

# Superconductivity: A New Approach Based on the Bethe-Salpeter Equation in the Mean-Field Approximation (Series on Directions in Condensed Matter Physics)

G P Malik



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Given the Debye temperature of an elemental superconductor (SC) and its  $T_c$ , BCS theory enables one to predict the value of its gap  $\Delta_0$  at T = 0, or vice versa. This monograph shows that non-elemental SCs can be similarly dealt with via the generalized BCS equations (GBCSEs) which, given any two parameters of the set  $\{T_c, \Delta_{10}, \Delta_{20} > \Delta_{10}\}$ , enable one to predict the third. Also given herein are new equations for the critical magnetic field and critical current density of an elemental and a non-elemental SC — equations that are derived directly from those that govern pairing in them.

The monograph includes topics that are usually not covered in any one text on superconductivity, e.g., BCS-BEC crossover physics, the long-standing puzzle posed by  $SrTiO_3$ , and heavy-fermion superconductors — all of which are still imperfectly understood and therefore continue to avidly engage theoreticians. It suggests that addressing the  $T_cs$ ,  $\Delta s$  and other properties (e.g., number densities of charge carriers) of high- $T_c$  SCs via GBCSEs incorporating chemical potential may lead to tangible clues about raising their  $T_cs$ . The final chapter in this monograph deals with solar emission lines and quarkonium spectra because of a feature common between them and superconductivity: existence of a bound state in a medium at finite temperature. This is a problem on which the author has worked for more than 25 years. The treatment in the text is elementary — even those who have only a cursory familiarity with Feynman diagrams should be able to follow it without much difficulty.

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