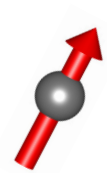
Magnetism of metals

Pauli paramagnetism, Landau diamagnetism
Stoner instability

de Haas - van Alphen effect

Wolfgang Pauli



by Alexander Tsirlin, Leipzig University

Lecture 4: November 11, 2024

Person

Wolfgang Pauli

Pauli principle: two electrons can not occupy the same state

Wolfgang Pauli
1900–1958

1945 Nobel prize in physics for
"his discovery of a new law of Nature,
the exclusion principle or Pauli principle"

Pauli principle: two electrons can not occupy the same state

Pauli effect: a functioning device and Wolfgang Pauli may not occupy the same room

(*second Pauli exclusion principle*)

Wolfgang Pauli
1900–1958

1945 Nobel prize in physics for
"his discovery of a new law of Nature,
the exclusion principle or Pauli principle"

Pauli principle and Pauli effect

Pauli principle: two electrons can not occupy the same state

Pauli effect: a functioning device and Wolfgang Pauli may not occupy the same room

(*second Pauli exclusion principle*)

"Das ist nicht nur nicht richtig, es ist nicht einmal falsch!"

W. Pauli

Wolfgang Pauli
1900–1958

1945 Nobel prize in physics for "his discovery of a new law of Nature, the exclusion principle or Pauli principle"

Pauli principle: two electrons can not occupy the same state

Pauli effect: a functioning device and Wolfgang Pauli may not occupy the same room

(*second Pauli exclusion principle*)

"When I die, my first question to the devil will be:

What is the meaning of the fine structure constant?"

W. Pauli

$\alpha \simeq 1/137$

Wolfgang Pauli
1900–1958

1945 Nobel prize in physics for "his discovery of a new law of Nature, the exclusion principle or Pauli principle"

Über Gasentartung und Paramagnetismus.

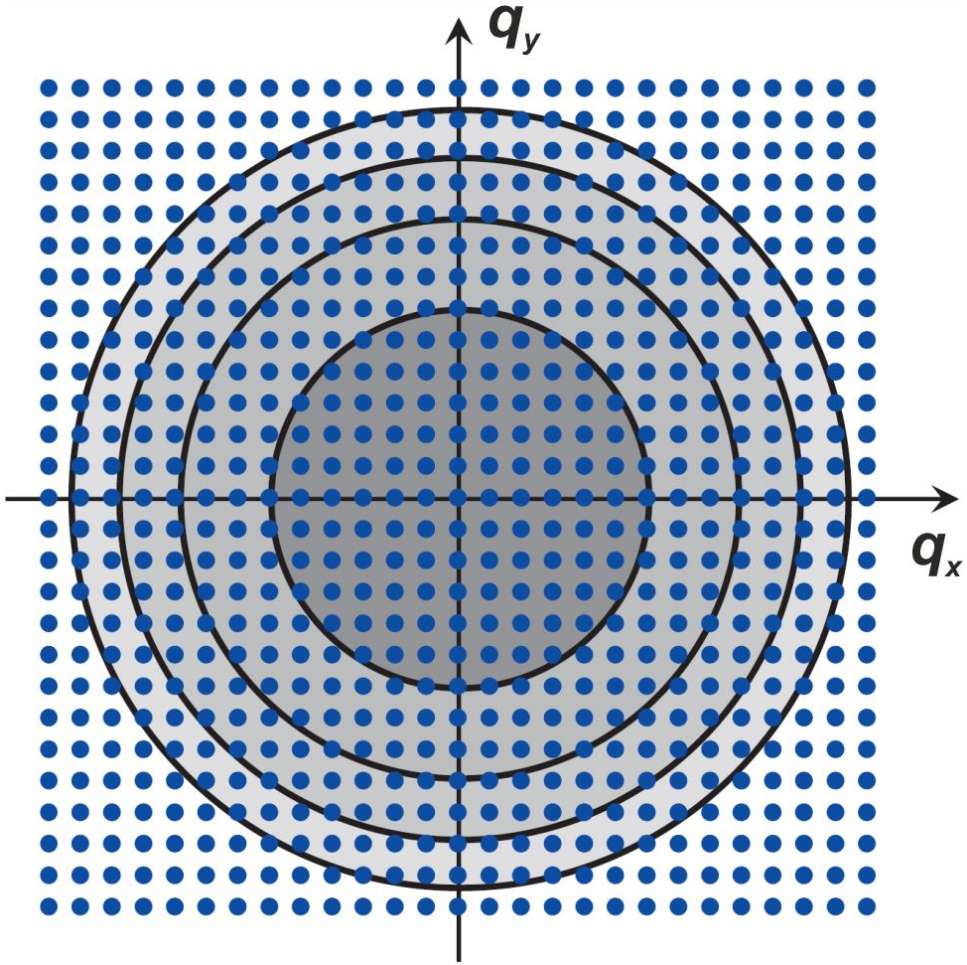
Von **W. Pauli jr.** in Hamburg.

(Eingegangen am 16. Dezember 1926.)

