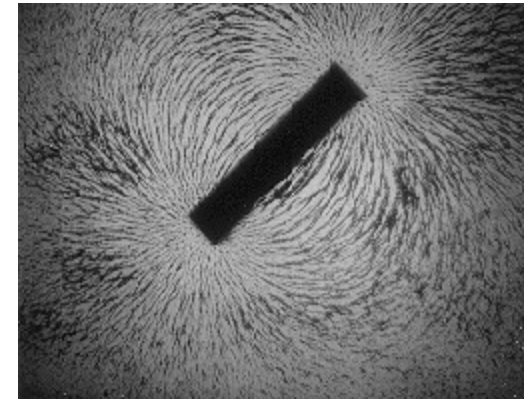
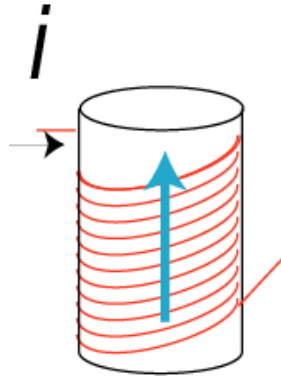


Background, (ferro)magnetism



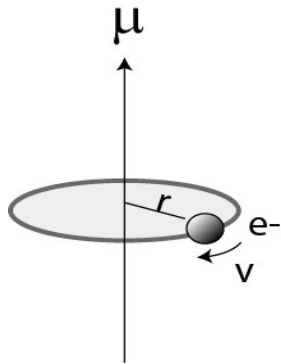
permanent magnet

solenoid magnet

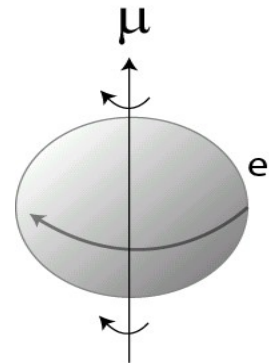


same magnetic fields

from internal electrons orbiting



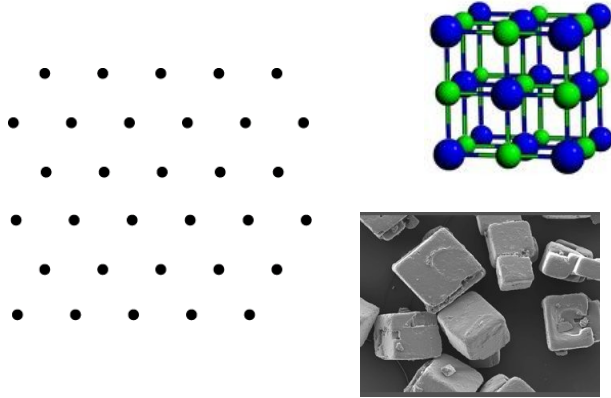
or spinning



Magnetization
Is average:
 $M = Nv\mu$

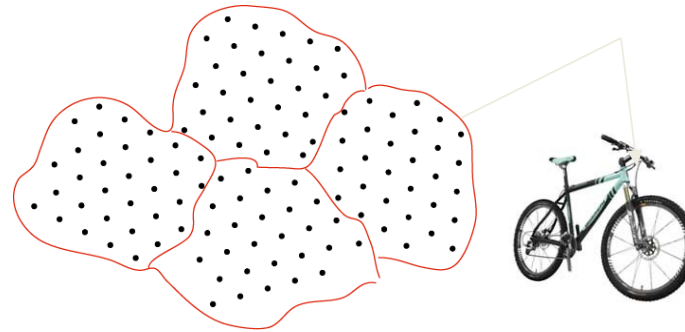


Macroscopic matter is made of atoms (Feynman) (not always the same way)



Single crystal

- ~ 0.2 nm spacing
- Perfect array to infinity
 - 230 flavors
- *Intrinsic behavior*



Polycrystal

- Crystal “grains” > 5 nm
 - Grain boundaries:
no long-range order
extrinsic behavior

