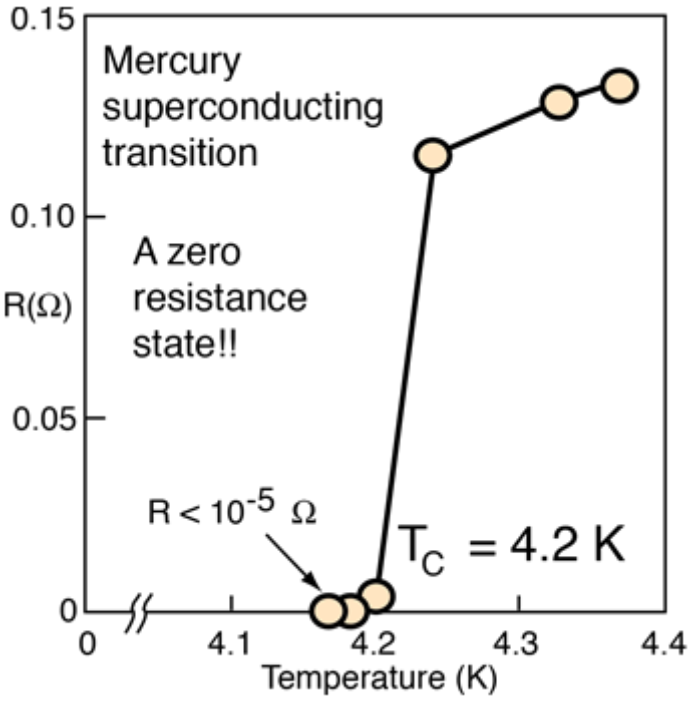
# The Discovery of Superconductivity




H. K. Onnes, Commun. Phys. Lab.12,120, (1911)

H. Kamerlingh Onnes, after having successfully liquified helium in 1908, investigated the low temperature resistivity of mercury in 1911. The mercury could be made very pure by distillation, and this was important because the resistivity at low temperatures tends to be dominated by impurity effects. He found that the resistivity suddenly dropped to zero at 4.2K, a phase transition to a zero resistance state. This phenomenon was called superconductivity, and the temperature at which it occurred is called its critical temperature.

| Compare to others | Magnetic levitation |
|---|---|

Is the resistance zero, or just small?

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# Lead as Superconductor

### Evidence for zero resistance

Lead is a Type I superconductor with a critical temperature of 7.2 K. Although such superconductors can conduct currents with zero resistance, their usefulness is limited because of low critical magnetic fields. Above a certain current, the magnetic field created by the current drives the material into a normal resistive state.

If a current is generated in a superconducting lead ring, it will persist because of the zero resistivity. Currents have been maintained in lead rings for several years to test the zero resistance condition. An induced current in an ordinary metal ring would

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decay rapidly from the dissipation of ordinary resistance, but superconducting rings had exhibited a decay constant of over a billion years!

An exactly zero resistance implies a quantum effect - an energy gap. If the charge carriers do not interact with their environment to reduce their energy even a little bit, it must be because they can't - they are forbidden to by conservation of energy. This implies that there are no available quantum states within reach of the energy they have. The evidence for an energy gap was one of the steps which led to the BCS theory of superconductivity.

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