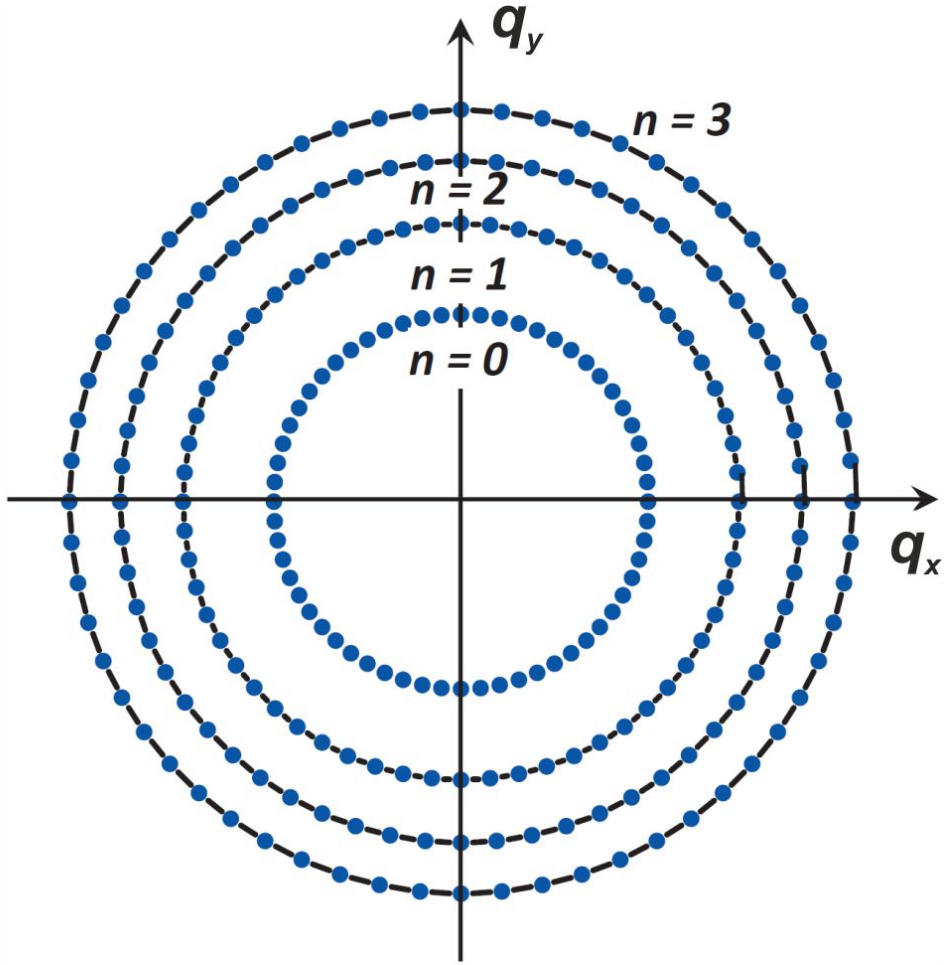
		Na	K	Rb	Cs
calc.	$(\chi_0)_{\text{ber.}} =$	(6,57;	5,2;	4,88;	4,54) . 10^{-7}
exp.	$(\chi_0)_{\text{beob.}} =$	(5,8 ;	5,1;	0,6 ;	− 0,5) . 10^{-7}

Z. Phys. 41, 81 (1927)

zero field ($B = 0$)



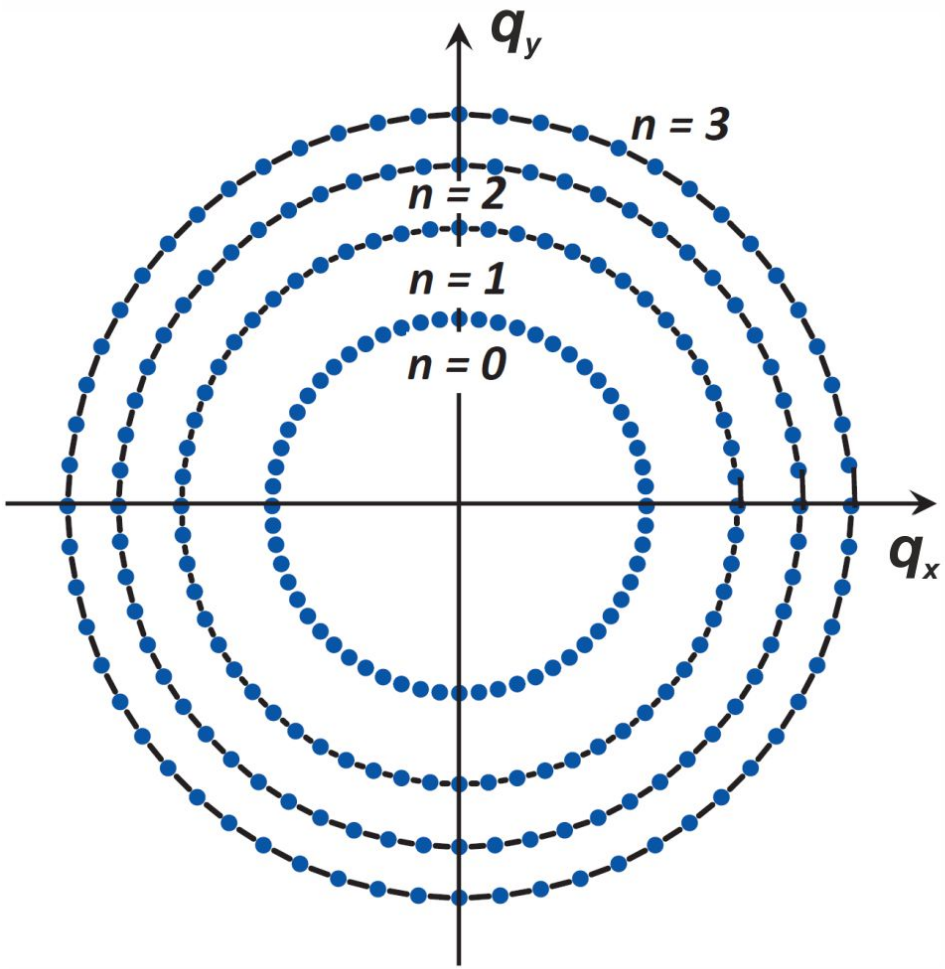
magnetic field ($B \neq 0$)

