Professional Master's Degree
Quantum Physics

Professional Master's Degree
Quantum Physics

- Modality: **online**
- Duration: **12 months**
- Certificate: **TECH Global University**
- Credits: **60 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Website: **www.techtitute.com/us/engineering/professional-master-degree/master-quantum-physics**

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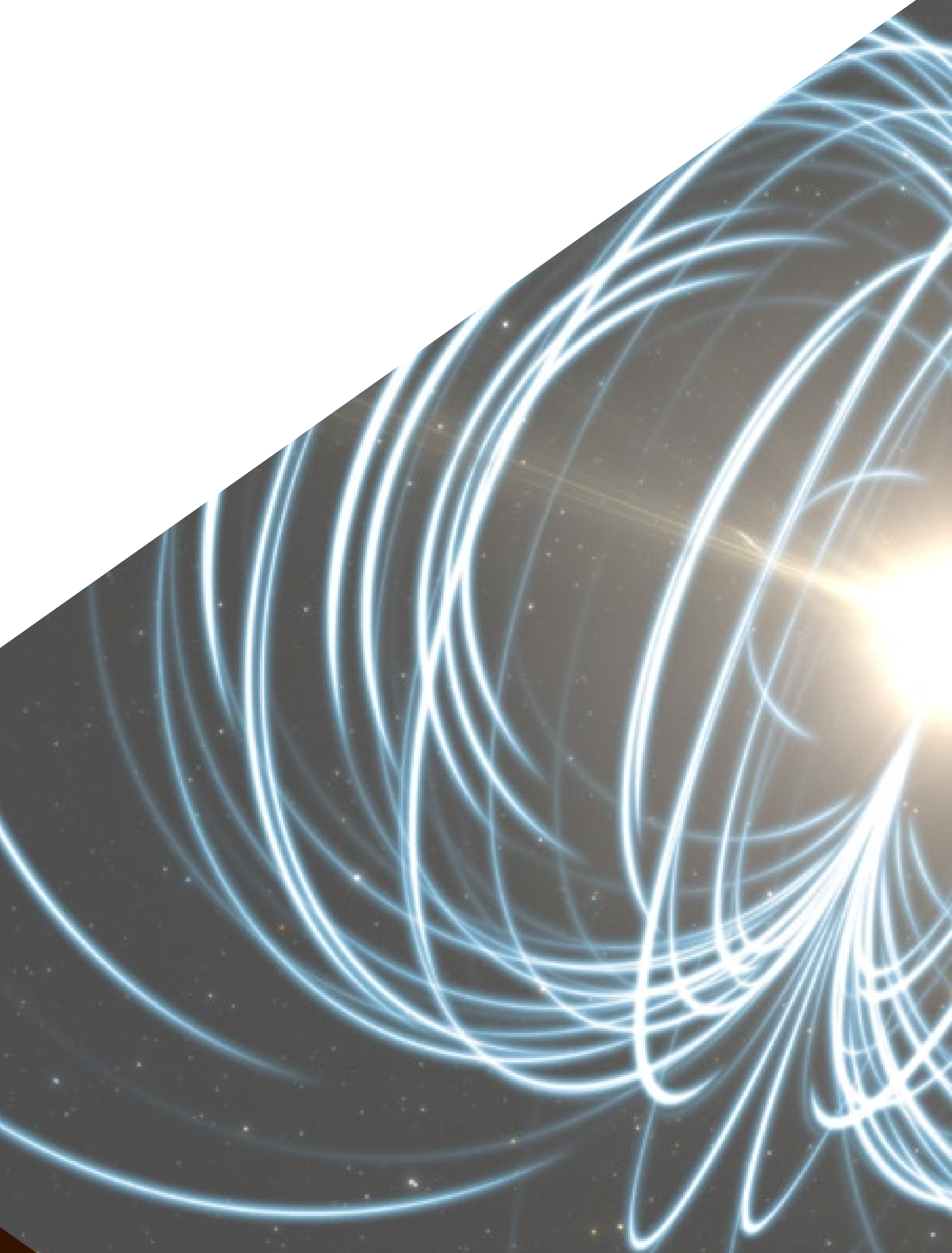
01

Introduction

Today, engineers with the ability to transfer knowledge from physics to technology are required. This fusion gave rise, for example, to the James Webb telescope or the particle accelerator which led to the discovery of the Higgs boson. Therefore, in this century, understanding the asymmetry between matter and antimatter, the search for exoplanets or supermassive black holes are still a great challenge for quantum physics. That is why TECH has created this program, 100% online with a theoretical-practical approach that will allow graduates to delve into astrophysics, nuclear physics or quantum mechanics. In addition, students have access to innovative teaching material that can be accessed 24 hours a day from any device with an Internet connection.



A 100% online Professional Master's Degree, with a syllabus available 24 hours a day, so that you can advance whenever you wish in the key concepts of Quantum Physics"

The research field of Quantum Physics offers a wide range of lines of development with great potential for engineering professionals who decide to delve into this field of exploration and discovery in energy production, ultracold atoms, trapped ions or photonics.

Recent advances in this field have opened multiple lines of study and actions in other disciplines such as astrophysics, cosmology, chemistry, biology, medicine or artificial intelligence: possibilities as vast as the universe. That is why TECH has designed this Professional Master's Degree in Quantum Physics, which will allow graduates to achieve, in only 12 months, the most advanced knowledge about the most common physical processes in planetary and solar physics, the studies of Paul Dirac or Richard Feynman and quantum field theory.

All this, through a program taught exclusively online, which will allow them to delve, whenever they wish, into Einstein's equations, Schwarzschild's solution, dark matter and energies or the thermodynamics of the early universe. The case studies will also help them to integrate the practice into their daily professional work.

This academic institution thus offers an excellent opportunity for engineering specialists who wish to progress in their professional career through a quality university education that is compatible with their work and/or personal responsibilities. They only need an electronic device with an Internet connection to view the content hosted on the virtual platform. With no classroom attendance or fixed class schedules, students have the freedom to distribute the course load according to their needs.

This **Professional Master's Degree in Quantum Physics** contains the most complete and up-to-date program on the market. The most important features include:

- Practical case studies are presented by experts in Physics
- The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- Practical exercises where the self-assessment process can be carried out to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with an Internet connection

Thanks to the knowledge acquired in this Professional Master's Degree you will be able to contribute to solve the problems of dark matter"

The library of multimedia resources of this course will allow you to learn the main contributions to Quantum Physics from Richard Feynman, Paul Dirac, Peter Higgs or Schrödinger"

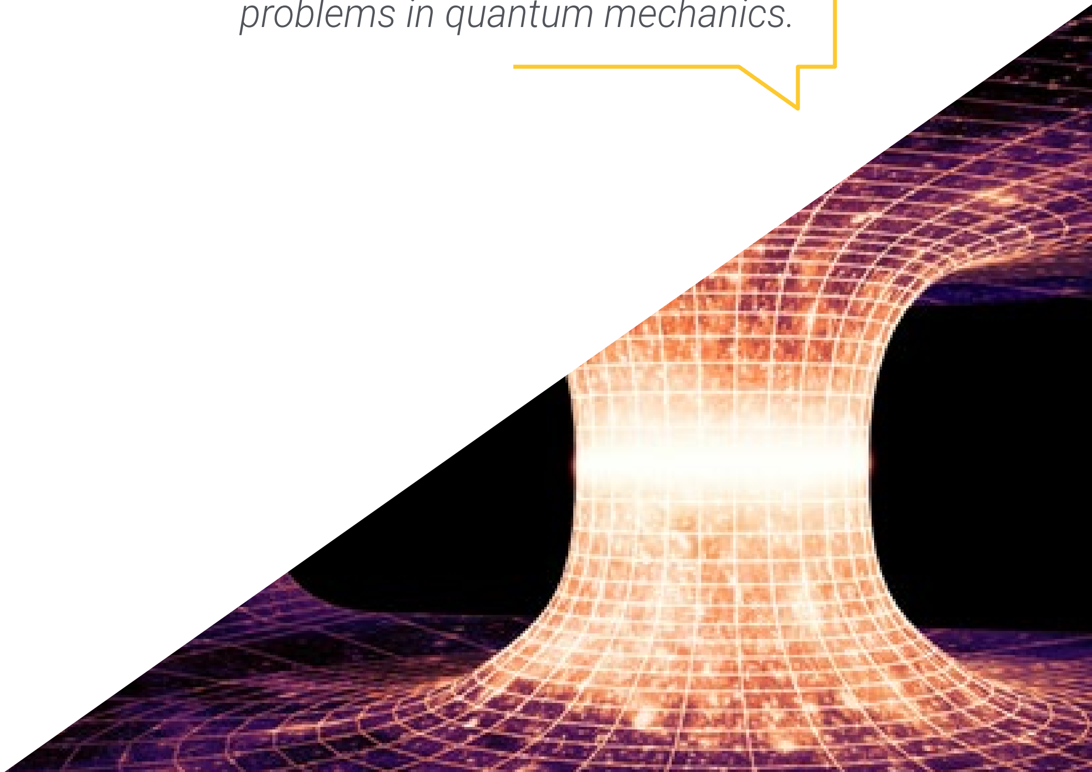
The program includes, in its teaching staff, professionals from the sector who bring to this program the experience of their work, in addition to recognized specialists from prestigious reference societies and universities.

