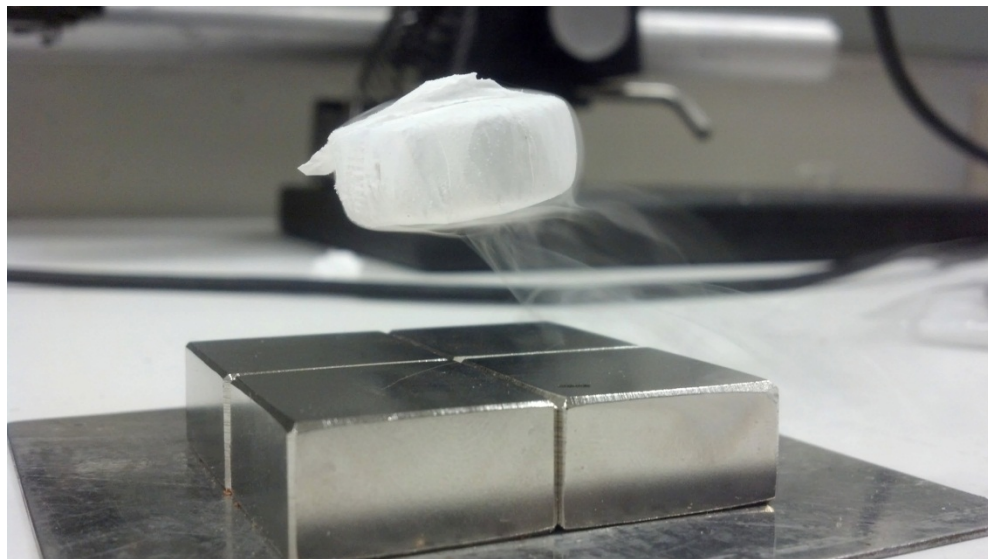


Cooper pairing in superconductors

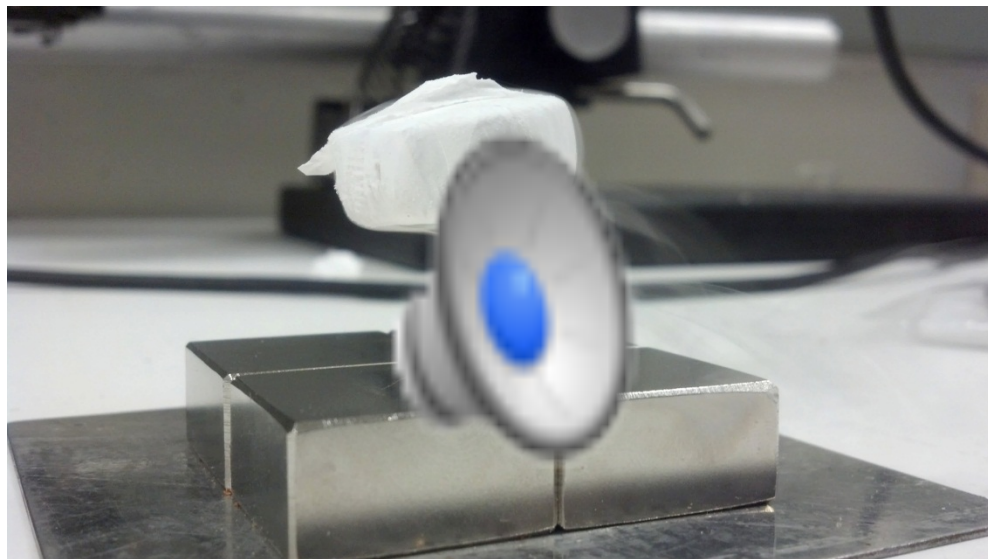
Part I: The phenomenon of superconductivity