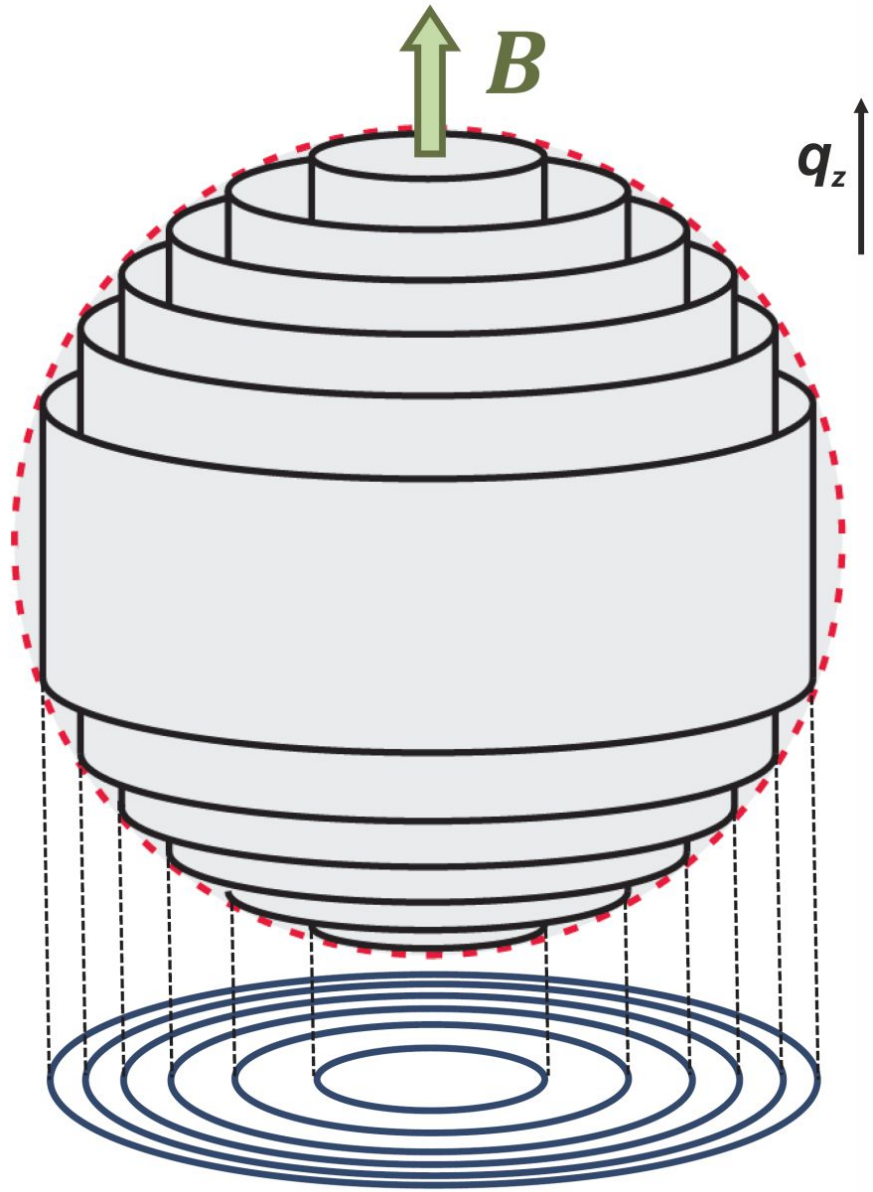


Magnetic field re-distributes electronic states of a crystal

Gross and Marx, Festkörperphysik

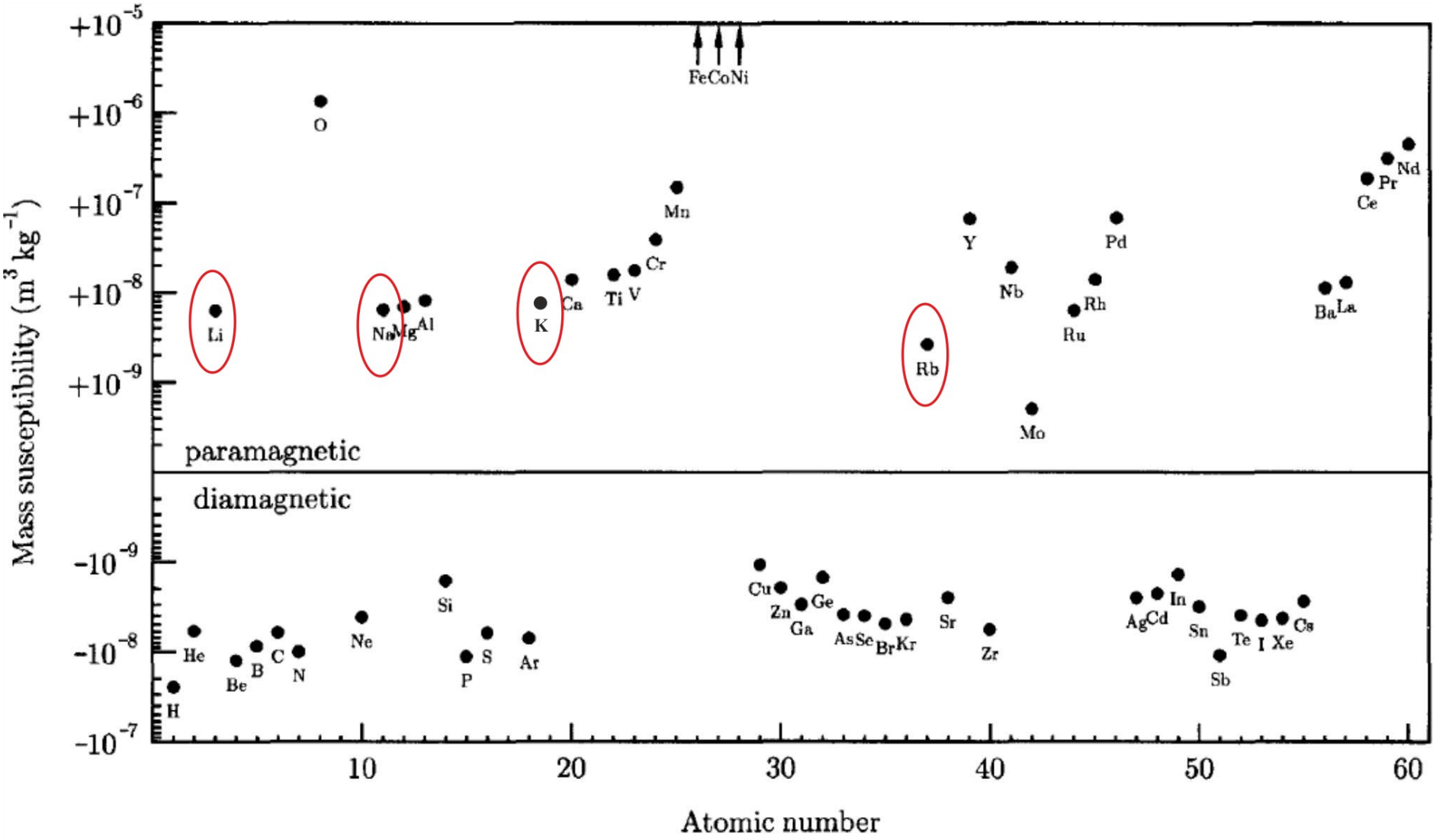
Landau levels