Its multimedia content, developed with the latest educational technology, will allow professionals to learn in a contextual and situated learning environment, i.e., a simulated environment that will provide them with immersive education programmed to learn them in real situations.

The design of this program focuses on Problem-Based Learning, by means of which professionals must try to solve the different professional practice situations that arise during the academic course. For this purpose, students will be assisted by an innovative interactive video system developed by renowned experts.

Click now and obtain a diploma that will allow you to progress in your Engineer professional career in Quantum Physics.

Enroll in a Professional Master's Degree that will lead you to be able to solve the main existing problems in quantum mechanics.



02
Objectives

TECH has designed this university degree with the main objective of offering students the most advanced and comprehensive information on Quantum Physics. For this purpose, it provides multimedia teaching resources, which will allow students to master quantum systems, cosmology, the concept of relativity and the main authors in this field. Additionally, the teaching team that is part of this program will guide the professionals to easily achieve these goals.

TECH's goal is you. Progress in your Engineer professional career thanks to the latest knowledge on the functioning of supersymmetry, strings and extra dimensions"

General Objectives

- Acquire basic concepts of astrophysics
- Obtain basic notions about Feynman diagrams, how they are drawn and their utilities
- Learn and apply approximate methods to study quantum systems
- Master the Klein-Gordon, Dirac and electromagnetic fields

You will get the most comprehensive knowledge about the most common symmetry breakings"

Specific Objectives

Module 1. Introduction to Modern Physics

- Identify and assess the presence of physical processes in daily life and in both specific (medical applications, fluid behavior, optics or radiation protection) and common scenarios (electromagnetism, thermodynamics or classical mechanics)
- Be able to use computer tools to solve and model physical problems
- Be familiar with new developments and advances in the field of physics, both theoretical and experimental
- Develop communication skills, to write reports and documents, or to make effective presentations of these

Module 2. Mathematical Methods

- Obtain basic notions of metric and Hilbert spaces
- Acquire knowledge about the characteristics of linear operators and the Surm-Liouville theory
- Know the theory of groups, group representation, tensor calculus and their applications to physics

Module 3. Quantum Physics

- Apply the fundamental concepts of Quantum Physics and their articulation in laws and theories
- Know the most common physical processes in Quantum Physics
- Be familiar with the postulates of Quantum Physics
- Know how to apply the mathematical tools characteristic to Quantum Physics to solve quantum mechanics problems

Module 4. Astrophysics
- Understand and use mathematical and numerical methods commonly used in Astrophysics
- Be familiar with new developments and advances in the field of Astrophysics, both theoretical and experimental
- Understand the most common physical processes in cosmology
- Know the most common physical processes in only Physics

Module 5. Quantum Physics
- Know the atomic models with the variational method
- Master the intrinsic angular momentum
- Understand time-dependent perturbation theory
- Understand and know how to apply the WKB method

Module 6. Nuclear and Particle Physics
- Obtain basic knowledge of nuclear and particle physics
- Know how to distinguish the different nuclear decay processes
- Know the Feynman diagrams, their use and how to draw them
- Know how to calculate relativistic collisions

Module 7. Quantum Field Theory
- Acquire basic notions of quantum field theory
- Know the main problems of quantization of some of the fields and how to solve them
- know how to calculate amplitudes of interactions between particles from Feynman diagrams
- Know the C, P, T symmetries, the most common symmetry violations and the C, P, T symmetry conservation theorem

Module 8. General Relativity and Cosmology
- Acquire basic notions of general relativity
- Apply knowledge of calculus and algebra to the study of gravity using the theory of general relativity
- Know the Einstein's equations in tensor format
- Acquire basic knowledge of cosmology and the primitive universe

Module 9. High Energy Physics
- Apply knowledge of quantum field theory and the mathematics of group and representations theory to elementary particle physics
- Know spontaneous symmetry breaking mechanisms and the Higgs mechanism
- Have notions of neutrino physics, their masses and oscillations
- Know Feynman's rules for quantum electrodynamics, quantum chromodynamics and weak interaction
- Acquire basic notions of Yang-Millis theory

Module 10. Information and Quantum Computing
- Acquire basic notions of classical and quantum information
- Identify the most common algorithms for quantum encryption of information
- Obtain basic notions about semiquantum and quantum theories of light-matter interaction
- Know the most common quantum information implementations

03
Skills

The structure of this Professional Master's Degree has been created with the aim of enhancing the skills of the engineering professionals in the field of Quantum Physics. Thus, after completing the 1,500 teaching hours of this course, graduates will be able to apply the concepts acquired on quantum field theory, the physical laws at the subatomic level or develop the different mathematical formulations shown in this program. The case study simulations will be very useful for professionals, who will be able to integrate the methodologies shown in their daily practice.

This academic teaching will show you from a theoretical-practical point of view the possibilities of the application of the laws of physics and the study of the Milky Way"

General Skills

- Know how the universe works on both cosmological and stellar scales
- Know how to apply the Schwarzschild solution and its consequences
- Understand the consequences of the equivalence principle
- Determine the mass of a binary system

“Boost your professional career by mastering the main postulates of quantum mechanics through this degree. Enroll now”

Specific Skills

- Develop an open and critical mind, the key to understanding physical laws at subatomic level
- Know the effects of gravitational waves on matter
- Use atomic models with the variational method
- Apply the postulates of quantum mechanics

03

Course Management

This academic program includes the most specialized teaching staff in the current educational market. They are specialists selected by TECH to develop the whole syllabus. In this way, starting from their own existence and the latest evidence, they have designed the most up-to-date content that provides a guarantee of quality in such a relevant subject.

TECH offers the most specialized teaching staff in the field of study. Enroll now and enjoy the quality you deserve"

International Guest Director

Dr. Philipp Kammerlander is an experienced expert in quantum physics, with high prestige among members of the international academic community. Since joining the Quantum Center in Zurich as Public Program Officer, he has played a crucial role in the creation of collaborative networks between institutions dedicated to quantum science and technology. Based on his proven results, he has assumed the role of Executive Director of that institution.

Specifically from this professional work, this expert has been involved in the coordination of various activities such as workshops and conferences, collaborating with various departments of the Swiss Federal Institute of Technology in Zurich (ETH). He has also been instrumental in fundraising and in the creation of more sustainable internal structures that help the rapid development of the functions of the center he represents.

In addition, he addresses innovative concepts such as the theory of quantum information and its processing. On these topics he has designed curricula and led their development in front of more than 200 students. Thanks to his excellence in these areas, he has received notable distinctions such as the Golden Owl Award and the VMP Assistant Award that highlight his commitment and ability in teaching.

In addition to his work at the Quantum Center and ETH Zurich, this researcher has extensive experience in the technology industry. He has worked as a freelance software engineer, designing and testing business analytics applications based on the ACTUS standard for smart contracts. He has also been a consultant at abaQon AG. His diverse background and significant achievements in academia and industry underscore his versatility and dedication to innovation and education in the field of quantum science.