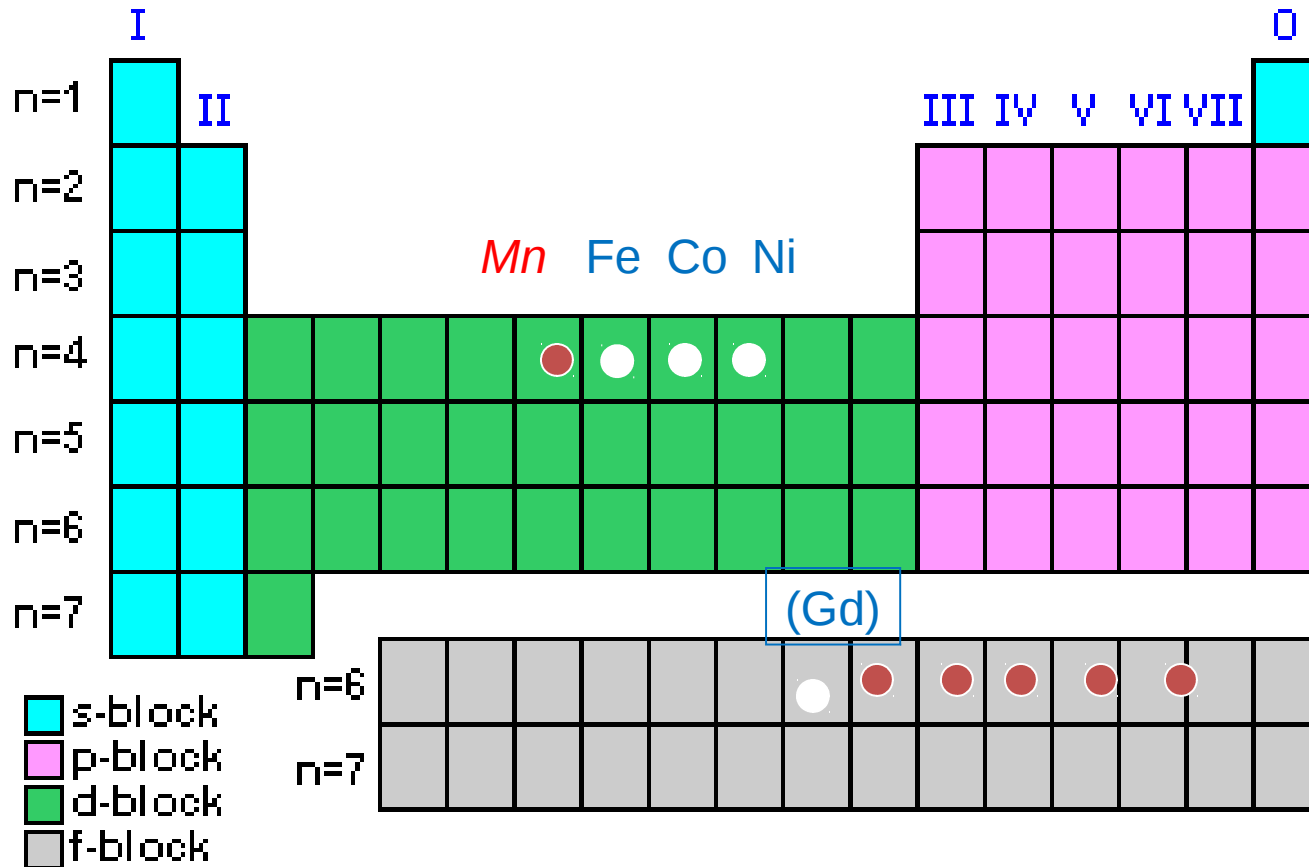


Glass

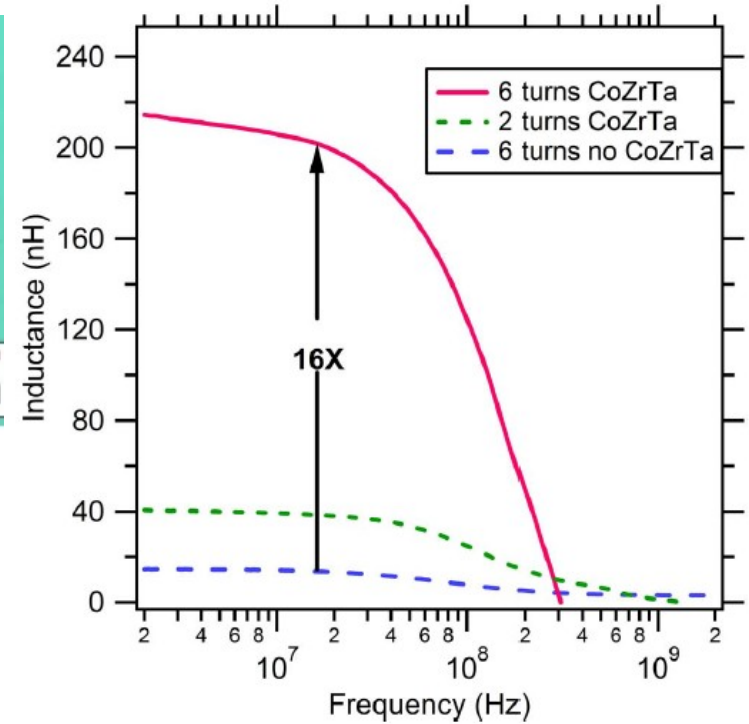
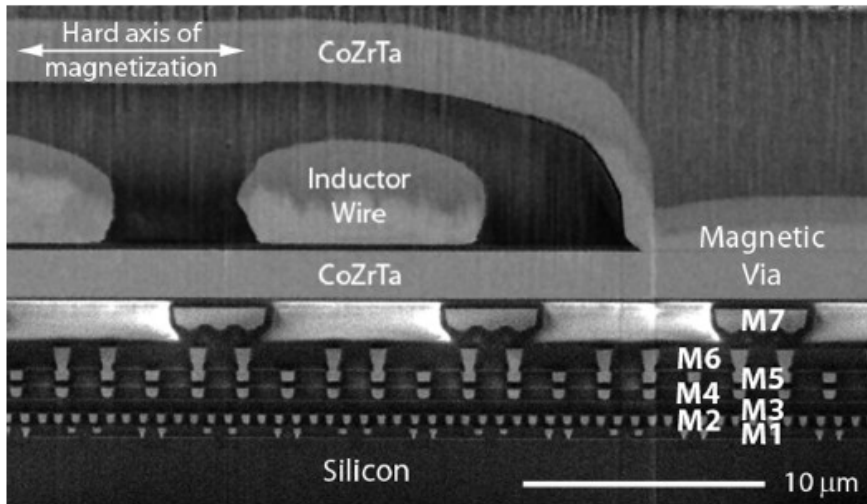
