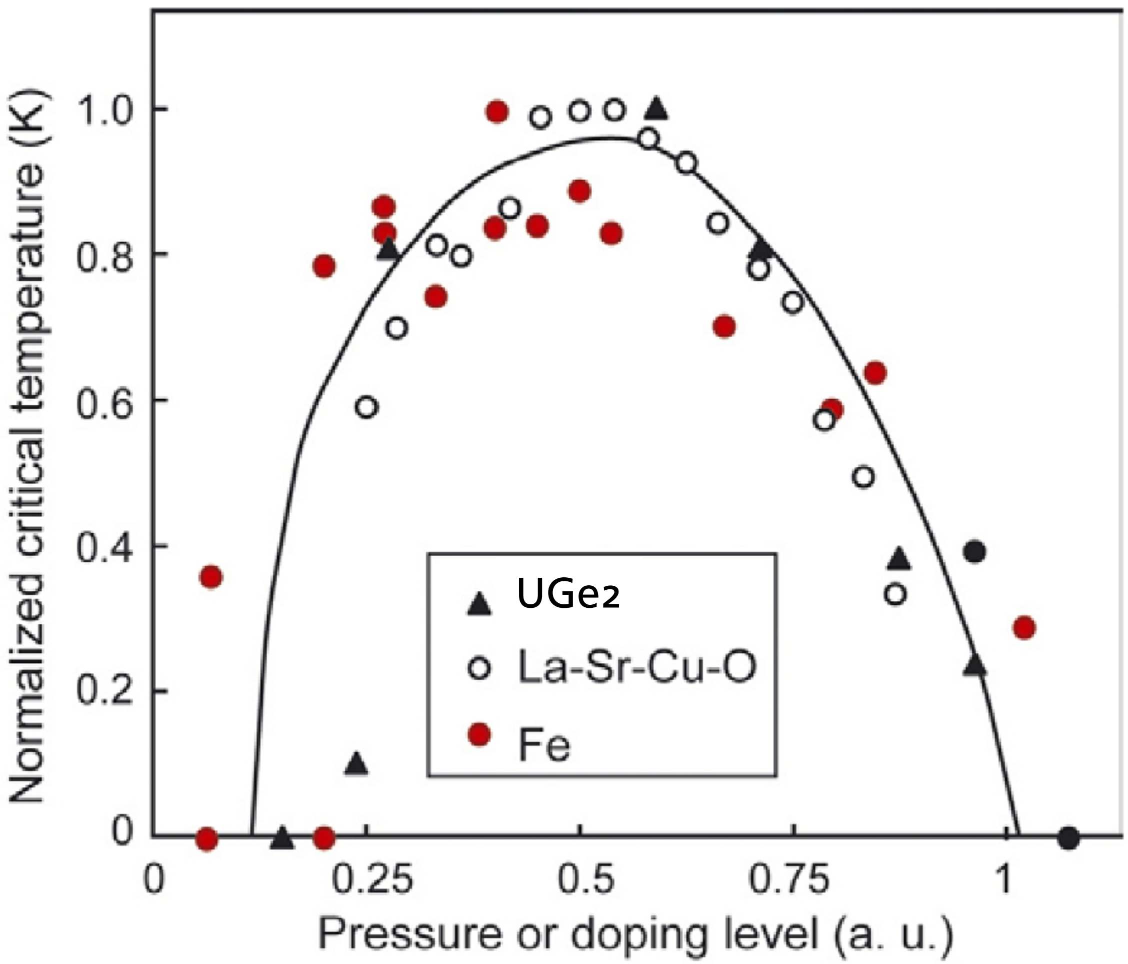
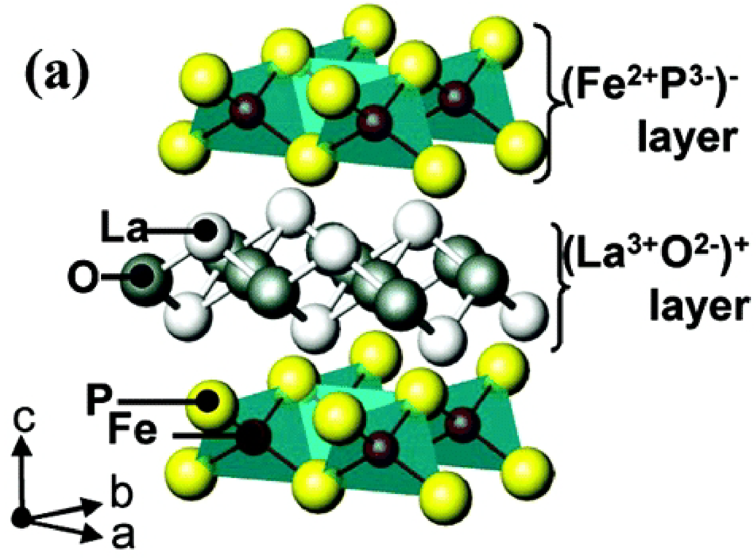
