Master's Degree

Quantum Physics

Master's Degree
Quantum Physics

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

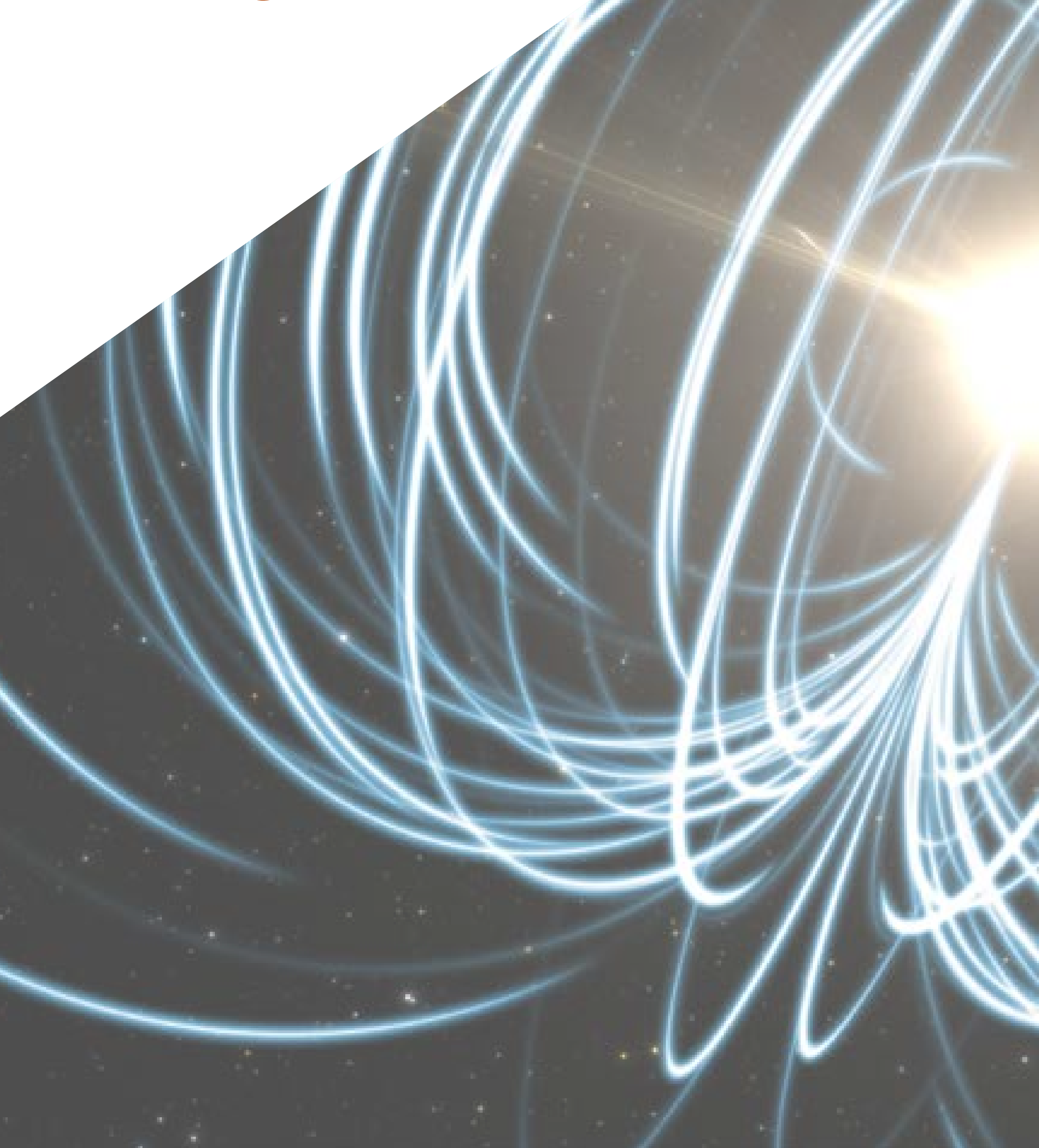
Website: **www.techtitute.com/us/engineering/master/master-quantum-physics**