Dr. Kammerlander, Philipp

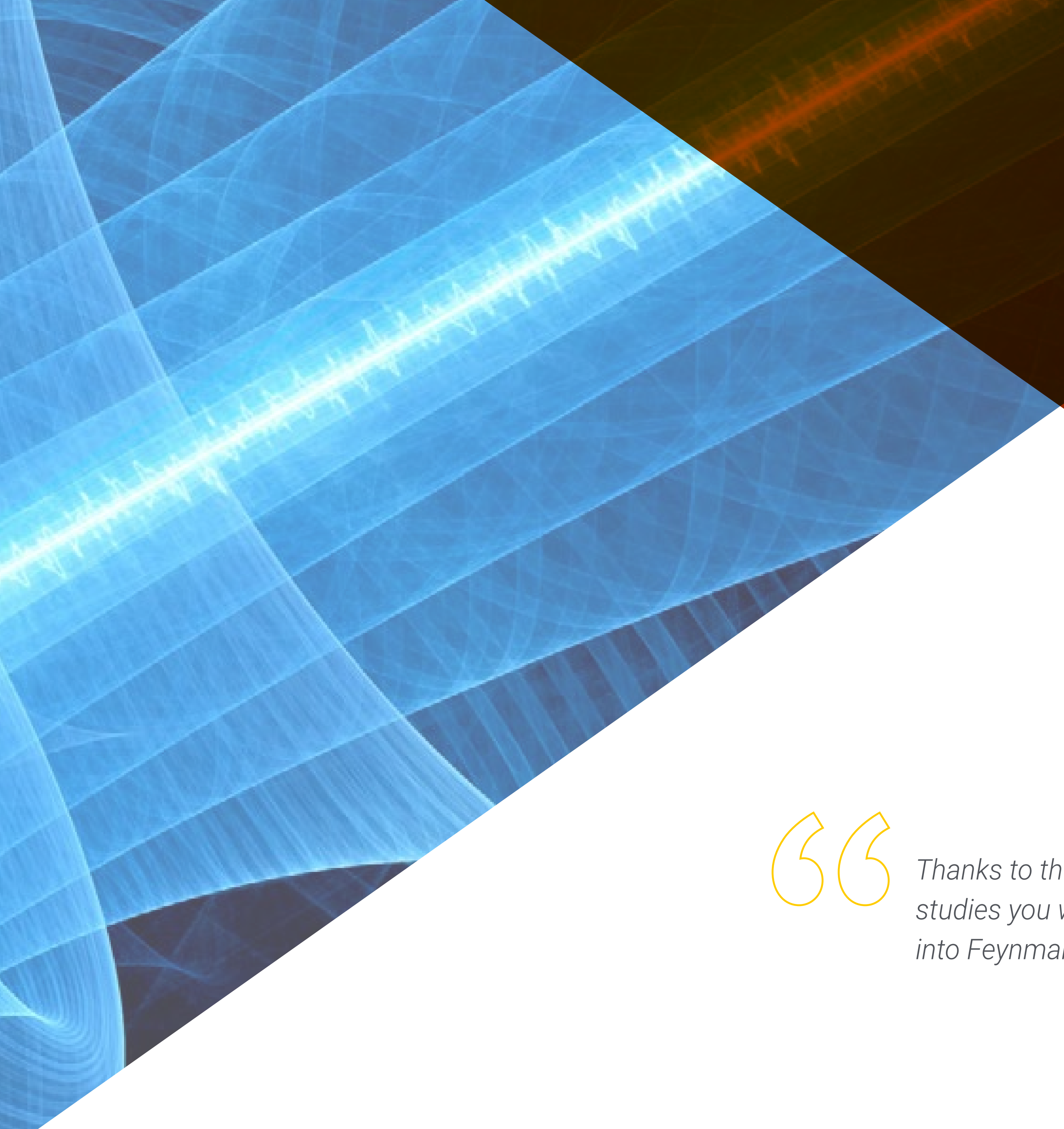
- Executive Director of the Quantum Center Zurich, Switzerland
- Professor at the Swiss Federal Institute of Technology Zurich, Switzerland
- Manager of public programs between different Swiss institutions
- Freelance Software Engineer at Ariadne Business Analytics AG
- Consultant at abaQon AG
- Doctorate in Theoretical Physics and Quantum Information Theory at the ETH Zurich
- Master's Degree in Physics at the ETH Zurich

Thanks to TECH, you will be able to learn with the best professionals in the world"

04

Structure and Content

TECH has prepared a Professional Master's Degree in Quantum Physics based on the most current and advanced knowledge in this field. Thus, throughout the 10 modules that make up the syllabus, engineering professionals will be able to delve into astrophysics, the dynamics of quantum mechanics, the problems of dark matter or the latest advances in cosmology. In addition, thanks to the Relearning system, the graduates will be able to progress through the content in a more natural way, reducing the long hours of study that are so common in other methodologies.



Thanks to the practical case studies you will easily delve into Feynman's rules"

Module 1. Introduction to Modern Physics

1.1. Introduction to Medical Physics
- 1.1.1. How to Apply Physics to Medicine
- 1.1.2. Energy of Charged Particles in Tissues
- 1.1.3. Photons through Tissues
- 1.1.4. Applications

1.2. Introduction to Particle Physics
- 1.2.1. Introduction and Objectives
- 1.2.2. Quantified Particles
- 1.2.3. Fundamental Forces and Charges
- 1.2.4. Particle Detection
- 1.2.5. Classification of Fundamental Particles and Standard Model
- 1.2.6. Beyond the Standard Model
- 1.2.7. Current Generalization Theories
- 1.2.8. High Energy Experiments

1.3. Particle Accelerators
- 1.3.1. Particle Acceleration Processes
- 1.3.2. Linear Accelerators
- 1.3.3. Cyclotrons
- 1.3.4. Synchrotrons

1.4. Introduction to Nuclear Physics
- 1.4.1. Nuclear Stability
- 1.4.2. New Methods in Nuclear Fission
- 1.4.3. Nuclear Fusion
- 1.4.4. Synthesis of Superheavy Elements

1.5. Introduction to Astrophysics
- 1.5.1. The Solar System
- 1.5.2. Birth and Death of a Star
- 1.5.3. Space Exploration
- 1.5.4. Exoplanets

1.6. Introduction to Cosmology
- 1.6.1. Distance Calculation in Astronomy
- 1.6.2. Velocity Calculations in Astronomy
- 1.6.3. Dark Matter and Energy
- 1.6.4. The Expansion of the Universe
- 1.6.5. Gravitational Waves

1.7. Geophysics and Atmospheric Physics
- 1.7.1. Geophysics
- 1.7.2. Atmospheric Physics
- 1.7.3. Meteorology
- 1.7.4. Climate Change

1.8. Introduction to Condensed Matter Physics
- 1.8.1. Aggregate States of Matter
- 1.8.2. Matter Allotropes
- 1.8.3. Crystalline Solids
- 1.8.4. Soft Matter

1.9. Introduction to Quantum Computing
- 1.9.1. Introduction to the Quantum World
- 1.9.2. Qubits
- 1.9.3. Multiple Qubits
- 1.9.4. Logic Gates
- 1.9.5. Quantum Programs
- 1.9.6. Quantum Computers

1.10. Introduction to Quantum Cryptography
- 1.10.1. Classic Information
- 1.10.2. Quantum Information
- 1.10.3. Quantum Encryption
- 1.10.4. Protocols in Quantum Cryptography

Module 2. Mathematical methods

2.1. Pre-Hibertian Spaces
- 2.1.1. Vector Spaces
- 2.1.2. Positive Hermitian Scalar Product
- 2.1.3. Single Vector Module
- 2.1.4. Schwartz Inequality
- 2.1.5. Minkowsky Inequality
- 2.1.6. Orthogonality
- 2.1.7. Dirac Notation

2.2. Topology of Metric Spaces
- 2.2.1. Definition of Distance
- 2.2.2. Definition of Metric Space
- 2.2.3. Elements of Topology of Metric Spaces
- 2.2.4. Convergent Successions
- 2.2.5. Cauchy Successions
- 2.2.6. Complete Metric Space

2.3. Hilbert Spaces
- 2.3.1. Hilbert Spaces: Definition
- 2.3.2. Herbatian Base
- 2.3.3. Schrödinger vs. Heisenberg. Lebesgue Integral
- 2.3.4. Continuous Frames of a Hilbert Space
- 2.3.5. Change of Basis Matrix

2.4. Linear Operations
- 2.4.1. Linear Operators: Basic Concepts
- 2.4.2. Inverse Operator
- 2.4.3. Adjoint Operator
- 2.4.4. Self-Adjoint Operator
- 2.4.5. Positive Definite Operator
- 2.4.6. Unitary Operator I: Change of Basis
- 2.4.6. Antiunitary Operator
- 2.4.7. Projector

2.5. Stumr-Liouville Theory
- 2.5.1. Eigenvalue Theorem
- 2.5.2. Eigenvector Theorem
- 2.5.3. Sturm-Liouville Problem
- 2.5.4. Important Theorems for Sturm-Liouville Theory