S. Hunklinger, Festkörperphysik

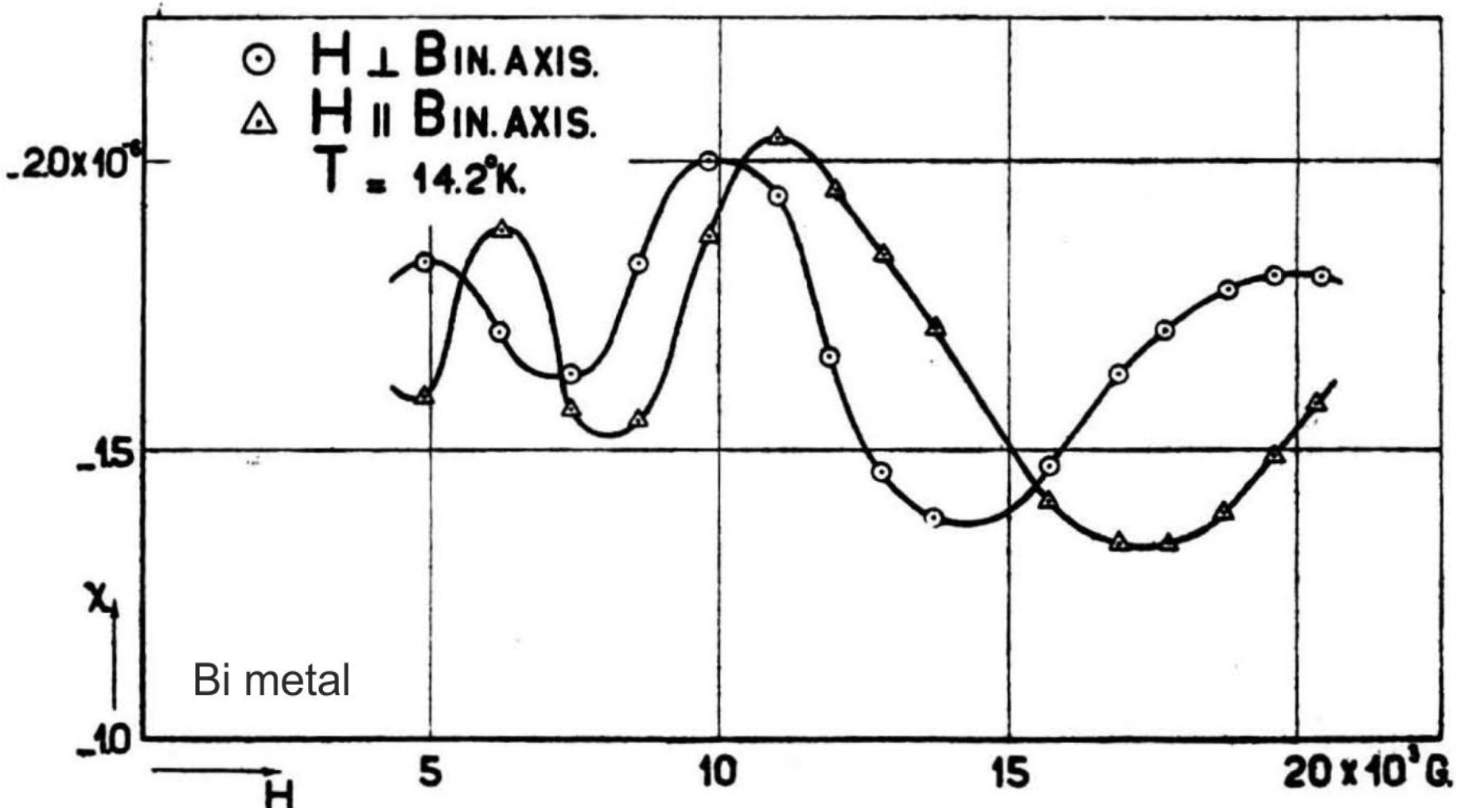
Paramagnetic vs. diamagnetic metals



S. Blundell, Magnetism in Condensed Matter
with corrections based on CRC Handook