Exploring Quantum Physics

Coursera, Spring 2013 Instructors: Charles W. Clark and Victor Galitski

Cooper pairing in superconductors Part I: *Superconductivity*



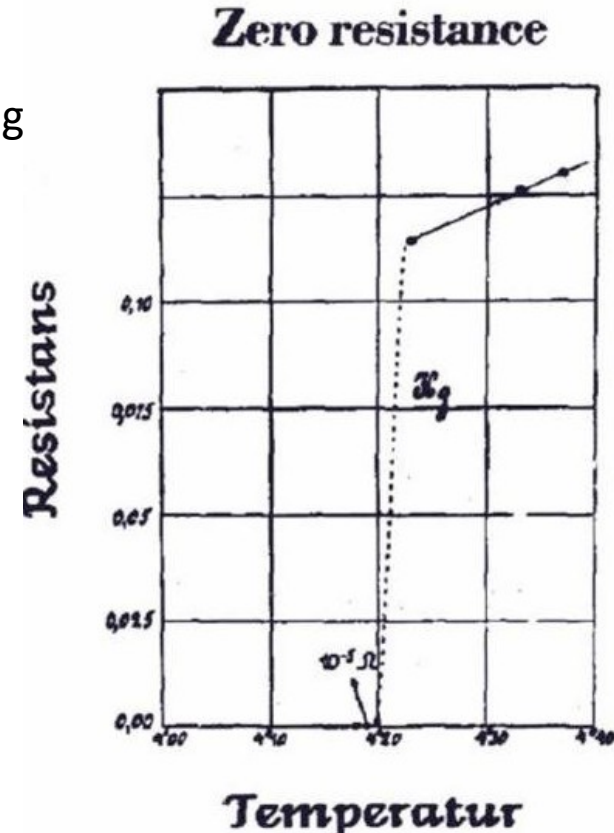
Zero-resistance state



- Superconductivity was discovered by Heike Kamerlingh Onnes in 1911 during experiments to liquefy helium.
- When measuring the resistivity of Hg, he noticed that it dropped to zero below $T_c = 4.2$ K.

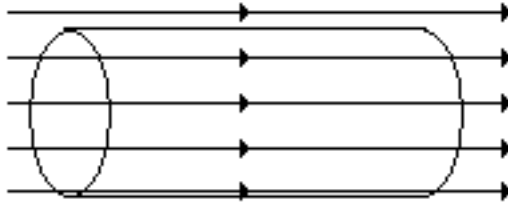
The Nobel Prize in Physics 1913
Heike Kamerlingh Onnes

"for his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium".

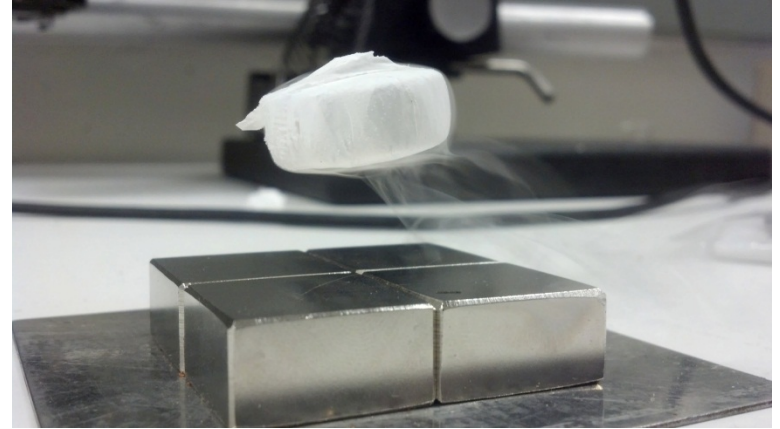
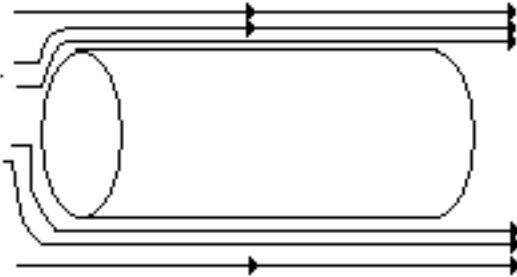