2.6. Introduction to Group Theory
- 2.6.1. Definition of Group and Characteristics
- 2.6.2. Symmetries
- 2.6.3. Study of SO (3), SU(2) and SU(N) Groups
- 2.6.4. Lie Algebra
- 2.6.5. Groups of Quantum Physics

2.7. Introduction to Representations
- 2.7.1. Definitions
- 2.7.2. Fundamental Representation
- 2.7.3. Adjoint Representation
- 2.7.4. Unitary Representation
- 2.7.5. Product of Representation
- 2.7.6. Young Tables
- 2.7.7. Okubo Theorems
- 2.7.8. Applications to Particle Physics

2.8. Introduction to Tensors
- 2.8.1. Definition of Covariant and Contravariant Tensors
- 2.8.2. Kronecker Delta
- 2.8.3. Levi-Civita Tensor
- 2.8.4. Study of SO(N) i SO (3)
- 2.8.5. Study of SO(N)
- 2.8.6. Relation between tensors and representations

2.9. Group Theory Applied to Physics
- 2.9.1. Translation Group
- 2.9.2. Lorentz Group
- 2.9.3. Discrete Groups
- 2.9.4. Continuous Groups

2.10. Representations and Particle Physics
- 2.10.1. Representations of SU(N) Groups
- 2.10.2. Fundamental Representations
- 2.10.3. Multiplication of Representations
- 2.10.4. Okubo Theorem and Eightfold Ways

Module 3. Quantum Physics

3.1. Origins of Quantum Physics
- 3.1.1. Blackbody Radiation
- 3.1.2. Photoelectric Effect
- 3.1.3. Compton Effect
- 3.1.4. Atomic Spectra and Models
- 3.1.5. Pauli Exclusion Principle
  - 3.1.5.1. Zeeman Effect
  - 3.1.5.2. Stern-Gerlach Experiment
- 3.1.6. Broglie Wavelength and the Double Slit Experiment

3.2. Mathematical Formulation
- 3.2.1. Hilbert Spaces
- 3.2.2. Dirac Nomenclature Bra - ket
- 3.2.3. Internal and External Product
- 3.2.4. Linear Operators
- 3.2.5. Hermetic Operators and Diagonalization
- 3.2.6. Sum and Tensor Product
- 3.2.7. Density Matrix

3.3. Quantum Mechanics Postulates
- 3.3.1. Postulate 1º: Definition of Status
- 3.3.2. Postulate 2º: Definition of Observables
- 3.3.3. Postulate 3º: Definition of Measurement
- 3.3.4. Postulate 4º: Probability of Measurement
- 3.3.5. Postulate 5º: Dynamics

3.4. Apply the postulates of quantum mechanics
- 3.4.1. Probability of Results Statistics
- 3.4.2. Indeterminism
- 3.4.3. Temporary Evolution of the Expected Values
- 3.4.4. Compatibility and Commuting of Observables
- 3.4.5. Pauli Matrices

3.5. Quantum Mechanics Dynamics
- 3.5.1. Representation of Positions
- 3.5.2. Momentum Representation
- 3.5.3. Schrödinger Equation
- 3.5.4. Ehrenfest Theorem
- 3.5.5. Virial Theorem

3.6. Potential Barriers
- 3.6.1. Infinite Square Well
- 3.6.2. Finite Square Well
- 3.6.3. Potential Step
- 3.6.4. Delta Potential
- 3.6.5. Tunnel Effect
- 3.6.6. Free Particle

3.7. Simple Harmonic Oscillator
- 3.7.1. Analogy with Classical Mechanics
- 3.7.2. Hamiltonian and eigenvalues of energy
- 3.7.3. Analytical Method
- 3.7.4. Blurred Quantum
- 3.7.5. Coherent States

3.8. 3D Operators and Observables
- 3.8.1. Review of Calculus Notions with Several Values
- 3.8.2. Position Operator
- 3.8.3. Linear Momentum Operator
- 3.8.4. Orbital Angular Momentum
- 3.8.5. Ladder Operators
- 3.8.6. Hamiltonian

3.9. Three-Dimensional Eigenvalues and Eigenfunctions
- 3.9.1. Position Operator
- 3.9.2. Linear Momentum Operator
- 3.9.3. Orbital Angular Momentum and Spherical Harmonics Operator
- 3.9.4. Angular Equation

3.10. Three-Dimensional Potential Barriers
- 3.10.1. Free Particle
- 3.10.2. Particle in a Box
- 3.10.3. Central Potentials and Radial Equations
- 3.10.4. Infinite Spheric Well
- 3.10.5. Hydrogen Atom
- 3.10.6. 3D Harmonic Oscillator

Module 4. Astrophysics

4.1. Introduction
- 4.1.1. Brief History of Astrophysics
- 4.1.2. Instruments
- 4.1.3. Observational Magnitude Scale
- 4.1.4. Calculation of Astronomical Distances
- 4.1.5. Color Index

4.2. Spectral Lines
- 4.2.1. Historical Introduction
- 4.2.2. Kirchoff's Laws
- 4.2.3. Relationship between Spectrum and Temperature
- 4.2.4. Doppler Effect
- 4.2.5. Spectrograph

4.3. Radiation Field Study
- 4.3.1. Prior Definitions
- 4.3.2. Lens opacity
- 4.3.3. Optical Depth
- 4.3.4. Microscopic Opacity Sources
- 4.3.5. Total Opacity
- 4.3.6. Extinction
- 4.3.7. Structure of Spectral Lines

4.4. Stars
- 4.4.1. Classification of Stars
- 4.4.2. Methods for Determining the Mass of a Star
- 4.4.3. Binary Stars
- 4.4.4. Classification of Binary Stars
- 4.4.5. Determining the Masses of a Binary System

4.5. Life of Stars
- 4.5.1. Characteristics of a Star
- 4.5.2. Birth of a Star
- 4.5.3. Life of a Star. Hertzprung-Russell Diagrams
- 4.5.4. Death of a Star

4.6. Death of Stars
- 4.6.1. White Dwarf
- 4.6.2. Supernovas
- 4.6.3. Neutron Stars
- 4.6.4. Black Holes

4.7. Study of the Milky Way
- 4.7.1. Shape and Dimensions of the Milky Way
- 4.7.2. Dark Matter
- 4.7.3. Phenomenon of Gravitational Lensing
- 4.7.4. Massive Particles of Weak Interaction
- 4.7.5. Shape and Halo of the Milky Way
- 4.7.6. Spiral Structure of the Milky Way

4.8. Galaxy Clusters
- 4.8.1. Introduction
- 4.8.2. Classification of Galaxies
- 4.8.3. Photometry of Galaxies
- 4.8.4. Local Group: Introduction

4.9. Distribution of Large-Scale Galaxies
- 4.9.1. Shape and Age of the Universe
- 4.9.2. Standard Cosmological Model
- 4.9.3. Formation of Cosmological Structures
- 4.9.4. Observational Methods in Cosmology

4.10. Dark Matter and Energies
- 4.10.1. Discovery and Characteristics
- 4.10.2. Consequences on the Distribution of Ordinary Matter
- 4.10.3. Dark Matter Problems
- 4.10.4. Candidate Particles for Dark Matter
- 4.10.5. Dark Energy and its Consequences

Module 5. Quantum Physics II

5.1. Descriptions of Quantum Mechanics: Images or Representations
- 5.1.1. Schrödinger Picture
- 5.1.2. Heisenberg Picture
- 5.1.3. Dirac Picture or Interaction Picture
- 5.1.4. Change of Pictures

5.2. 3D Harmonic Oscillator
- 5.2.1. Creation and annihilation operators
- 5.2.2. Wave Functions of Fock States
- 5.2.3. Coherent States
- 5.2.4. States of Minimum Indeterminacy
- 5.2.5. Squeezed States

5.3. Angular Momentum
- 5.3.1. Rotations
- 5.3.2. Switches of Angular Momentum
- 5.3.3. Angular Momentum Basis
- 5.3.4. Scale Operators
- 5.3.5. Matrix Representation
- 5.3.6. Intrinsic Angular Momentum: The Spin
- 5.3.7. Spin Cases 1/ 2, 1, 3/ 2

5.4. Multi-Component Wave Functions: Spinorials
- 5.4.1. Single-Component Wave Functions: Spin 0
- 5.4.2. Double-Component Wave Functions: Spin 1/2
- 5.4.3. Expected Value of Spin Observable
- 5.4.4. Atomic States
- 5.4.5. Addition of Angular Momentum
- 5.4.6. Clebsch-Gordan Coefficient