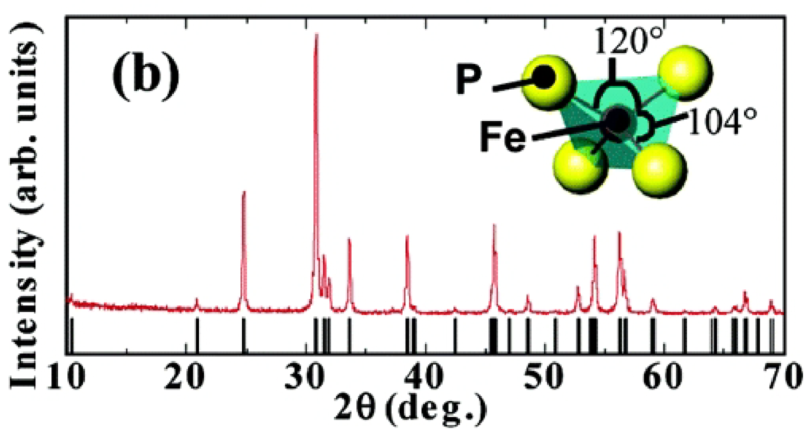
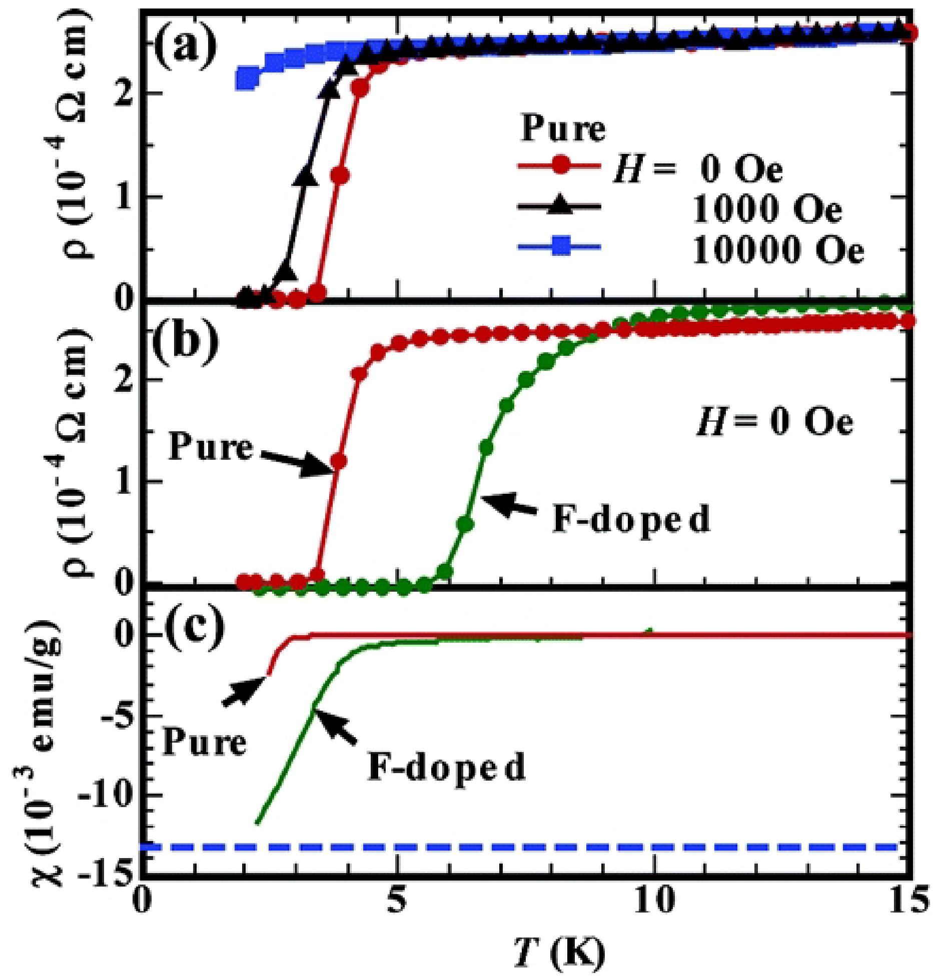