Index

01

Introduction to the Program

In an increasingly global context driven by advances in quantum physics, it has become essential to have professionals capable of translating scientific knowledge into technological innovation. From this interaction, milestones such as the James Webb Telescope or the particle accelerator that enabled the discovery of the Higgs boson have emerged. Likewise, challenges such as understanding the asymmetry between matter and antimatter, the detection of exoplanets, or the study of supermassive black holes continue to be a priority. According to CERN, these challenges are giving rise to a new era of multidisciplinary research. For this reason, TECH has developed a 100% online degree program, with a theoretical-practical approach and permanent access, which delves into astrophysics, nuclear physics, and quantum mechanics.



Study the phenomena related to dark matter and dark energy in a specialized and up-to-date academic environment"

The field of research in Quantum Physics offers a wide range of lines of development with enormous potential for engineering professionals who decide to enter this universe of scientific exploration. Areas such as energy production, ultracold atoms, trapped ions, or photonics represent only a portion of the possibilities that this discipline presents at both the theoretical and applied levels.

Recent advances in physics have opened new avenues of study in fields as diverse as astrophysics, cosmology, chemistry, medicine, or artificial intelligence. For this reason, TECH has designed this Master's Degree in Quantum Physics, with the aim of enabling graduates to master key concepts of planetary and solar physics, the work of authors such as Paul Dirac or Richard Feynman, and the fundamentals of quantum field theory, among other highly relevant scientific contents.

All knowledge is delivered through a 100% online program, allowing students to delve into aspects such as Einstein's equations, the Schwarzschild solution, dark matter and dark energy, or the thermodynamics of the early universe. The practical cases included will serve to integrate what has been learned into everyday professional practice, becoming a valuable tool for intellectual and technical growth.

Through this proposal, TECH provides a unique opportunity for engineers who wish to advance in their professional careers through high-quality university education, without barriers of time or place. Only a device with an internet connection is required to access a flexible learning experience, adapted to each lifestyle. In addition, this academic pathway includes 10 exclusive Masterclasses delivered by a prestigious international expert, who serves as Guest Director.

This **Master's Degree in Quantum Physics** contains the most complete and up-to-date university program on the market. Its most notable features are:

- The development of practical cases presented by experts in quantum 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 exclusive Masterclasses delivered by TECH's International Guest Director, you will be able to update all your research competencies in the field of quantum physics"

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"