Magnetic flux expulsion

Above Critical Temperature



Below Critical Temperature



Interestingly, theoretically, the Meissner effect is to some degree equivalent to the Higgs mechanism (which really should be called Anderson-Higgs mechanism):

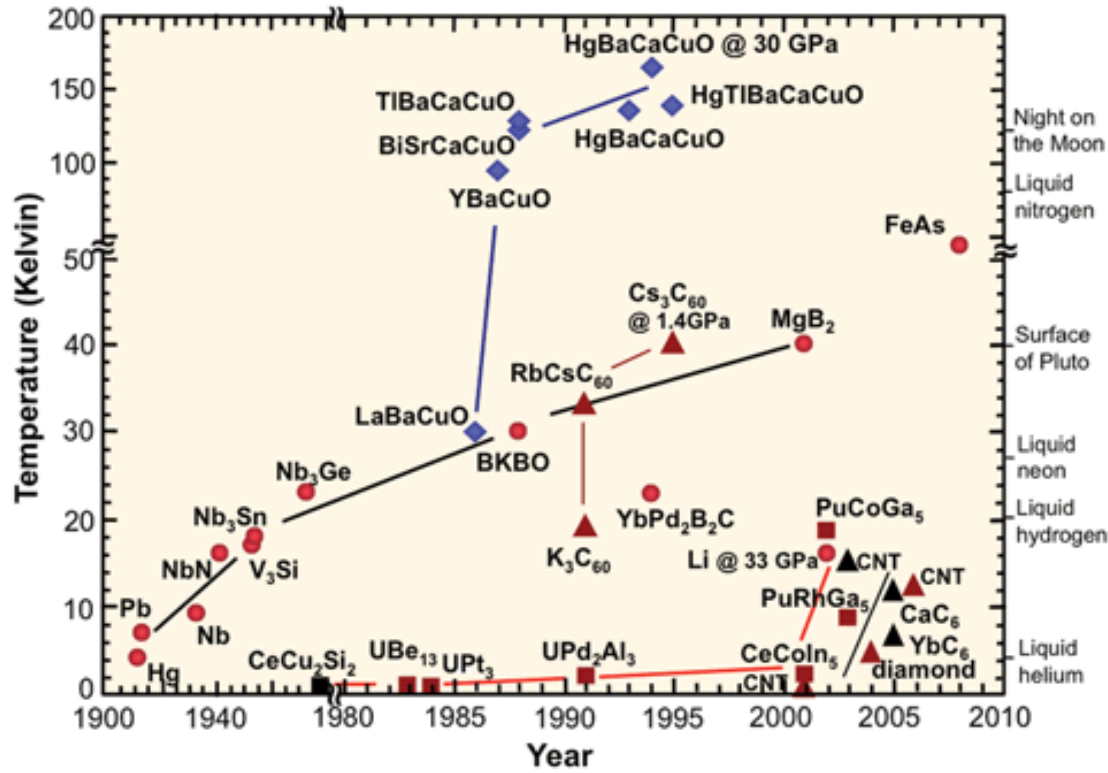
P.W. Anderson, Phys. Rev. **130**, 439 (1963)

P.W. Higgs, Phys. Rev. Lett. **13**, 508 (1964)

10 Nobel prizes for superconductivity

1. Heike Kamerlingh Onnes (1913): discovery of the first SC
2. John Bardeen, Leon N. Cooper, and J. Robert Schrieffer (1972): microscopic theory of SC
3. Ivar Giaever, and Brian D. Josephson (1973): tunneling phenomena in SCs
4. Georg Bednorz and K. Alex Müller (1987): for discovery of high-T_c SCs
5. Alexei A. Abrikosov and Vitaly L. Ginzburg (2003): theory of vortices in SCs
6. ??? (>2013): theory of high-T_c superconductors

A race to increase the transition temperatures



Bernd Matthias' rules

- high symmetry is good
- cubic symmetry is best
- stay away from oxygen
- stay away from magnetism
- stay away from insulators