of Chemistry and Physics

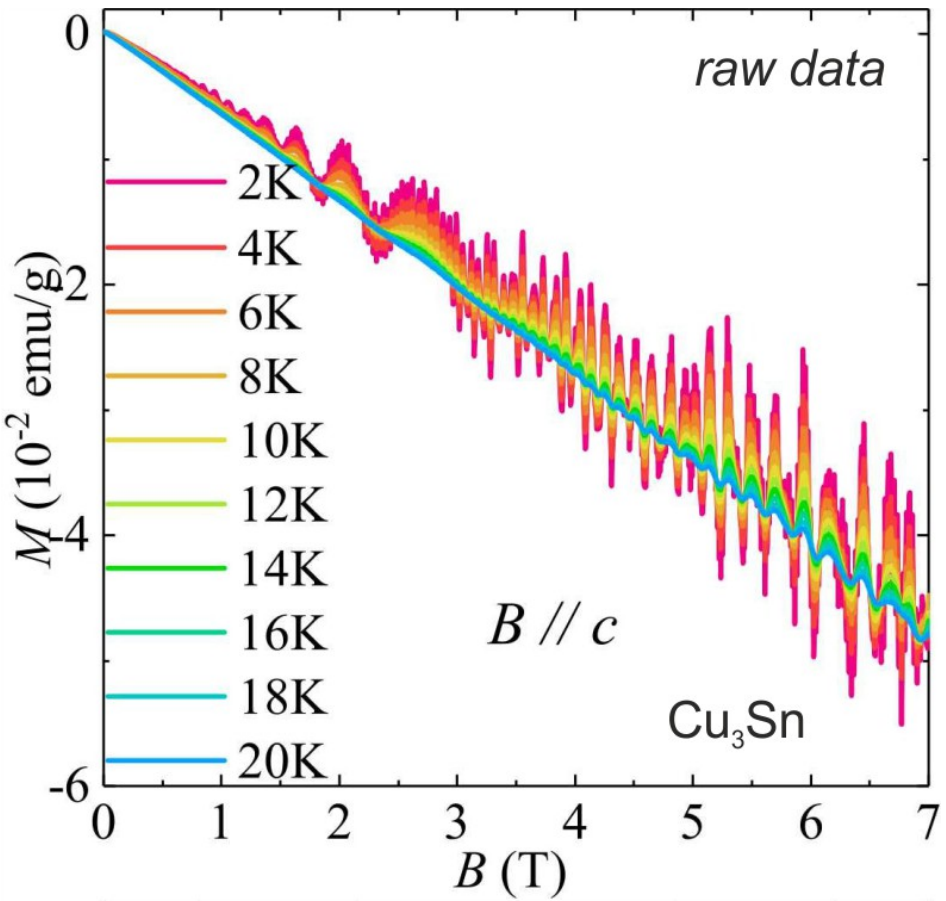
Experiment

de Haas - van Alphen effect



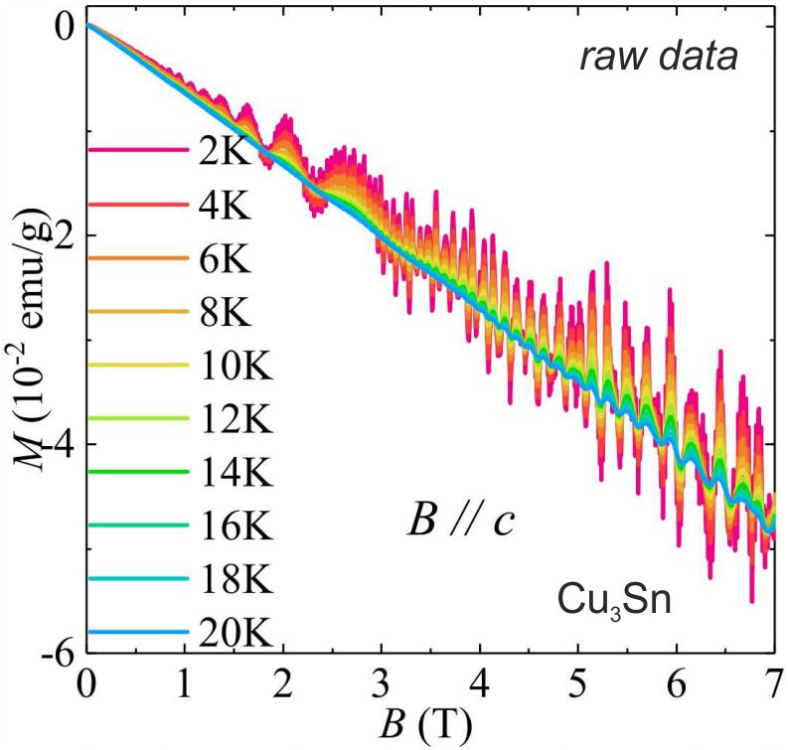
Proc. Acad. Sci. Amst. 33, 1106 (1930)

