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The phase transition to superconductivity–what information can thermal expansion measurements provide?

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At the phase transition from the normal (non-superconducting) to superconducting state, thermodynamics tells us that a change in slope of the sample volume is expected [1]. This transition is known as a second-order, or continuous, phase transition. However, the change of slope is very small, roughly 1 part in 10 million. Therefore, the study of phase transitions such as this requires measurements with outstanding resolution and stability. In addition, many of the exciting single crystalline materials at the forefront of physics, are only available in the millimeter-size range. This adds another complication. In this presentation, a novel thermal expansion cell will be described. It is constructed entirely of quartz, which has a very small thermal expansion coefficient. The thermodynamics associated with the normal to superconducting phase transition will be explained, and some recent results on the 39 Kelvin superconductor MgB_2 will be presented.

[1] A. B. Pippard, *The Elements of Classical Thermodynamics* (Cambridge University Press, New York, 1957)