Heat Capacity Anomaly of Superconducting Transitions and Occurrence of Superconductivity

Peter Love [C, S]
University of Connecticut, Department of Chemistry, Stamford, CT, U.S.A.
peter.love@uconn.edu

The boson-fermion transition of a superconductor is generally accompanied by a characteristic heat capacity anomaly at the transition temperature, T_c . The line shape of this saw-tooth geometric figure is essentially the same for a wide variety of chemically different superconductors. This shows that the delocalized electronic processes of the superconducting transition are to a first approximation essentially independent of any given chemical lattice structure. The superconducting transition can be understood in terms of two temperature regimes. The first is the classical thermodynamic Kelvin temperature of the atomic lattice system. The second is the temperature of the itinerant, or conduction, electron system. It is shown that the line shape of a boson-fermion transition anomaly consists of a singular transition line at T_c , and a series of very closely spaced left satellite lines that constitutes the low temperature wing. The saw-tooth figure can be described analytically. Although the boson-fermion transition can be considered as an equilibrium at T_c , it does not follow classical thermodynamics for an equilibrium system. This type of equilibrium is compared to the boson-fermion equilibrium that occurs in superfluid helium. By postulating the formation of effective coordinate covalent bonds in superconducting materials one can account for the occurrence, and lack of occurrence, of superconductivity of many metallic elements with respect to their positions in the Periodic Table.