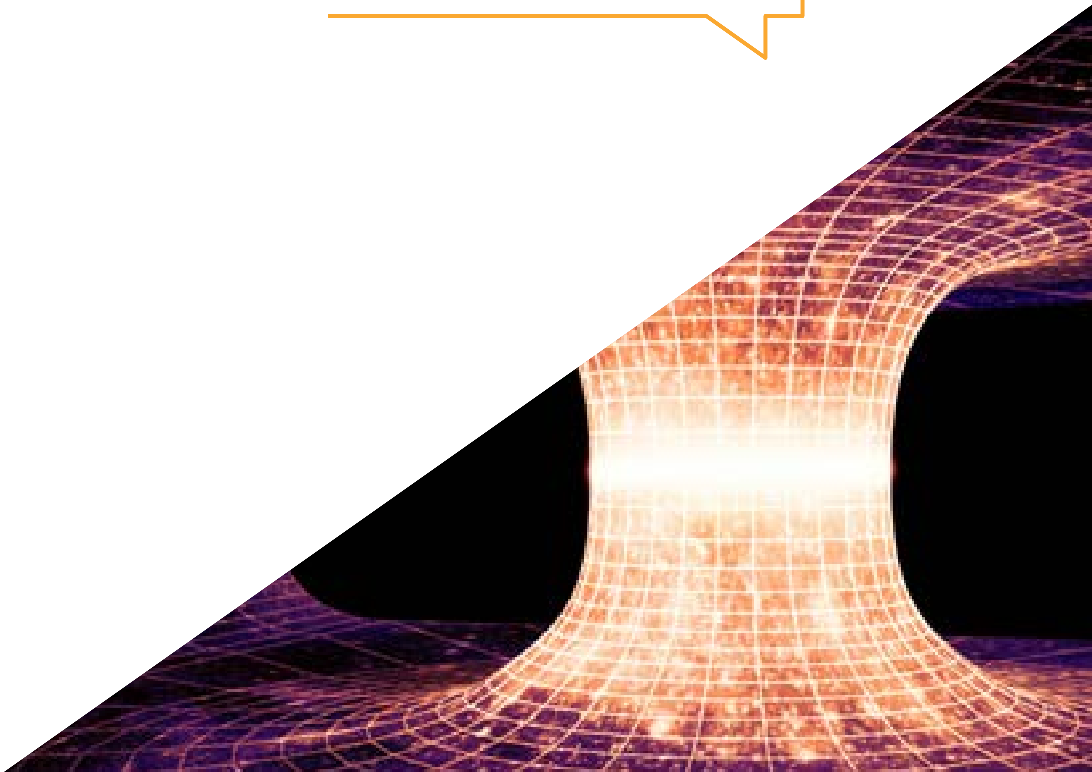
Its teaching staff includes professionals from the field of quantum physics, who contribute to this program the experience gained through their work, as well as renowned specialists from leading societies and prestigious universities.

The multimedia content, developed with the latest educational technology, will provide the professional with situated and contextual learning, i.e., a simulated environment that will provide an immersive learning experience designed to prepare for real-life situations.

This program is designed around Problem-Based Learning, whereby the student must try to solve the different professional practice situations that arise throughout the program. For this purpose, the professional will be assisted by an innovative interactive video system created by renowned and experienced experts.

Explore the secrets of the expansion of the universe and its relationship with the theory of general relativity.

Study the impact of gravitational waves and their relevance in contemporary cosmology.



02

Why Study at TECH?

TECH is the world's largest online university. With an impressive catalog of more than 14,000 university programs, available in 11 languages, it is positioned as a leader in employability, with a 99% job placement rate. In addition, it has a huge faculty of more than 6,000 professors of the highest international prestige.

Study at the largest online university in the world and ensure your professional success. The future begins at TECH"

The world's best online university, according to FORBES

The prestigious Forbes magazine, specialized in business and finance, has highlighted TECH Euromed University as "the best online university in the world" This is what they have recently stated in an article in their digital edition in which they echo the success story of this institution, "thanks to the academic offer it provides, the selection of its teaching staff, and an innovative learning method oriented to form the professionals of the future".

The most complete syllabuses on the university scene

TECH Euromed University offers the most complete syllabuses on the university scene, with programs that cover fundamental concepts and, at the same time, the main scientific advances in their specific scientific areas. In addition, these programs are continuously updated to guarantee students the academic vanguard and the most demanded professional skills. and the most in-demand professional competencies. In this way, the university's qualifications provide its graduates with a significant advantage to propel their careers to success.

The best top international faculty

TECH Euromed University's faculty is made up of more than 6,000 professors of the highest international prestige. Professors, researchers and top executives of multinational companies, including Isaiah Covington, performance coach of the Boston Celtics; Magda Romanska, principal investigator at Harvard MetaLAB; Ignacio Wistumba, chairman of the department of translational molecular pathology at MD Anderson Cancer Center; and D.W. Pine, creative director of TIME magazine, among others.

A unique learning method

TECH Euromed University is the first university to use Relearning in all its programs. This is the best online learning methodology, accredited with international teaching quality certifications, provided by prestigious educational agencies. In addition, this innovative academic model is complemented by the "Case Method", thereby configuring a unique online teaching strategy. Innovative teaching resources are also implemented, including detailed videos, infographics and interactive summaries.