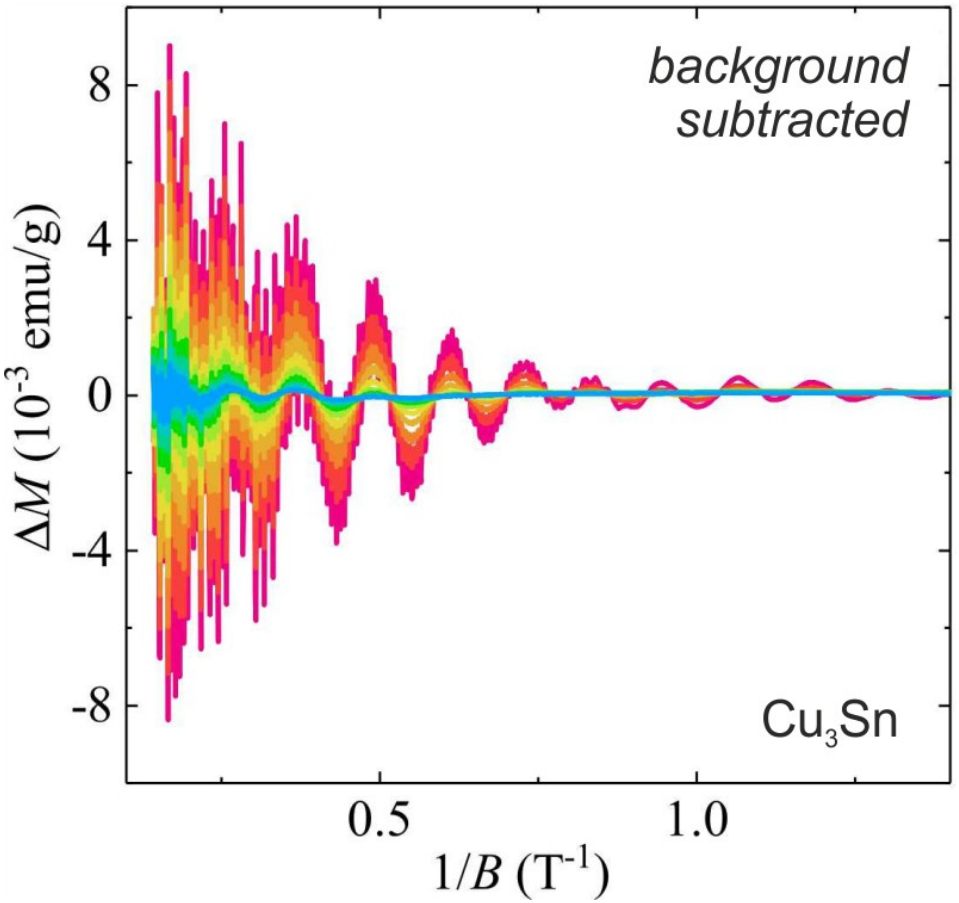
Getting the oscillations



J. Alloys Comp. 928, 167017 (2022)

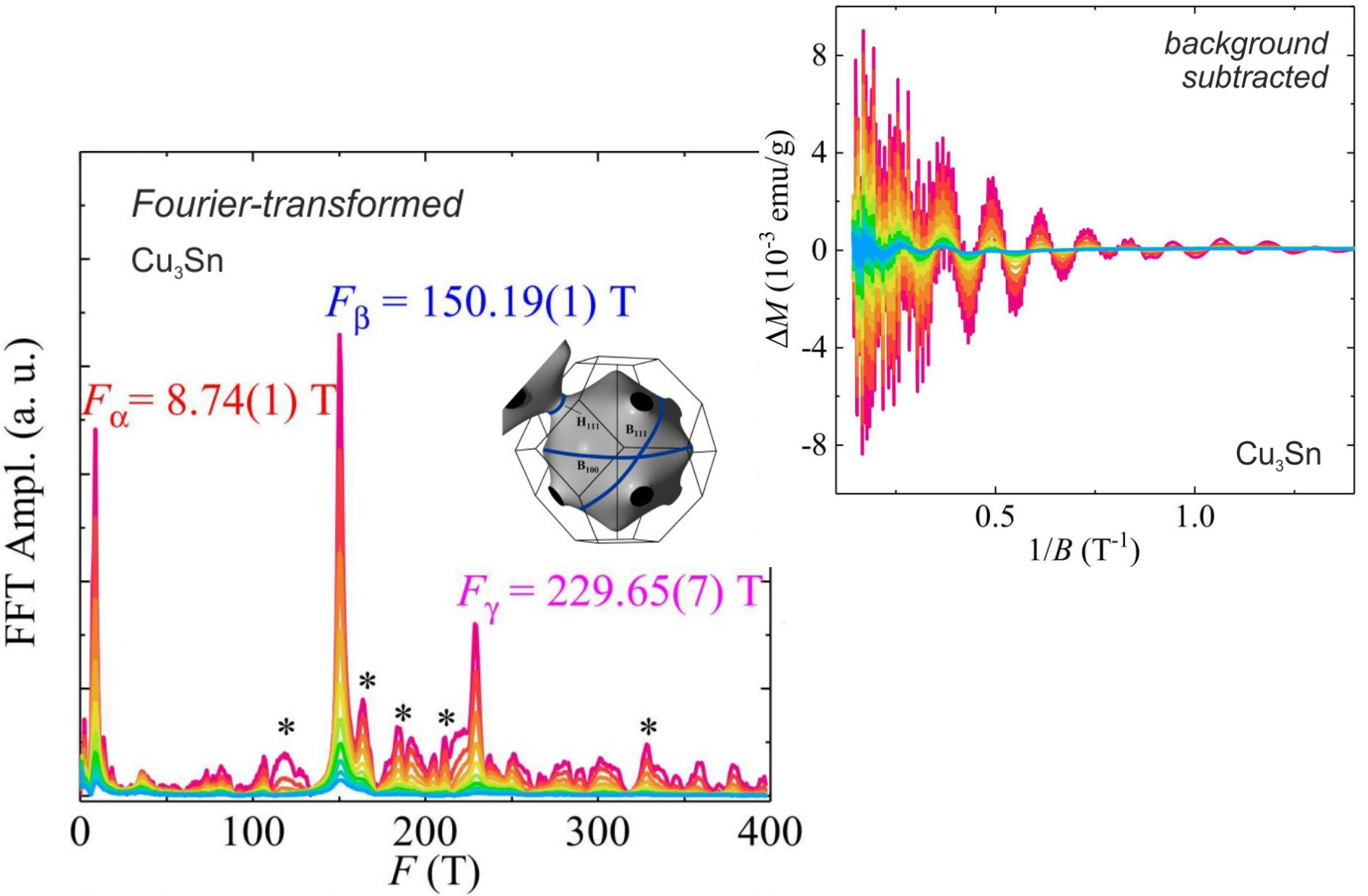