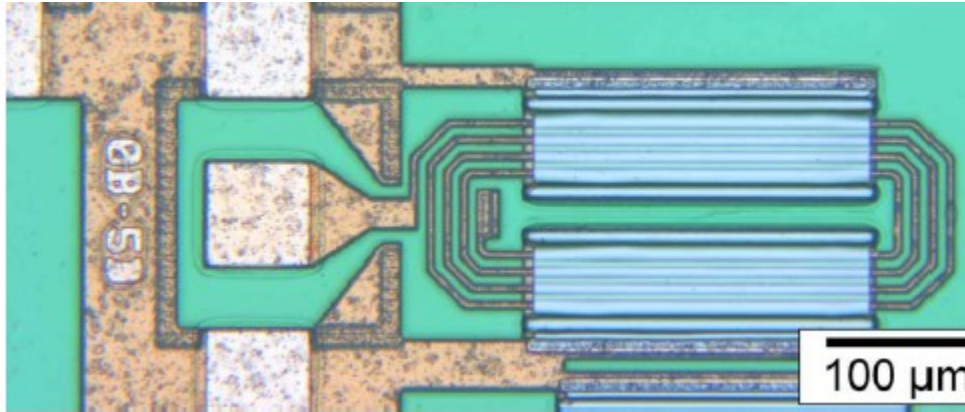
- No long-range order at all
Metallic glasses exist



Only a few “ferromagnetic elements”



