<u>Introduction to Symmetries</u>

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This course of 8 lectures (plus 1 examples class) is intended for first year graduate students in experimental Particle and Nuclear Physics. It aims to give an informal introduction to the general subject of symmetries in quantum systems, and to provide the basis for a "practical" knowledge of the most common continuous symmetry groups and their representations, as used in particle physics. The course will assume knowledge of basic non-relativistic quantum mechanics (e.g. hermitian and unitary operators, eigenvalues, constants of the motion, degeneracy, spin-$\frac{1}{2}$ formalism), of the mathematics of vectors and matrices, and of four-vectors in Special Relativity. Very little emphasis will be placed on group theory as such.

The topics I plan to cover are:-

1. Symmetries in quantum systems: translation and rotation invariance, and conservation of linear and angular momentum.
2. Symmetry and degeneracy: representations of SO(3).
3. Spin-$\frac{1}{2}$ particles.
4. The Lorentz group.
5. SU(2).
6. SU(3).
7. Symmetries in Lagrangian field theory.

Note:

1. The above sections do not necessarily correspond to single lectures.
2. The course will cover a lot of ground, quite rapidly; copies of the lecture notes will be available.
3. Some preparation for topic 7 above would be desirable, e.g. Lagrangians in classical mechanics.

<u>Textbooks</u>

A useful general introduction to symmetries in quantum mechanics (including ones like P and T which this course won't cover) is provided by chapter 7 of Schiff's book on Quantum Mechanics (3rd Edition). An alternative is chapter 17 of Merzbacher's Quantum Mechanics (3rd Edition). A book that is in some ways at about the right level for the course is "Groups, Representations and Physics" by H.F. Jones (IOP Publishing), but it includes far more than I can cover (in particular, the group theory). An earlier but still useful book is "Unitary Symmetry and Elementary Particles" by D.B. Lichtenberg (2nd Edition, Academic Press).