

Cambridge University Press 0521017513 - The Electrical Properties of Disordered Metals J. S. Dugdale Index More information

Aharonov-Bohm effect, 111, 121

Index

and weak localisation, 105-39

with conduction electrons, 111-14 temperature dependence due to weak anomalous dispersion localisation, 117-18 in electron wavefunctions, 90-4, 97 conduction electrons, 21-3 Cooper channel interactions, 162-4, 174 in optics, 87-90 and magnetoresistance, 181-2 anti-localisation, 128 Coulomb interaction between conduction electrons, 143-62 Boltzmann equation, 26, 33 Coulomb anomaly (see also enhanced Boltzmann theory of electrical conduction, interaction effect), 140-75 25 - 32Coupling constant in exchange interaction, Born approximation, 36, 39, 51 154-6for Hartree terms, 159-60, 230-1 Ca-Al metallic glasses in Cooper channel, 162-4, 174, band structure, 212-13 229-31 characteristic parameters, 218-19 Cu-Ti metallic glasses, conductivity of, conductivity of, 211-23 201 - 5dephasing times, 222 electronic heat capacity and Hall coefficient, 213 Debye-Waller factor, 58-60 magnetic impurities in, 222 density of states (for free electrons), magnetoresistance, 213-23 24 - 5resistivity, temperature dependence, changes due to enhanced electron 222 - 3interaction, 141 et seq. effect of spin-orbit scattering on, 220-2 changes with temperature, 165 value of F, 218-19, 221 dephasing processes, 117-18, 120-3, 207, closed paths, probability of, 115-16, 157-9 211 coherence of electron wavefunction, 111-12, characteristic time in Ca-Al glasses, 222 115 - 20diffusion, effect on electron wavefunctions, collective electron modes, 70 149-55 comparison of experiment and theory, importance of, in enhanced interaction 200 - 24effect, 161-2 conductivity, electrical (see also resistivity), diffusion coefficient of electrons, 32-3, 115 calculation by Boltzmann theory, 25-32 et seq., 200-1 of Ca-Al metallic glassess, 211-23 values in Ca-Al glasses, 216, 218-20 of Cu-Ti metallic glassess, 201-5 values in Cu-Ti glasses, 205 and diffusion, 32-3 values in a range of metallic glasses, 207 effect of Coulomb interaction on, 167–75 diffusive screening, 154-5, 171 Cooper channel, 174 particle-hole channel, 167–70 Einstein relation, 32, 165, 200 Einstein relation, 32



Cambridge University Press 0521017513 - The Electrical Properties of Disordered Metals J. S. Dugdale Index More information

Index 239

electrical conductivity (see conductivity, independent electron picture, 63-4 electrical) inelastic scattering, 116-18, 120, 124, 201, 207, 222 electron, independent, picture, 63-4 electron transport in metals, conventional interaction effect (see also enhanced theory, 20-33 interaction effect), 140-87 electron-electron interaction, interaction mechanism in Hartree terms of collective electron modes, 70 particle-hole channel, 156-7, 168-9 in crystalline metals, 64, 231-2 interactions and quasi-particles, 63-70 in disordered metals, 183, 231-2 mediated by phonons, 67-9 Kohler's rule in magnetoresistance, 102–3 via screened Coulomb potential, 38 k-space, 23 electrons, conduction, 21-3 k-states in disordered metals, 44, 48-9 electrons, collective modes, 70 enhanced interaction effect, 140-75 Lindhard screening, 43-4, 53 and conductivity, 167-75 liquid metals, Ziman theory, 48-54 and density of states, 140-66 localisation, weak (see weak localisation) and Hall effect, 184-7 and magnetoresistance, 176-82 magnetoresistance, 100-4 effect of spin-orbit scattering, 171-4 due to weak localisation, 121-5 exchange terms in particle-hole channel, at high fields, 122-3 147-53 at low fields, 123-5 Hartree terms in particle-hole channel, due to enhanced interaction effect, 156 - 9176-84 exchange contribution to interaction energy, at high fields, 176-7 145-56 at low fields, 178 in the Cooper channgel, 181–2 spin-orbit effects, 180-1 F coupling constant, 159–60, 228–30 temperature dependence, 178-80 Fermi electrons, 24 energy, 22-4 Kohler's rule, 102–3 of metallic glasses, 204-23 surface, 23, 48, 80, 201 simple theory, 100-4 Fourier transforms, 37–8, 227–8 two-band model, 100-2 Maki-Thompson correction, 183, 209-12, glass, insultating, 6 229-31 nature of, 6 melt spinning, 10-11 properties in general, 7 metallic glasses, transition temperature, 9 atomic deposition techniques, 11 glasses, metallic (see metallic glasses) Hall coefficient, 81-2, 86, 97-9, 184-7 how produced, 9-11 magnetoresistance, 204-23 Hall coefficient, Hall effect, 81-99, 184-7 range of stability, hybridisation theory of, 87-94, in composition, 11-12 97-9, 234 in temperature, 9 influence of enhanced interaction effect, resistivity (see also conductivity), 105-9, 201-4in metallic glasses, 81-2, 86, 97-9 structure of, 13-19 in terms of Fermi surface, 85 thermopower, 194-9 simple theory, 81-3 what are they? 6 with two types of carrier, 84-5 metals, liquid, Ziman theory of, 48-54 Hartree terms in interaction energy, 145-6 Mooij correlation, 107-9, 118 contribution to density of states, 157-9 Mott model of transition metal, 74-6 hybridisation, of electron wavefunctions in crystalline normal modes in glasses, 55 metals, 73-5 of s- and d-character in transition metal glasses, 87-94 particle-hole pairs, 66-7 theory of Hall coefficient, 87-94, 97-9, Peltier heat, 188-93 234 phonon drag, 58, 194



