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Quantum Theory, Groups and Representations: An Introduction Revised and expanded version, under construction Peter Woit Department of Mathematics, Columbia University

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Geared toward research students in physics and chemistry, this text introduces the three main uses of group theory in quantum mechanics: (1) to label energy levels and the corresponding eigenstates; (2) to discuss qualitatively the splitting of energy levels, starting from an approximate Hamiltonian and adding correction terms; and (3) to aid in the evaluation of matrix elements of all kinds.

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Unitary groups in quantum field theory. Group theory is an abstract way of mathematically analyzing symmetries. Unitary operators are paramount to quantum theory, so unitary groups are important in particle physics. The group of N dimensional unitary square matrices is denoted U(N). Unitary operators preserve inner products which means probabilities are also preserved, so the quantum mechanics of the system is invariant under unitary transformations.

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Group Theory in Physics Group theory is the natural language to describe symmetries of a physical system | symmetries correspond to conserved quantities | symmetries allow us to classify quantum mechanical states representation theory degeneracies / level splittings | evaluation of matrix elements) Wigner-Eckart theorem

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Thus, quantum mechanics attracted some of the ablest scientists of the 20th century, and they erected what is perhaps the finest intellectual edifice of the period. Historical basis of quantum theory Basic considerations. At a fundamental level, both radiation and matter have characteristics of particles and waves.

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This landmark among mathematics texts applies group theory to quantum mechanics, first covering unitary geometry, quantum theory, groups and their representations, then applications themselves - rotation, Lorentz, permutation groups, symmetric permutation groups, and the algebra of symmetric transformations.

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Symmetry is important in the world of atoms, and Group Theory is its mathematics Quantum mechanics showed that the elementary systems that matter is made of, such as electrons and protons, are truly identical, not just very similar, so that symmetry in their arrangement is exact, not approximate as in the macroscopic world.

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