5.5. State of the Compound Systems
- 5.5.1. Distinguishable Particles
- 5.5.2. Indistinguishable Particles
- 5.5.3. Photon Case: Semitransparent Mirror Experiment
- 5.5.4. Quantum Bonding
- 5.5.5. Bell Inequalities
- 5.5.6. EPR Paradox
- 5.5.7. Bell Theorem

5.6. Introduction to Approximate Methods: Variational Method
- 5.6.1. Introduction to the Variational Method
- 5.6.2. Linear Variations
- 5.6.3. Rayleigh-Ritz Variational Method
- 5.6.4. Harmonic Oscillator: A Study by Variational Methods

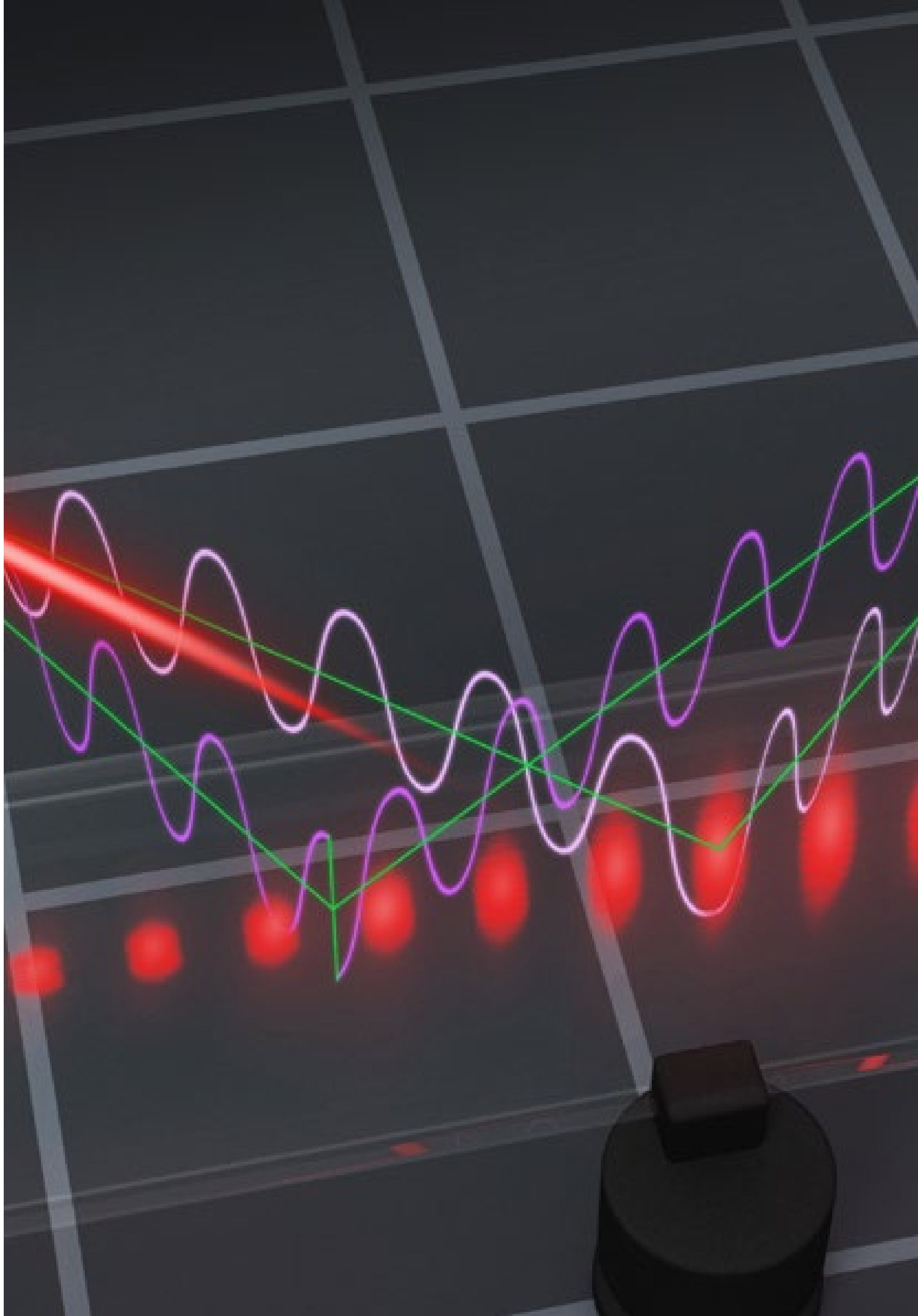
5.7. Study of Atomic Models with the Variational Method
- 5.7.1. Hydrogen Atom
- 5.7.2. Helium Atom
- 5.7.3. Ionized Hydrogen Molecule
- 5.7.4. Discrete Symmetries
    - 5.7.4.1. Parity
    - 5.7.4.2. Temporary Inversion

5.8. Introduction to Disturbance Theory
- 5.8.1. Time-Independent Perturbations
- 5.8.2. Non-Degenerate Case
- 5.8.3. Degenerate Case
- 5.8.4. Fine Structure of Hydrogen Atom
- 5.8.5. Zeeman Effect
- 5.8.6. Coupling Constant between Spins. Hyperfine Structure
- 5.8.7. Time-Dependent Perturbation Theory
    - 5.8.7.1. Two-Level Atom
    - 5.8.7.2. Sinusoidal Perturbation

5.9. Adiabatic Approximation
  5.9.1. Introduction to Adiabatic Approximation
  5.9.2. The Adiabatic Theorem
  5.9.3. Berry Phase
  5.9.4. Aharonov-Bohm Effect
5.10. Wentzel-Kramers-Brillouin (WKB) Approximation
  5.10.1. Introduction to the WKB Method
  5.10.2. Classical Region
  5.10.3. Tunnel Effect
  5.10.4. Connection Formulas

Module 6. Nuclear and Particle Physics

6.1. Introduction to Nuclear Physics
  6.1.1. Periodic Table of the Elements
  6.1.2. Important Discoveries
  6.1.3. Atomic Models
  6.1.4. Important Definitions Scales and Units in Nuclear Physics
  6.1.5. Segré's Diagram
6.2. Nuclear Properties
  6.2.1. Binding Energy
  6.2.2. Semiempirical Mass Formula
  6.2.3. Fermi Gas Model
  6.2.4. Nuclear Stability
    6.2.4.1. Alpha Decay
    6.2.4.2. Beta Decay
    6.2.4.3. Nuclear Fusion
  6.2.5. Nuclear Deexcitation
  6.2.6. Double Beta Decay



6.3. Nuclear Scattering
- 6.3.1. Internal Structure: Dispersion Study
- 6.3.2. Effective Section
- 6.3.3. Rutherford's Experiment: Rutherford's Effective Section
- 6.3.4. Mott's Effective Section
- 6.3.5. Momentum Transfer and Shape Factors
- 6.3.6. Nuclear Charge Distribution
- 6.3.7. Neutron Scattering

6.4. Nuclear Structure and Strong Interaction
- 6.4.1. Nucleon Scattering
- 6.4.2. Bound States Deuterium
- 6.4.3. Strong Nuclear Interaction
- 6.4.4. Magic Numbers
- 6.4.5. The Layered Model of the Nucleus
- 6.4.6. Nuclear Spin and Parity
- 6.4.7. Electromagnetic Moments of the Nucleus
- 6.4.8. Collective Nuclear Excitations: Dipole Oscillations, Vibrational States and Rotational States

6.5. Nuclear Structure and Strong Interaction II
- 6.5.1. Classification of Nuclear Reactions
- 6.5.2. Reaction Kinematics
- 6.5.3. Conservation Laws
- 6.5.4. Nuclear Spectroscopy
- 6.5.5. The Compound Nucleus Model
- 6.5.6. Direct Reactions
- 6.5.7. Elastic Dispersion

6.6. Introduction to Particle Physics
- 6.6.1. Particles and Antiparticles
- 6.6.2. Fermions and Baryons
- 6.6.3. The Standard Model of Elementary Particles: Leptons and Quarks
- 6.6.4. The Quark Model
- 6.6.5. Intermediate Vector Bosons

6.7. Dynamics of Elementary Particles
- 6.7.1. The Four Fundamental Interactions
- 6.7.2. Quantum Electrodynamics
- 6.7.3. Quantum Chromodynamics
- 6.7.4. Weak Interaction
- 6.7.5. Disintegrations and Conservation Laws

