Symmetries in Quantum Mechanics: Group Theory and Applications in Sciences

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About the Course:

Lectures are aimed at Ph.-D. broad student audiences, among others at the students working in experimental domains such as condensed matter, molecular, atomic and subatomic physics, but will be profitable also to young theorists working in the domains of chemistry or physics and students of mathematics interested in group theory applications in natural sciences. Students will acquire knowledge necessary to understand publications which use methods and concepts of symmetries, group- and group-representation theories and enable them as well to easily enter/follow a specialised physics literature employing these methods.

Lectures can be delivered in English or Polish.

About the Programme:

- We begin with the general-scope lectures, possibly opened to broad public, about **Symmetries in Living Objects** (From plants to humans and aesthetic surgery; The mathematics of symmetries in living objects)
- **From Quantum Mechanics to Group Theory Concepts** (Electrons, molecules, nucleons, quantum Hamiltonians, symmetries, underlying groups)
- **Introduction to Group Theory from the Physicist and/or Chemist Perspective**(Fundamental notions, properties and theorems - and how to deal with them, apply and use)
- **Symmetries and Groups of Symmetry: Focus on Finite Groups But Not Only** (Fundamental symmetries in 3D space, invariance properties. Example: the point groups)
- **Group Representations - A General Introduction** (Representations in vector spaces, reducibility, character theory, general theorems of representation theory, group-induced vector spaces and algebras, regular representations etc.)
- **Group Representations and Quantum Mechanics** (Groups, symmetries, irreducible representations, generalised Clebsch-Gordan decomposition, degeneracy, wave-function induced representations, projection techniques, spectroscopic properties of group-symmetric Hamiltonians, ...)
- **Lie Groups and Algebras: Importance for-, and Applications in Quantum Description of Nature** (Infinitesimal operators, generators, structure constants, fundamental notions, theorems and general properties, applications in advanced quantum mechanics and other domains)

About the Lecturer:

Professor Jerzy DUDEK is Excellence Class Professor at the University of Strasbourg, France and Honorary Professor of the Marie Sklodowska-Curie University, Poland. He studied physics at the Jagiellonian University, and next completed his Ph.-D. thesis and habilitation at the University of Warsaw, Poland. He was invited professor at-, and had long collaboration contacts with various foreign institutions. Among the most important are: The Niels Bohr Institute of the University of Copenhagen, Denmark; University of Liverpool, UK; University of Manchester, UK; University of Bonn, FRG; University of Tubingen, FRG; Max-Planck Institute, Heidelberg, FRG; University of Fukuoka, Japan; University of Tennessee at Knoxville and Oak Ridge National Laboratory, USA; Florida State University, USA.

Professor Dudek, specialist in theoretical sub-atomic physics, is among the most cited 1% physicists in the world. So far, over 50 young physicists have prepared their Ph.-D. or Master diplomas under his supervision. Among various fields of sub-atomic physics research to which Professor Dudek importantly contributed count: Microscopic theories of nuclear isomerism and exotic nuclear configurations, in particular theories of fission-isomers and physics of super- and hyper-deformed states and bands, structure of the so-called yrast-trap isomers, various forms of subatomic symmetries including nuclear point-group symmetries and symmetry-breaking phenomena, nuclear mean-field theory of collective nuclear rotation and interplay with the single-nucleonic and quasi-particle degrees of freedom, spontaneous symmetric breaking phenomena in the intrinsic nuclear frames, the so-called pseudo-symmetries in nuclei, nuclear behaviour at the extreme conditions: high-spins, extreme-isospins, high-temperatures and high-deformation limits, nuclear microscopic mechanisms within self-consistent Hartree-Fock theories, time-reversal and chiral-symmetries and symmetry breaking, transitions between nuclear-superfluid on normal phases, etc., to mention the most important.