The world's largest online university

TECH Euromed University is the world's largest online university. We are the largest educational institution, with the best and widest digital educational catalog, one hundred percent online and covering most areas of knowledge. We offer the largest selection of our own degrees and accredited online undergraduate and postgraduate degrees. In total, more than 14,000 university programs, in ten different languages, making us the largest educational institution in the world.

The official online university of the NBA

TECH Euromed University is the official online university of the NBA. Thanks to our agreement with the biggest league in basketball, we offer our students exclusive university programs, as well as a wide variety of educational resources focused on the business of the league and other areas of the sports industry. Each program is made up of a uniquely designed syllabus and features exceptional guest hosts: professionals with a distinguished sports background who will offer their expertise on the most relevant topics.

Leaders in employability

TECH Euromed University has become the leading university in employability. Ninety-nine percent of its students obtain jobs in the academic field they have studied within one year of completing any of the university's programs. A similar number achieve immediate career enhancement. All this thanks to a study methodology that bases its effectiveness on the acquisition of practical skills, which are absolutely necessary for professional development.

Google Partner
PREMIER 2023

The Official Online University of the **NBA**

4.9/5
global score

99%
maximun employability guaranteed

Google Premier Partner

The American technology giant has awarded TECH Euromed University the Google Premier Partner badge. This award, which is only available to 3% of the world's companies, highlights the efficient, flexible and tailored experience that this university provides to students. The recognition not only accredits the maximum rigor, performance and investment in TECH Euromed University's digital infrastructures, but also places this university as one of the world's leading technology companies.

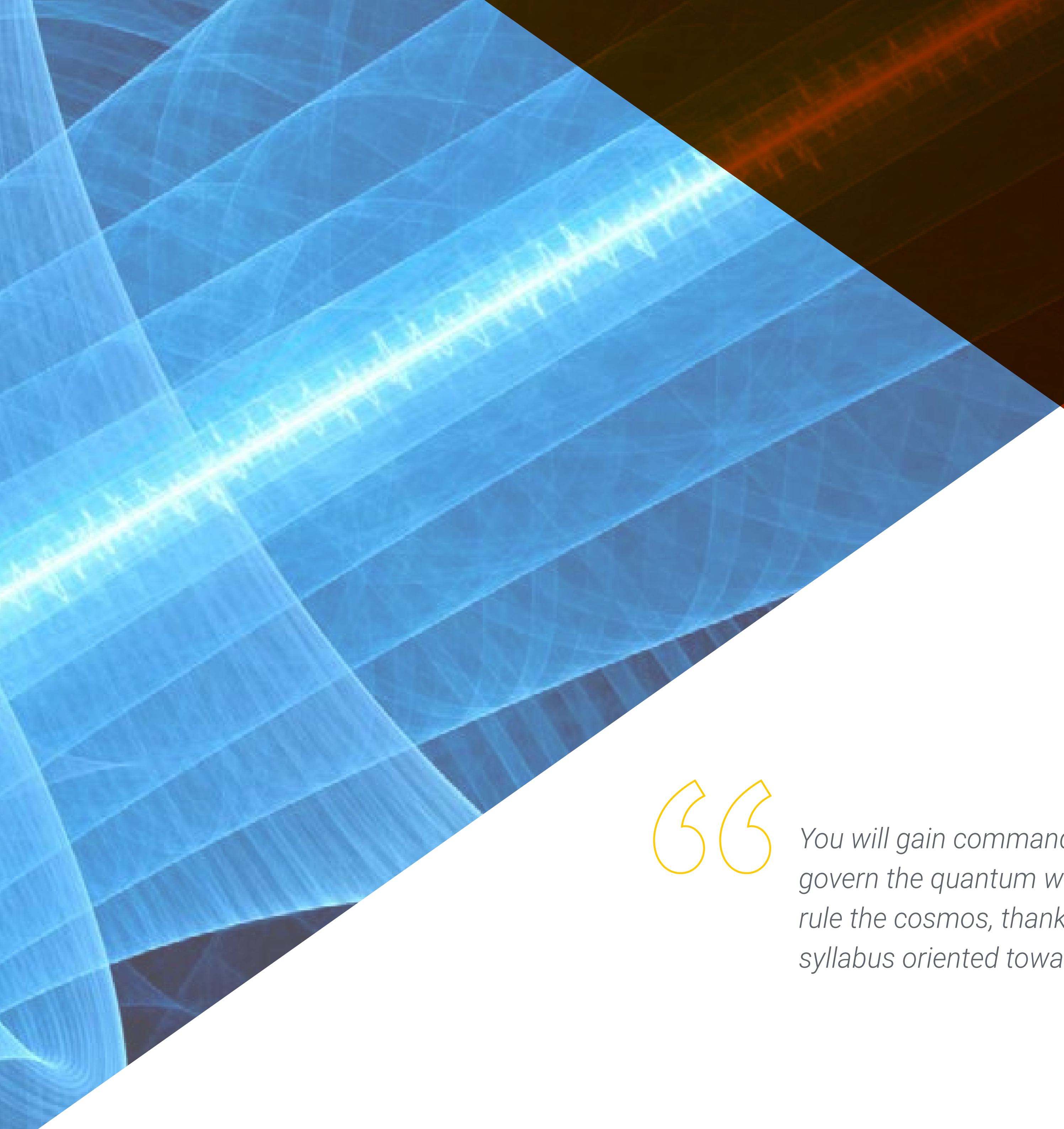
The top-rated university by its students