6.8. Relativistic Kinematics
- 6.8.1. Lorentz Transformations
- 6.8.2. Quatrivectors
- 6.8.3. Energy and Linear Momentum
- 6.8.4. Collisions
- 6.8.5. Introduction to Feynman Diagrams

6.9. Symmetries
- 6.9.1. Groups, Symmetries and Conservation Laws
- 6.9.2. Spin and Angular Momentum
- 6.9.3. Addition of Angular Momentum
- 6.9.4. Flavor Symmetries
- 6.9.5. Parity
- 6.9.6. Load Conjugation
- 6.9.7. CP Violation
- 6.9.8. Time Reversal
- 6.9.9. CPT Conservation

6.10. Bound States
- 6.10.1. Schrödinger's Equation for Central Potentials
- 6.10.2. Hydrogen Atom
- 6.10.3. Fine Structure
- 6.10.4. Hyperfine Structure
- 6.10.5. Positronium
- 6.10.6. Quarkonium
- 6.10.7. Lightweight Mesons
- 6.10.8. Baryons

Module 7. Quantum field theory

- 7.1. Classical Field Theory
  - 7.1.1. Notation and Conventions
  - 7.1.2. Lagrangian Formulation
  - 7.1.3. Euler Lagrange Equations
  - 7.1.4. Symmetries and Conservation Laws
- 7.2. Klein-Gordon Field
  - 7.2.1. Klein-Gordon Equations
  - 7.2.2. Klein-Gordon Field Quantization
  - 7.2.3. Lorentz Invariance of the Klein-Gordon Field
  - 7.2.4. Vacuum Vacuum and Fock States
  - 7.2.5. Vacuum Energy
  - 7.2.6. Normal Arrangement: Agreement
  - 7.2.7. Energy and Momentum of States
  - 7.2.8. Study of Causality
  - 7.2.9. Klein-Gordon propagator
- 7.3. Dirac Field
  - 7.3.1. Dirac Equation
  - 7.3.2. Dirac Matrices and their Properties
  - 7.3.3. Representation of Dirac Matrices
  - 7.3.4. Dirac Lagrangian
  - 7.3.5. Solution to Dirac Equation: Plane Waves
  - 7.3.6. Commuting and Anticommuting
  - 7.3.7. Quantification of Dirac Field
  - 7.3.8. Fock Space
  - 7.3.9. Dirac Propagator
- 7.4. Electromagnetic Field
  - 7.4.1. Classical Field of Electromagnetic Theory
  - 7.4.2. Quantization of the Electromagnetic Field and its Problems
  - 7.4.3. Fock Space
  - 7.4.4. Gupta-Bleuler Formalism
  - 7.4.5. Photon Propagator
- 7.5. S-Matrix Formalism
  - 7.5.1. Lagrangian and Hamitonian of Interaction
  - 7.5.2. S Matrix: Definition and Properties
  - 7.5.3. Dyson Expansion
  - 7.5.4. Wick Theorem
  - 7.5.5. Dirac Picture
- 7.6. Feinman Diagrams in the Position Space
  - 7.6.1. How to Draw Feynman Diagrams? Rules Utilities
  - 7.6.2. First Order
  - 7.6.3. Second Order
  - 7.6.4. Dispersion Processes with Two Particles
- 7.7. Feynman Rules
  - 7.7.1. Normalization of States in Fock Space
  - 7.7.2. Feynman Amplitude
  - 7.7.3. Feynman Rules for QED
  - 7.7.4. Gauge Invariance in the Amplitudes
  - 7.7.5. Examples:
- 7.8. Cross Section and Decay Rates
  - 7.8.1. Definition of Cross Sections
  - 7.8.2. Definition of Decay Rate
  - 7.8.3. Example with Two Bodies in Final State
  - 7.8.4. Unpolarized Cross Section
  - 7.8.5. Summation on Fermion Polarization
  - 7.8.6. Summation on Photon Polarization
  - 7.8.7. Examples:
- 7.9. Study of Muons and Other Charged Particles
  - 7.9.1. Muons
  - 7.9.2. Charged Particles
  - 7.9.3. Scalar Charged Particles
  - 7.9.4. Feynman Rules for Scalar Quantum Electrodynamics Theory

7.10. Symmetries
- 7.10.1. Parity
- 7.10.2. Load Conjugation
- 7.10.3. Time Reversal
- 7.10.4. Violation of Some Symmetries
- 7.10.5. CPT Symmetry

Module 8. General Relativity and Cosmology

8.1. Special Relativity
- 8.1.1. Postulates
- 8.1.2. Lorentz Transformations in Standard Configuration
- 8.1.3. Impulses (Boosts)
- 8.1.4. Tensors
- 8.1.5. Relativistic Kinematics
- 8.1.6. Relativistic Linear Momentum and Energy
- 8.1.7. Lorentz Covariance
- 8.1.8. Energy-Momentum Tensor

8.2. Equivalence Principle
- 8.2.1. Weak Equivalence Principle
- 8.2.2. Experiments on the Weak Equivalence Principle
- 8.2.3. Locally Inertial Reference Systems
- 8.2.4. Principle of Equivalence
- 8.2.5. Consequences on the Equivalence Principle

8.3. Particle Motion in the Gravitational Field
- 8.3.1. Path of Particles under Gravity
- 8.3.2. Newtonian Limit
- 8.3.3. Gravitational Redshift and Tests
- 8.3.4. Temporary Dilatation
- 8.3.5. Geodesic Equation

8.4. Geometry: Necessary Concepts
- 8.4.1. Two-Dimensional Spaces
- 8.4.2. Scalar, Vector and Tensor Fields
- 8.4.3. Metric Tensor: Concept and Theory
- 8.4.4. Partial Derivative
- 8.4.5. Covariant Derivative
- 8.4.6. Christoffel Symbols
- 8.4.7. Covariant Derivatives of Tensors
- 8.4.8. Directional Covariant Derivatives
- 8.4.9. Divergence and Lapacian

8.5. Curved Space-Time
- 8.5.1. Covariant Derivative and Parallel Transport: Definition
- 8.5.2. Geodesics from Parallel Transport
- 8.5.3. Riemann Curvature Tensor
- 8.5.4. Riemann Tensor: Definition and Properties
- 8.5.5. Ricci Tensor: Definition and Properties

8.6. Einstein Equations: Derivation
- 8.6.1. Reformulation of the Equivalence Principle
- 8.6.2. Applications of the Equivalence Principle
- 8.6.3. Conservation and Symmetries
- 8.6.4. Derivation of Einstein's Equations from the Equivalence Principle

8.7. Schwarzschild Solution
- 8.7.1. Schwartzschild Metrics
- 8.7.2. Length and Time Elements
- 8.7.3. Conserved Quantities
- 8.7.4. Equation of Motion
- 8.7.5. Light Deflection. Study of Schwartzschild Metrics
- 8.7.6. Schwartzschild Radius
- 8.7.7. Eddington-Finkelstein Coordinates
- 8.7.8. Black Holes

8.8. Linear Gravity Limits Consequences
- 8.8.1. Linear Gravity: Introduction
- 8.8.2. Coordinate Transformation
- 8.8.3. Linearized Einstein Equations
- 8.8.4. General Solution of Linearized Einstein Equations
- 8.8.5. Gravitational Waves
- 8.8.6. Effects of Gravitational Waves on Matter
- 8.8.7. Generation of Gravitational Waves

8.9. Cosmology: Introduction
- 8.9.1. Observation of the Universe: Introduction
- 8.9.2. Cosmological Principle
- 8.9.3. System of Coordinates
- 8.9.4. Cosmological Distances
- 8.9.5. The Hubble's Law
- 8.9.6. Inflation

8.10. Cosmology: Mathematical Study
- 8.10.1. Friedmann's First Equation
- 8.10.2. Friedmann's Second Equation
- 8.10.3. Densities and Scale Factor
- 8.10.4. Consequences of Friedmann Equations Curvature of the Universe
- 8.10.5. Primitive Universe Thermodynamics

Module 9. High-Energy Physics

9.1. Mathematical Methods: Groups and Representations
- 9.1.1. Theory of Groups
- 9.1.2. SO (3), SU(2) and SU(3) and SU(N) Groups
- 9.1.3. Lie Algebra
- 9.1.4. Representations
- 9.1.5. Multiplication of Representations

9.2. Symmetries
- 9.2.1. Symmetries and Conservation Laws
- 9.2.2. C, P, T Symmetries
- 9.2.3. CPT Symmetry Violation and Conservation
- 9.2.4. Angular Momentum
- 9.2.5. Addition of Angular Momentum