Inductors in computer chips

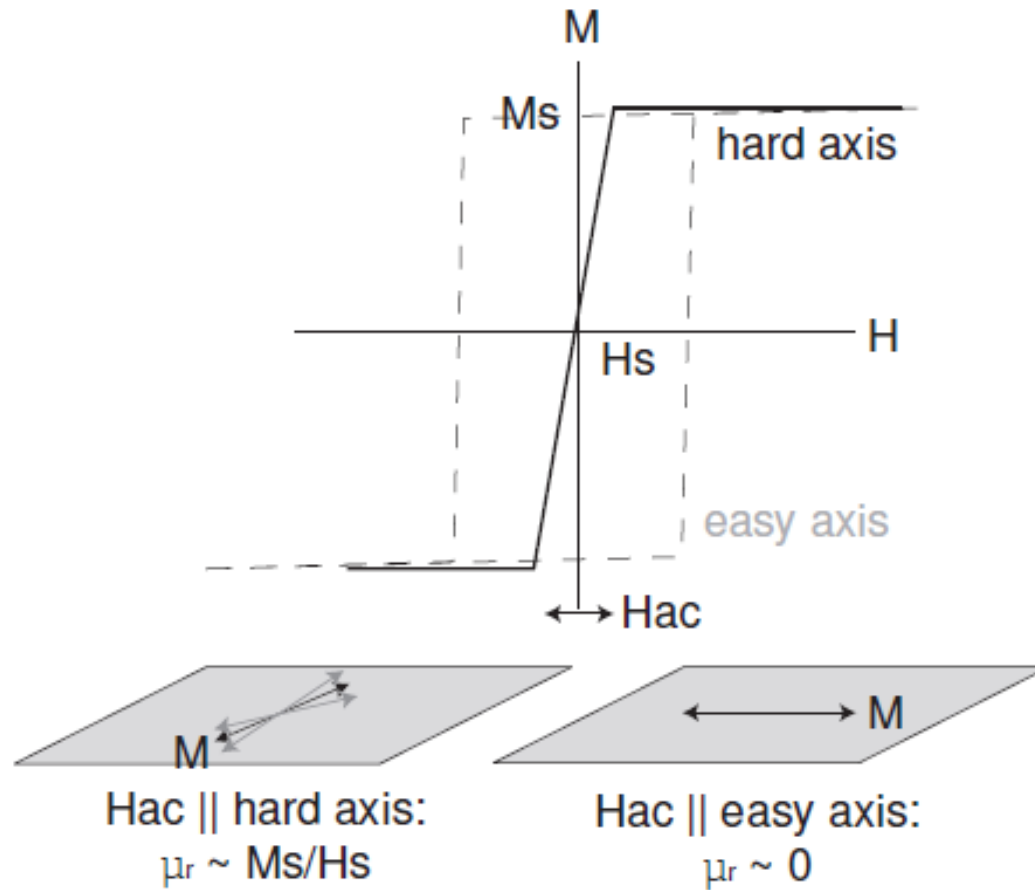


**D. Gardner (Intel) review,
IEEE T. Mag 2009
[31x in stripes]**

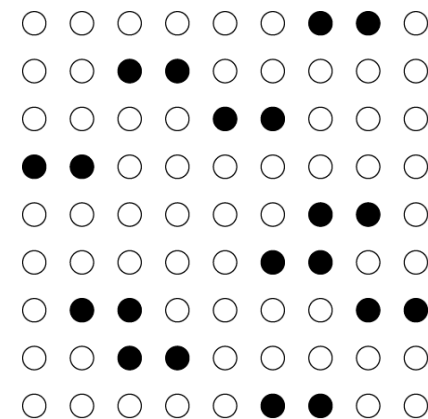
$$\mu \ll \mu_r$$



Materials problem: uniaxial μ



Induced anisotropy
(pair ordering)