Possible similarities in the superconducting behavior of superconductors that are proximal to magnetic behavior, for *eg.* the famous superconducting dome.

Buzea, Robbie, *Supercond. Sci. Technol.* **18** (2005) R1-R8.







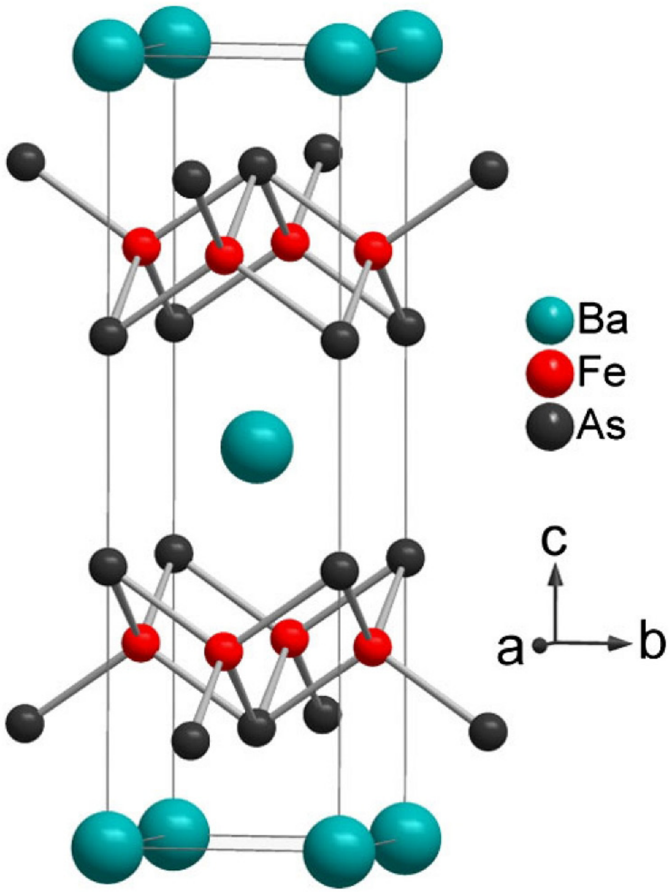
Kamihara, Hiramatsu, Hirano, Kawamura, Yanagi, Kamiya, Hosono, *J. Am. Chem. Soc.* **128** (2006) 10012.

Class 1: Recent developments in superconductivity

PRL **101**, 107006 (2008) PHYSICAL REVIEW LETTERS week ending 5 SEPTEMBER 2008

Superconductivity at 38 K in the Iron Arsenide $(Ba_{1-x}K_x)Fe_2As_2$

Marianne Rotter, Marcus Tegel, and Dirk Johrendt*



Superconductivity in arsenides with the $ThCr_2Si_2$ crystal structure.

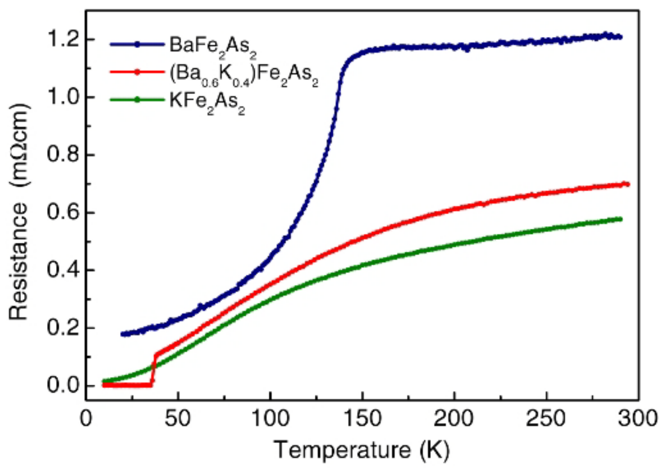


FIG. 3 (color online). Electrical resistance of $BaFe_2As_2$, KFe_2As_2, and $(Ba_{0.6}K_{0.4})Fe_2As_2$.

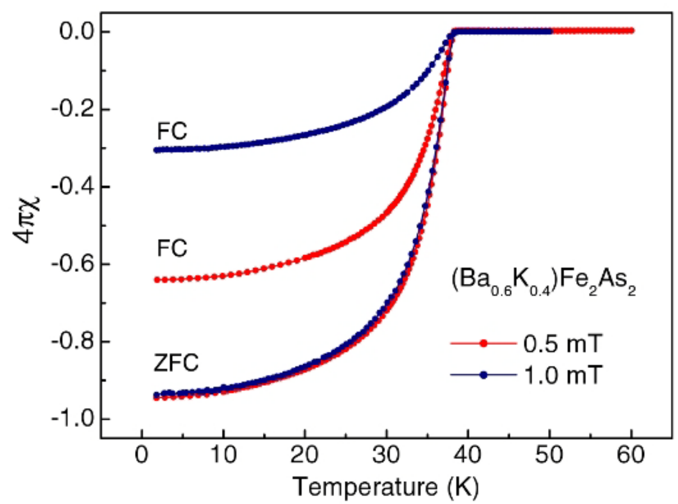


FIG. 5 (color online). Magnetic susceptibility of $(Ba_{0.6}K_{0.4})Fe_2As_2$ at 0.5 and 1 mT. FC is field cooled; ZFC is zero-field cooled.