9.3. Feynman Calculus: Introduction
- 9.3.1. Average Lifetime
- 9.3.2. Cross Section
- 9.3.3. Fermi's Golden Rule for Decay
- 9.3.4. Fermi's Golden Rule for Dispersion
- 9.3.5. Dispersion of Two Bodies in the Center of Masses of Reference Systems

9.4. Application of Feynman Calculation: Toy Model
- 9.4.1. Toy Model: Introduction
- 9.4.2. Feynman Rules
- 9.4.3. Average Lifetime
- 9.4.4. Dispersion
- 9.4.5. Higher Order Diagrams

9.5. Quantum Electrodynamics
- 9.5.1. Dirac Equation
- 9.5.2. Solution for Dirac Equations
- 9.5.3. Bilinear Covariants
- 9.5.4. The Photon
- 9.5.5. Feynman Rules for Quantum Electrodynamics
- 9.5.6. Casimir's Trick
- 9.5.7. Renormalization

9.6. Electrodynamics and Chromodynamics of Quarks
- 9.6.1. Feynman Rules
- 9.6.2. Production of Hadrons in Electron-Positron Collisions
- 9.6.3. Feynman Rules for Chromodynamics
- 9.6.4. Color Factors
- 9.6.5. Quark-Antiquark Interaction
- 9.6.6. Quark-Quark Interaction
- 9.6.7. Pair Annihilation in Quantum Chromodynamics

- 9.7. Weak Interaction
  - 9.7.1. Weak Charged Interaction
  - 9.7.2. Feynman Rules
  - 9.7.3. Muon Decay
  - 9.7.4. Neutron Decay
  - 9.7.5. Pion Decay
  - 9.7.6. Weak Interaction between Quarks
  - 9.7.7. Weak Neutral Interaction
  - 9.7.8. Electroweak Unification
- 9.8. Gauge Theories
  - 9.8.1. Local Gauge Invariance
  - 9.8.2. Yang-Millis Theory
  - 9.8.3. Quantum Chromodynamics
  - 9.8.4. Feynman Rules
  - 9.8.5. Mass Term
  - 9.8.6. Spontaneous Symmetry Breaking
  - 9.8.7. Higgs Mechanism
- 9.9. Neutrino Oscillation
  - 9.9.1. Solar Neutrino Problem
  - 9.9.2. Neutrino Oscillation
  - 9.9.3. Neutrino Masses
  - 9.9.4. Mixing Matrix
- 9.10. Advanced Topics Brief Introduction
  - 9.10.1. Higgs Boson
  - 9.10.2. Grand Oscillation
  - 9.10.3. Matter-Antimatter Asymmetry
  - 9.10.4. Supersymmetry, Strings and Extra Dimensions
  - 9.10.5. Dark Matter and Energy

Module 10. Information and Quantum Computing

- 10.1. Introduction: Mathematics and Quantum
  - 10.1.1. Complex Vector Spaces
  - 10.1.2. Linear Operators
  - 10.1.3. Scalar Products and Hilbert Spaces
  - 10.1.4. Diagonalization
  - 10.1.5. Tensor Product
  - 10.1.6. The Role of Operators
  - 10.1.7. Important Theorems on Operators
  - 10.1.8. Checked Quantum Mechanics Postulates
- 10.2. Statistical States and Samples
  - 10.2.1. The Qubit
  - 10.2.2. Density Matrix
  - 10.2.3. Two-Part System
  - 10.2.4. Schmidt Decomposition
  - 10.2.5. Statistical Interpretation of the Mixing States
- 10.3. Measurements and Temporary Evolution
  - 10.3.1. Von Neumann Measurements
  - 10.3.2. Generalized Measurements
  - 10.3.3. Neumark Theorem
  - 10.3.4. Quantum Channels
- 10.4. interwoven and its Applications
  - 10.4.1. ERP States
  - 10.4.2. Dense Coding
  - 10.4.3. State Teleportation
  - 10.4.4. Density Matrix and its Representations

10.5. Classic and Quantum Information
- 10.5.1. Introduction to Probability
- 10.5.2. Information
- 10.5.3. Shannon Entropy and Mutual Information
- 10.5.4. Communication
  - 10.5.4.1. The Bynary Symmettric Channel
  - 10.5.4.2. Channel Capacity
- 10.5.5. Shannon Theorems
- 10.5.6. Difference between Classic and Quantum Information
- 10.5.7. Von Neumann Entropy
- 10.5.8. Schumacher Theorem
- 10.5.9. Holevo Information
- 10.5.10. Accessible Information and Holevo Limit

10.6. Quantum Computing
- 10.6.1. Turing Machines
- 10.6.2. Circuits and Classification of Complexity
- 10.6.3. Quantum Computer
- 10.6.4. Quantum Logic Gates
- 10.6.5. Deutsch-Josza and Simon´s Algorithm
- 10.6.6. Unstructured Search; Grover´s Algorithm
- 10.6.7. RSA Encryption Method
- 10.6.8. Factorization: Shor Algorithm

10.7. Quantum Theory of the Light-Matter Interaction
- 10.7.1. Two-Level Atom
- 10.7.2. AC-Stark Splitting
- 10.7.3. Rabi Oscillations
- 10.7.4. Light Dipole Force

10.8. Quantum Theory of the Light-Matter Interaction
- 10.8.1. Quantum States of the Electromagnetic Field
- 10.8.2. Jaynes-Cummings Model
- 10.8.3. The Problem of Decoherence
- 10.8.4. Treatment of Weisskopf-Wigner Model of Spontaneous Emission

10.9. Quantum Communication
- 10.9.1. Quantum Cryptography: BB84 and Ekert91 protocols
- 10.9.2. Bell Inequalities
- 10.9.3. Generation of Individual Photons
- 10.9.4. Propagation of Individual Photons
- 10.9.5. Detection of Individual Photons

10.10. Quantum Computing and Simulation
- 10.10.1. Neutral Atoms in Dipolar Traps
- 10.10.2. Cavity Quantum Electrodynamics
- 10.10.3. Ions in Paul Tramps
- 10.10.4. Superconducting Cubits

A 100% online program that will allow you to delve into astrophysics and cosmology through the most innovative multimedia content in academic education"

05

Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**
This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"

Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

> *At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world"*

You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.

The student will learn to solve complex situations in real business environments through collaborative activities and real cases.

A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

Relearning Methodology

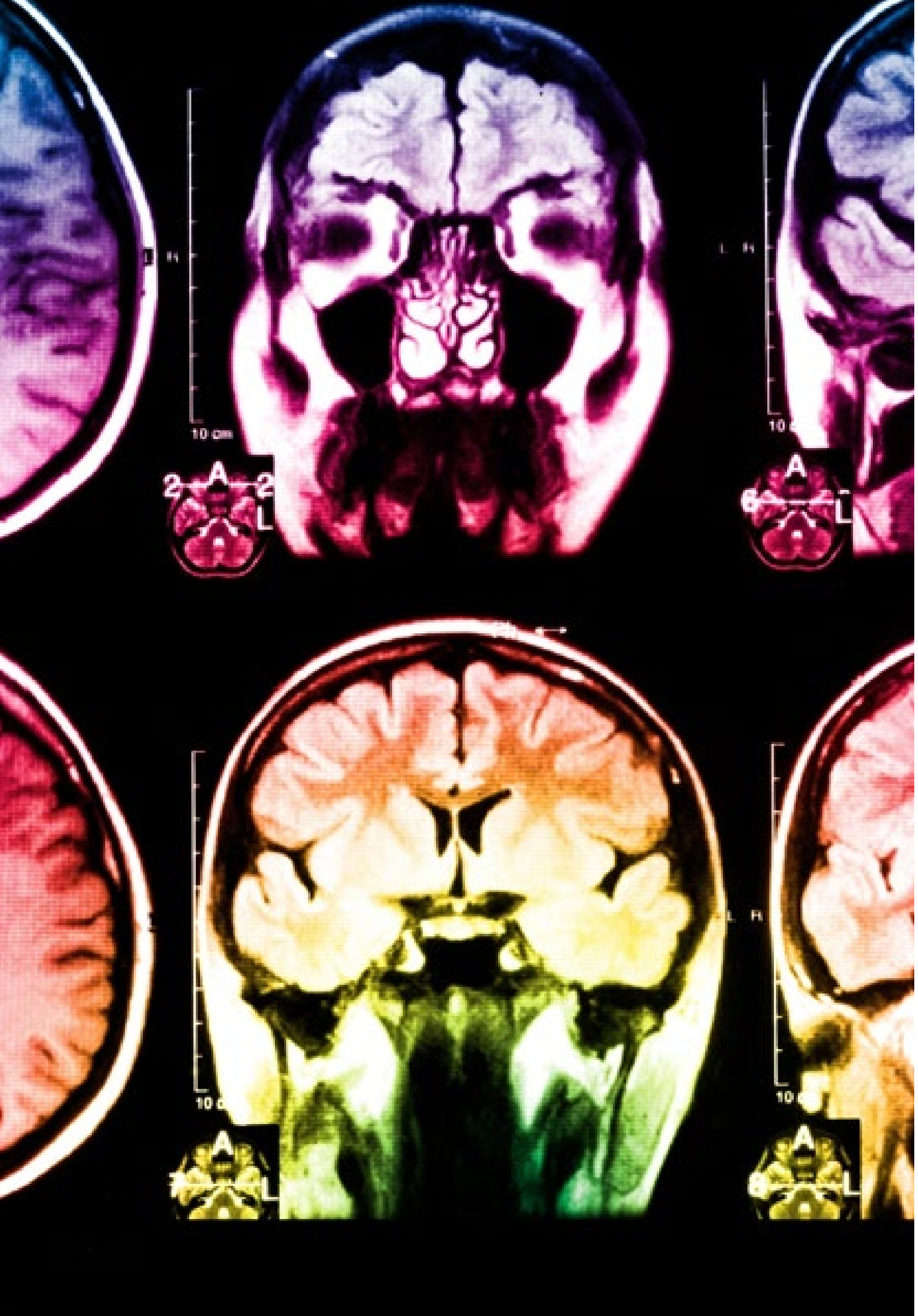
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