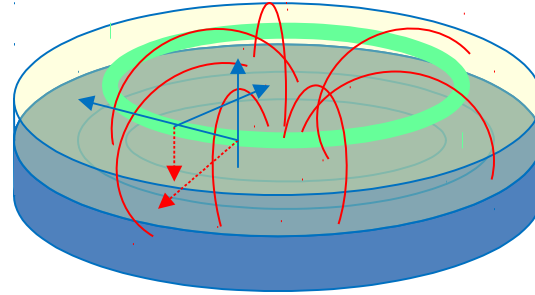
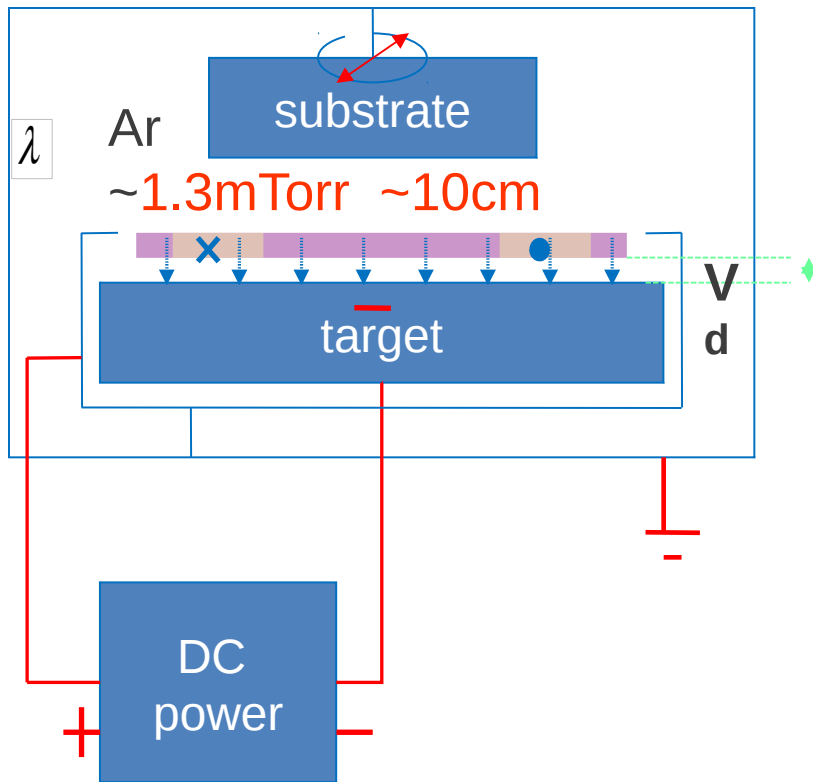


→
Deposition field

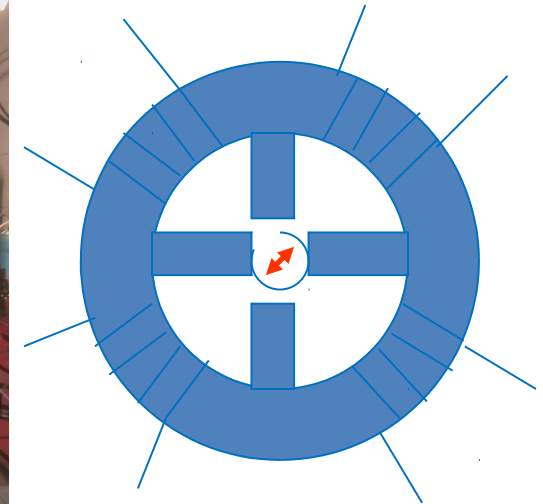
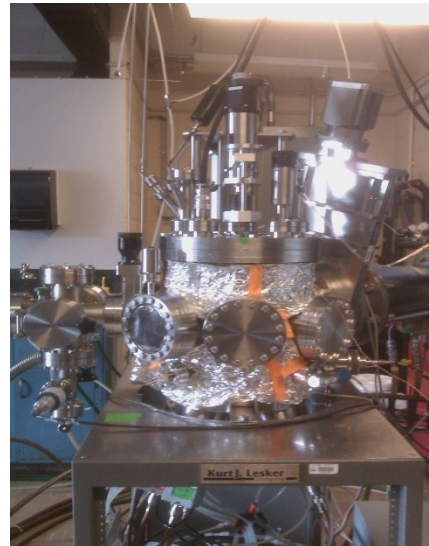
← Easy axis →



Making magnetic films 10-10000 atoms thick



-Magnetron:
Trap for charged
particles



**H_dep synchronized w/
sample rotation**