Students have positioned TECH Euromed University as the world's top-rated university on the main review websites, with a highest rating of 4.9 out of 5, obtained from more than 1,000 reviews. These results consolidate TECH Euromed University as the benchmark university institution at an international level, reflecting the excellence and positive impact of its educational model.

03

Syllabus

The teaching materials that make up this Master's Degree have been developed by a group composed of experts in quantum physics, astrophysics, cosmology, quantum computing, and other related disciplines. As a result, the syllabus rigorously and comprehensively addresses the theoretical and experimental foundations of quantum mechanics, field theories, general relativity, and emerging technologies. This academic pathway will enable graduates to master the physical principles that govern the universe, as well as to apply advanced methodologies in research or technological development contexts.



You will gain command of the postulates that govern the quantum world and the laws that rule the cosmos, thanks to a complete, in-depth syllabus oriented toward current scientific practice”

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
- 1.1.1. Introduction and Objectives
- 1.1.2. Quantified Particles
- 1.1.3. Fundamental Forces and Charges
- 1.1.4. Particle Detection
- 1.1.5. Classification of Fundamental Particles and Standard Model
- 1.1.6. Beyond the Standard Model
- 1.1.7. Current Generalization Theories
- 1.1.8. 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. Prehibertian 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 Metricl Space

2.3. Hilbert Spaces
- 2.3.1. Hilbert Spaces: Definition
- 2.3.2. Herbatian Base
- 2.3.3. Schrödinger versus 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
- 2.4.7. Antiunitary Operator
- 2.4.8. 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 and 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