In 2019, we obtained the best learning results of all online universities in the world.

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:

Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

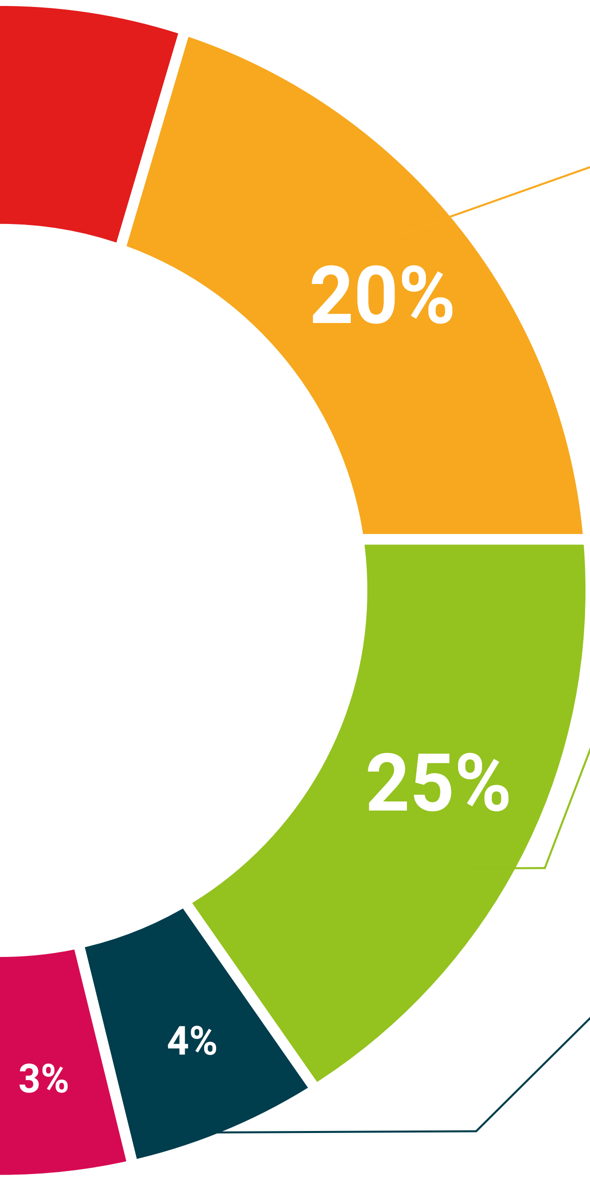
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.

Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.



Case Studies

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.

Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.

06

Certificate

The Professional Master's Degree in Quantum Physics guarantees students, in addition to the most rigorous and up-to-date education, access to a Professional Master's Degree issued by TECH Global University.

Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork"

This program will allow you to obtain your **Professional Master's Degree diploma in Quantum Physics** endorsed by **TECH Global University**, the world's largest online university.

TECH Global University is an official European University publicly recognized by the Government of Andorra (***official bulletin***). Andorra is part of the European Higher Education Area (EHEA) since 2003. The EHEA is an initiative promoted by the European Union that aims to organize the international training framework and harmonize the higher education systems of the member countries of this space. The project promotes common values, the implementation of collaborative tools and strengthening its quality assurance mechanisms to enhance collaboration and mobility among students, researchers and academics.

This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Professional Master's Degree in Quantum Physics**

Modality: **online**

Duration: **12 months**

Accreditation: **60 ECTS**

tech global university

Mr./Ms. _________________, with identification document ____________
has successfully passed and obtained the title of:

Professional Master's Degree in Quantum Physics

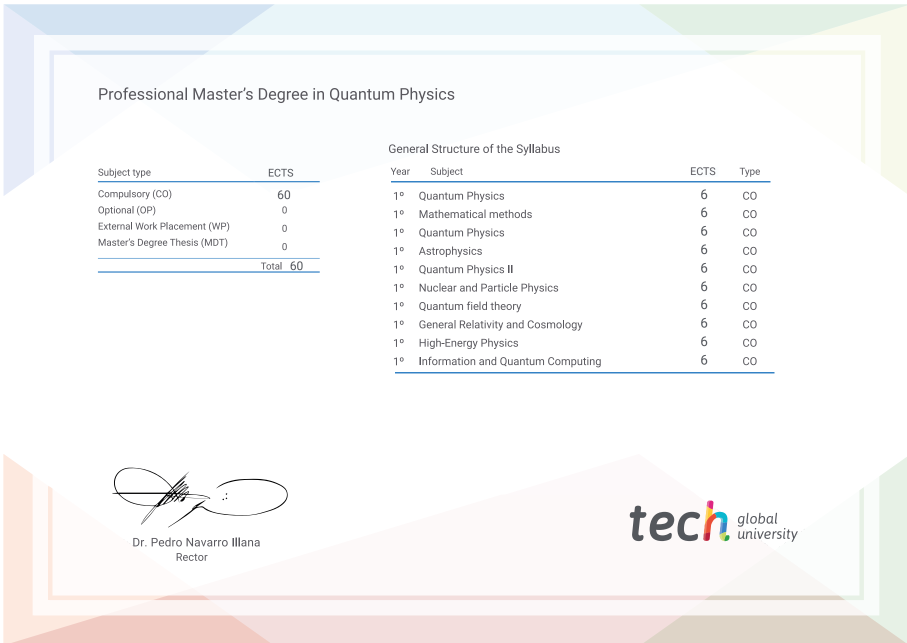
This is a program of 1,500 hours of duration equivalent to 60 ECTS, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH Global University is a university officially recognized by the Government of Andorra on the 31st of January of 2024, which belongs to the European Higher Education Area (EHEA).

In Andorra la Vella, on the 28th of February of 2024

Dr. Pedro Navarro Illana
Rector

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country. Unique TECH Code: AFWORD23S techtitute.com/certificates



Professional Master's Degree in Quantum Physics

Subject type	ECTS
Compulsory (CO)	60
Optional (OP)	0
External Work Placement (WP)	0
Master's Degree Thesis (MDT)	0
Total	60

General Structure of the Syllabus

Year	Subject	ECTS	Type
1º	Quantum Physics	6	CO
1º	Mathematical methods	6	CO
1º	Quantum Physics	6	CO
1º	Astrophysics	6	CO
1º	Quantum Physics II	6	CO
1º	Nuclear and Particle Physics	6	CO
1º	Quantum field theory	6	CO
1º	General Relativity and Cosmology	6	CO
1º	High-Energy Physics	6	CO
1º	Information and Quantum Computing	6	CO

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Rector

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*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH Global University will make the necessary arrangements to obtain it, at an additional cost.

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Professional Master's Degree
Quantum Physics

- Modality: **online**
- Duration: **12 months**
- Certificate: **TECH Global University**
- Credits: **60 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Professional Master's Degree
Quantum Physics