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Nota di contenuto	Preface; Acknowledgments; Contents; Part 1: Potential Scattering; 1. Basic Notions; 1.1 Introduction; 1.2 Several definitions; 1.2.1 Types of collisions - reaction channels; 1.2.2 Q-values, threshold, open and closed channels; 1.3 Cross sections; 1.3.1 Center of mass and laboratory frames; 1.4 Classical scattering; 1.4.1 The classical cross section; 1.4.2 Orbiting, rainbow and glory scattering; 1.5 Stationary scattering of a plane wave; 1.6 Scattering of a wave packet; 1.6.1 Propagation of a free wave packet; 1.6.2 Collision of the wave packet with a target; 1.6.3 The Optical Theorem 1.7 Systems of units1.7.1 Nuclear physics; 1.7.2 Atomic and molecular physics; Exercises; 2. The Partial Wave Expansion Method; 2.1 Free particle in spherical coordinates; 2.2 Numerical solutions of the radial equation; 2.3 Scattering amplitude and cross section; 2.4 Wronskian relations; 2.5 Integral formulae for the phase shifts; 2.6 Convergence of the partial-wave expansion; 2.7 Hard sphere scattering; 2.8 Absolute phase shifts - Levinson Theorem; 2.9 Resonances; 2.9.1 Time delay; 2.10 Scattering from a square-well; 2.11 Low energy scattering; 2.11.1 The scattering length

2.11.2 The effective range formula Exercises; 3. Coulomb Scattering; 3.1 Classical mechanics description of Coulomb scattering; 3.2 Quantum mechanical description; 3.2.1 The quantum mechanical cross section in Coulomb scattering; 3.3 Partial wave expansion; 3.3.1 Approximate Coulomb phase shifts - asymptotic series; 3.3.2 Some numerical results; 3.3.2.1 Coulomb phase shifts; 3.3.2.2 Coulomb wave functions; 3.3.3 Partial-wave expansion of  $(+)$   $(k; r)$ ; 3.4 Coulomb plus short-range potentials; 3.4.1 An illustration:  $-$  scattering; Exercises; 4. Green's Functions, T- and S-Matrices 4.1 Lippmann-Schwinger equations 4.1.1 The free particle Green's function; 4.1.2 The scattering amplitude; 4.1.3 Orthonormality relation for scattering states; 4.1.4 The Moller wave operators; 4.2 The transition and the scattering operators; 4.2.1 The Optical Theorem; 4.2.2 The S-matrix; 4.3 The time-dependent picture; 4.3.1 Time-dependent definition of the scattering operator; 4.3.2 Energy conservation; 4.3.3 Time-reversal; 4.4 Scattering from non-local separable potentials; 4.5 Scattering from the sum of two potentials; 4.5.1 The Gell-Mann Goldberger relations 4.5.2 The Distorted Wave series 4.6 Partial-wave expansions; 4.6.1 Partial-wave projection of the S- and the T-matrices; 4.6.2 The partial-wave projected two-potential formula; 4.7 Long range potentials; 4.8 Evaluation of partial-wave Green's functions; 4.8.1 Free particle's Green's function; 4.8.2 Green's functions for an arbitrary potential; Exercises; 5. Approximate Methods in Potential Scattering; 5.1 Perturbative approximations; 5.1.1 The Born series; 5.1.1.1 Applications of the first Born approximation; 5.1.2 The Distorted Wave Born series; 5.1.2.1 Partial-wave projections 5.1.2.2 An illustrative application of the DWBA

## Sommario/riassunto

The aim of the book is to give a coherent and comprehensive account of quantum scattering theory with applications to atomic, molecular and nuclear systems. The motivation for this is to supply the necessary theoretical tools to calculate scattering observables of these many-body systems. Concepts which are seemingly different for atomic/molecular scattering from those of nuclear systems, are shown to be the same once physical units such as energy and length are diligently clarified. Many-body resonances excited in nuclear systems are the same as those in atomic systems and come under the name

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