Getting the oscillations





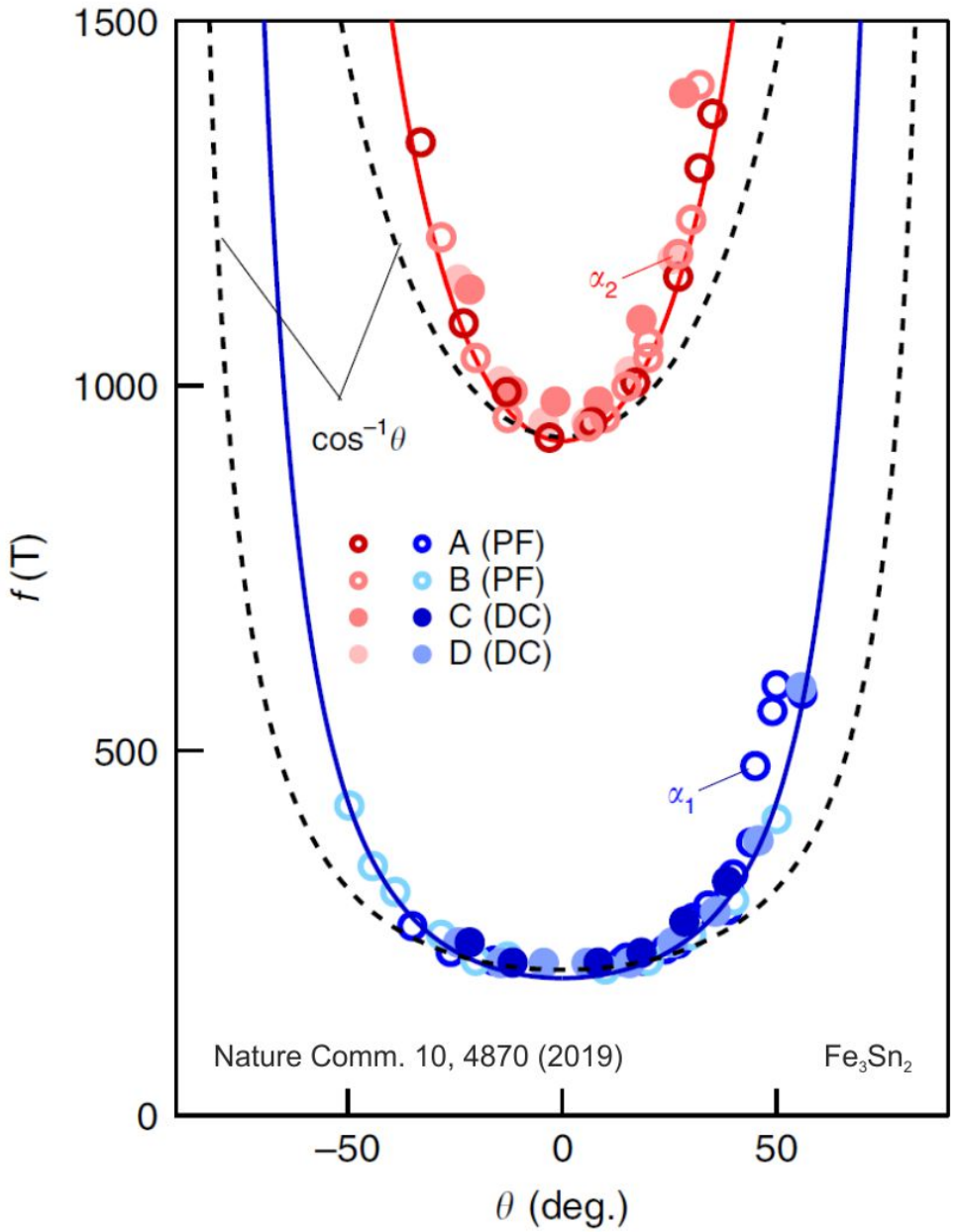
J. Alloys Comp. 928, 167017 (2022)