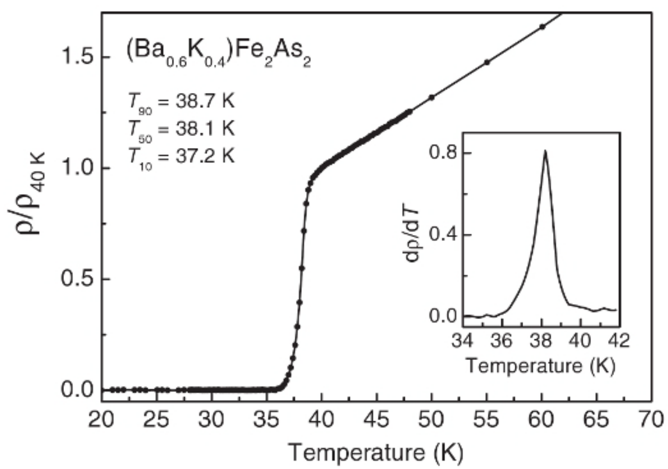
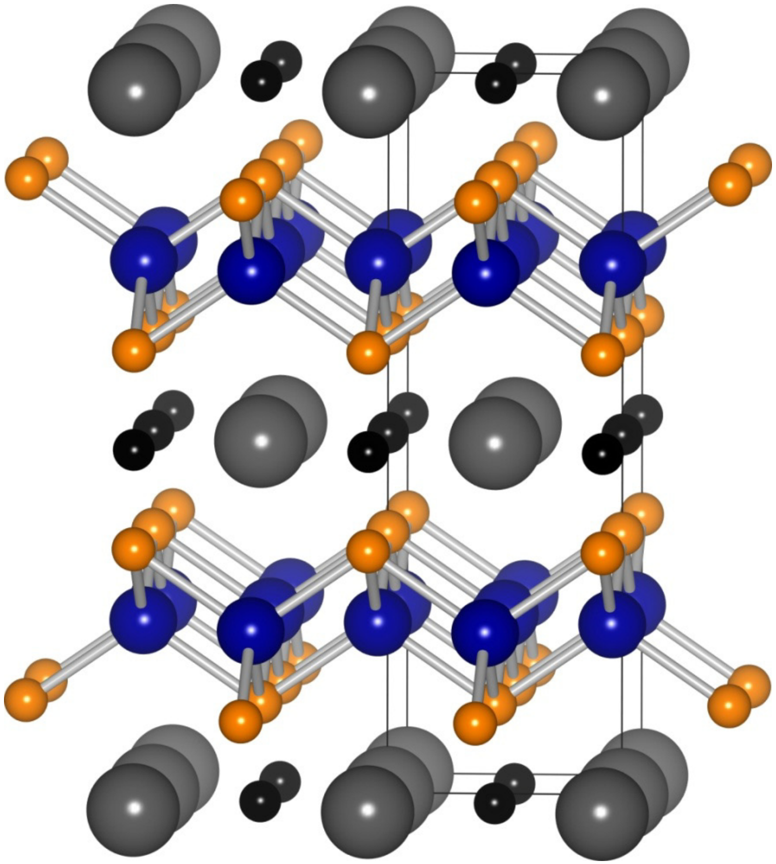


FIG. 4. Resistivity transition of $(Ba_{0.6}K_{0.4})Fe_2As_2$.

Characterization of the superconducting state.

LuNi2B2C is a related superconductor with a stufed ThCr2Si2 crystal structure.



Nagarajan, Mazumdar, Hossain, Dhar, Gopalakrishnan, Gupta, Godart, Padalia, Vijayaraghavan, Bulk superconductivity at an elevated temperature ($T_c \approxeq 12$ K) in a nickel containing alloy system Y-Ni-B-C, *Phys. Rev. Lett.* **72** (1994) 274;

Cava, Takagi, Zandbergen, Krajewski, Peck, Siegrist, Batlogg, van Dover, Felder, Mizuhashi, Lee, Eisaki, Uchida, Superconductivity in the quaternary intermetallic compounds $LnNi_2B_2C$, *Nature* **367** (1994) 252