Cambridge University Press 0521017513 - The Electrical Properties of Disordered Metals J. S. Dugdale Index More information

> 240 Index

phonons in disordered systems, 55-62 phonon ineffectiveness, 60-1 pseudopotential, 44-7 applied to liquid metals, 49, 51-2 Principle of Least Action, 109-10 quantum interference, 109-11, 121 and Aharonov-Bohm effect, 111, 121 with conduction electrons, 111-4 and Principle of Least Action, 109-10 quasi-particles, 64-5 radial distribution function, 17-18 resistance, resistivity, electrical (see also conductivity), Mooij correlation, 107-9, 118 magnetic field dependence,

due to enhanced electron interaction, 176-83 due to weak localisation, 121-5 temperature dependence due to enhanced electron interaction, 167-75 with spin-orbit scattering, 171-4 temperature dependence due to weak localisation, 117-18

with spin-orbit scattering, 127-31

sources of, 20-1

s- and d-electrons, 71-6, 78, 86-7, 90-4, 97-9, 103, 124, 201, 226-7 scaling theory and weak localisation, 136-9 scattering, 34-47 angle, influence on resistivity, 39-40, 51 of electrons by phonons, 56 at low temperatures, 57-8 at high temperatures, 61-2 inelastic, 116-18, 120, 124, 201, 207, 222 influence of Pauli principle, 40-1 by phonons in disorder systems, 140 screening by electrons in metals, 41-4 influence of diffusion, 154-5, 171 Thomas-Fermi, 41-3, 45, 144, 201 self-energy of electrons, 65, 142-3 short-range order, 15, 18-19 singularity in density of states, 153, 161-2

skew-scattering of electrons, 94-6

spectral function of electrons, 49

spin-orbit interaction, 94-6 spin-orbit scattering, in the enhanced interaction effect, 171-4 in weak localisation, 126-35 spin-spin or spin-flip scattering, 135-6, 222 structure factor, 49-53 superconducting fluctuations, 163 174, 183 superconductivity mechanism via phonons,

67 - 9temperature coefficient of resistance, negative, 106-9 thermopower, 188-99 absolute, 189-90 calculation of, in metals, 190-4 electron phonon enhancement, 195-9 general and definitions, 188-94 in metallic glasses, 194-9 Mott formula, 193 Thomas-Fermi screening, 41-3, 45, 144, 201 transition metals and alloys, 71-80 crystalline, 71-4 Fermi surface in glasses, 79-80 glasses, 77-80 Mott model, 74-6

virtual processes, 68

weak localisation, 105-39 and diffusion of electrons, 115-17 and conductivity, some formulae for temperature and magnetic field dependence, 225-6 and electron spin, 125-36 and quantum interference, 115 and scaling theory, 136-9 and spin-orbit scattering, 126-35 and Zeeman splitting, 182-3 with s- and d-bands, 226-7

Zeeman splitting in magnetoresistance, due to enhanced electron interaction, 177 - 8due to weak localisation, 182-3 Ziman model of liquid metals, 48-54 applied to metallic glasses, 105