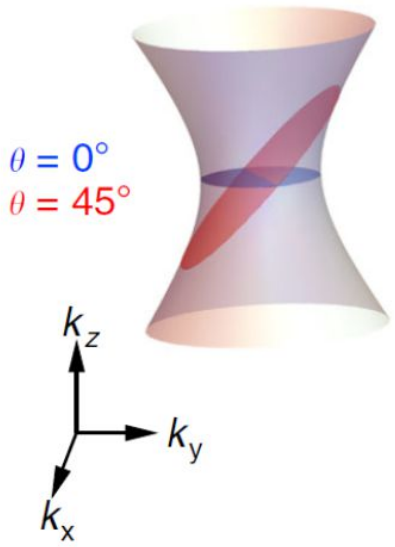
Getting the oscillations

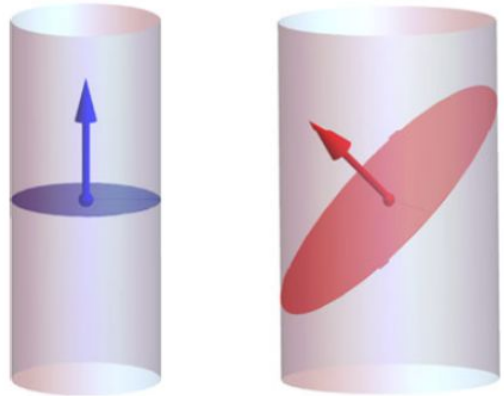


J. Alloys Comp. 928, 167017 (2022)

Angular dependence: full Fermi surface

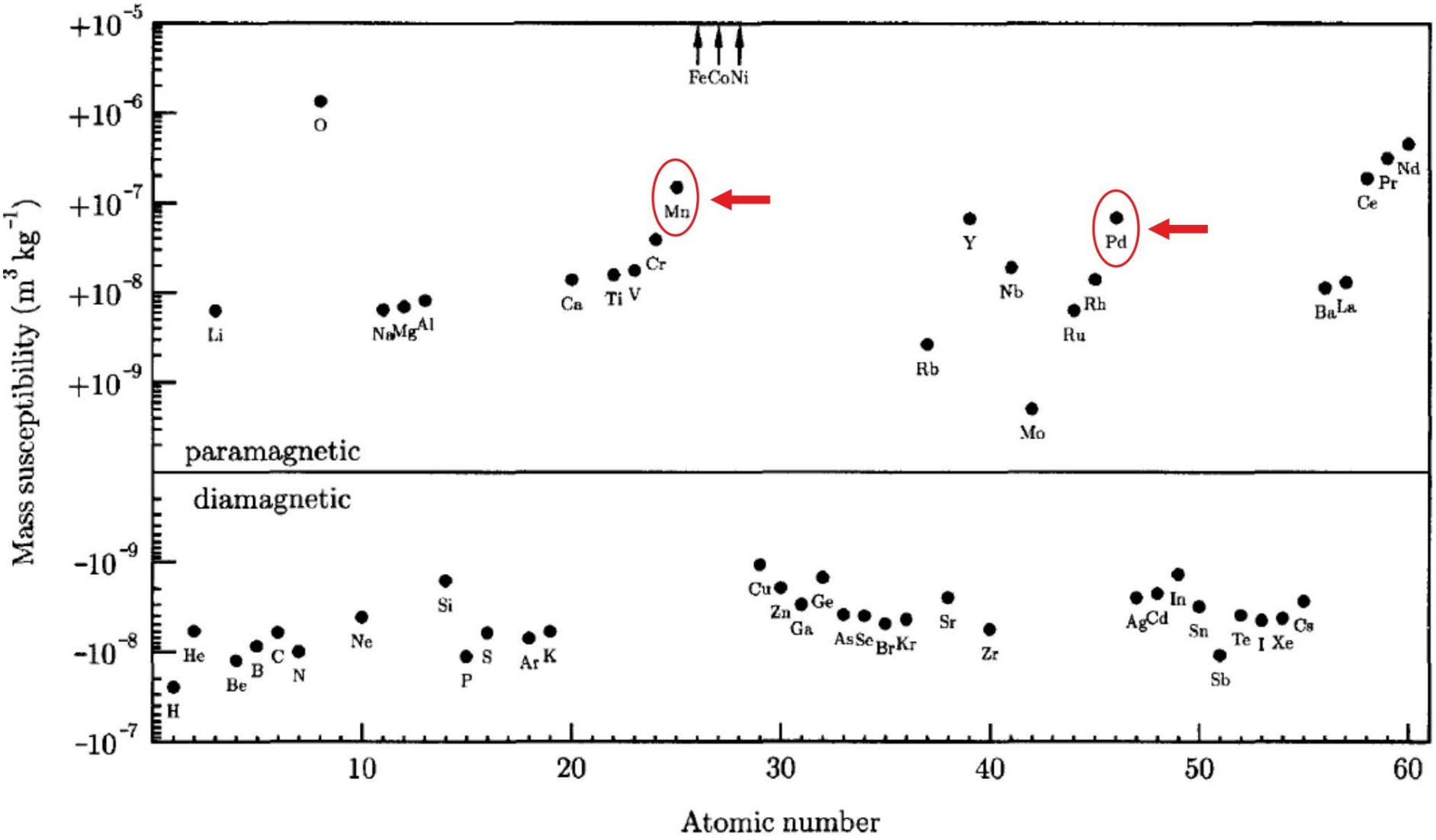






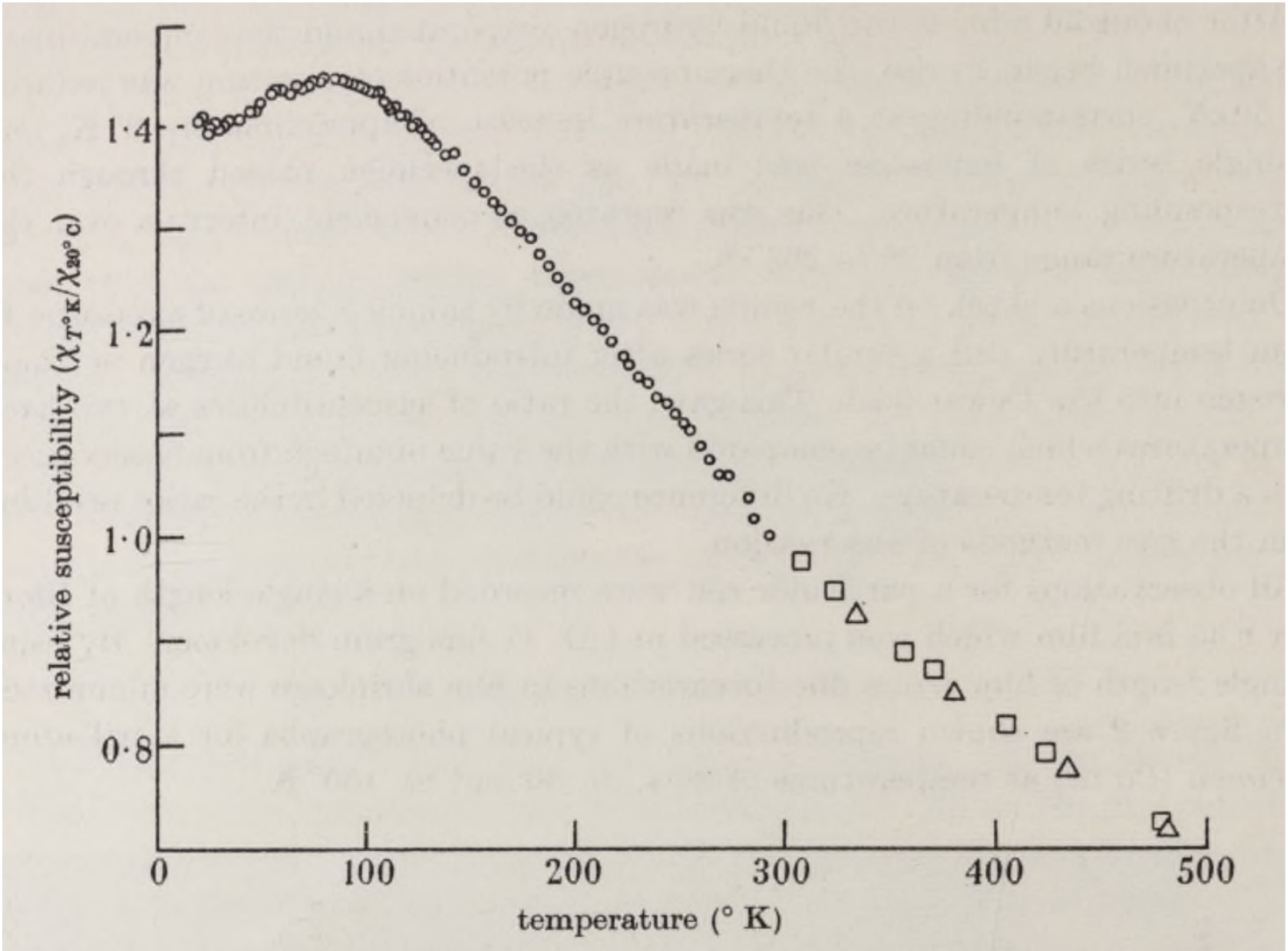
θ = 0° θ = 45°

Stoner enhancement



S. Blundell, Magnetism in Condensed Matter

Magnetism of palladium



Proc. Royal Soc. A 212, 137 (1952)