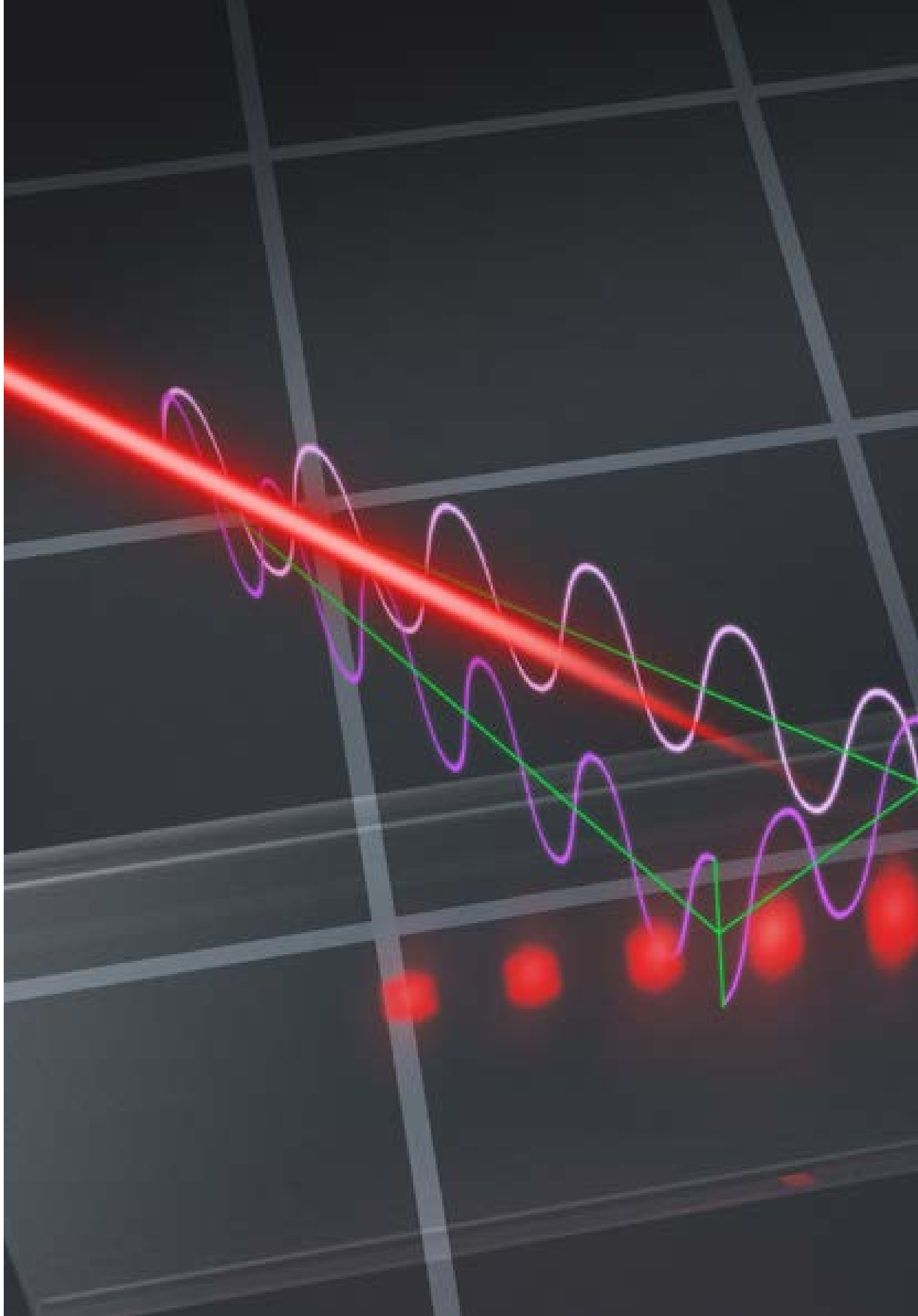
- 3.1. Origins of Quantum Physics
    - 3.1.1. Blackbody Radiation
    - 3.1.2. Photoelectric Effect
    - 3.1.3. Compton Effect
    - 3.1.4. Atomic Spectra and Models
    - 3.1.5. Pauli Exclusion Principle
        - 3.5.1.1. Zeeman Effect
        - 3.5.1.2. Stern-Gerlach Experiment
    - 3.1.6. Broglie Wave Length and the Double Slit Experimient
- 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 1: Definition of State
    - 3.3.2. Postulate 2: Definition of Observables
    - 3.3.3. Postulate 3: Definition of Measurements
    - 3.3.4. Postulate 4: Probability of Measurements
    - 3.3.5. Postulate 5: Dynamics

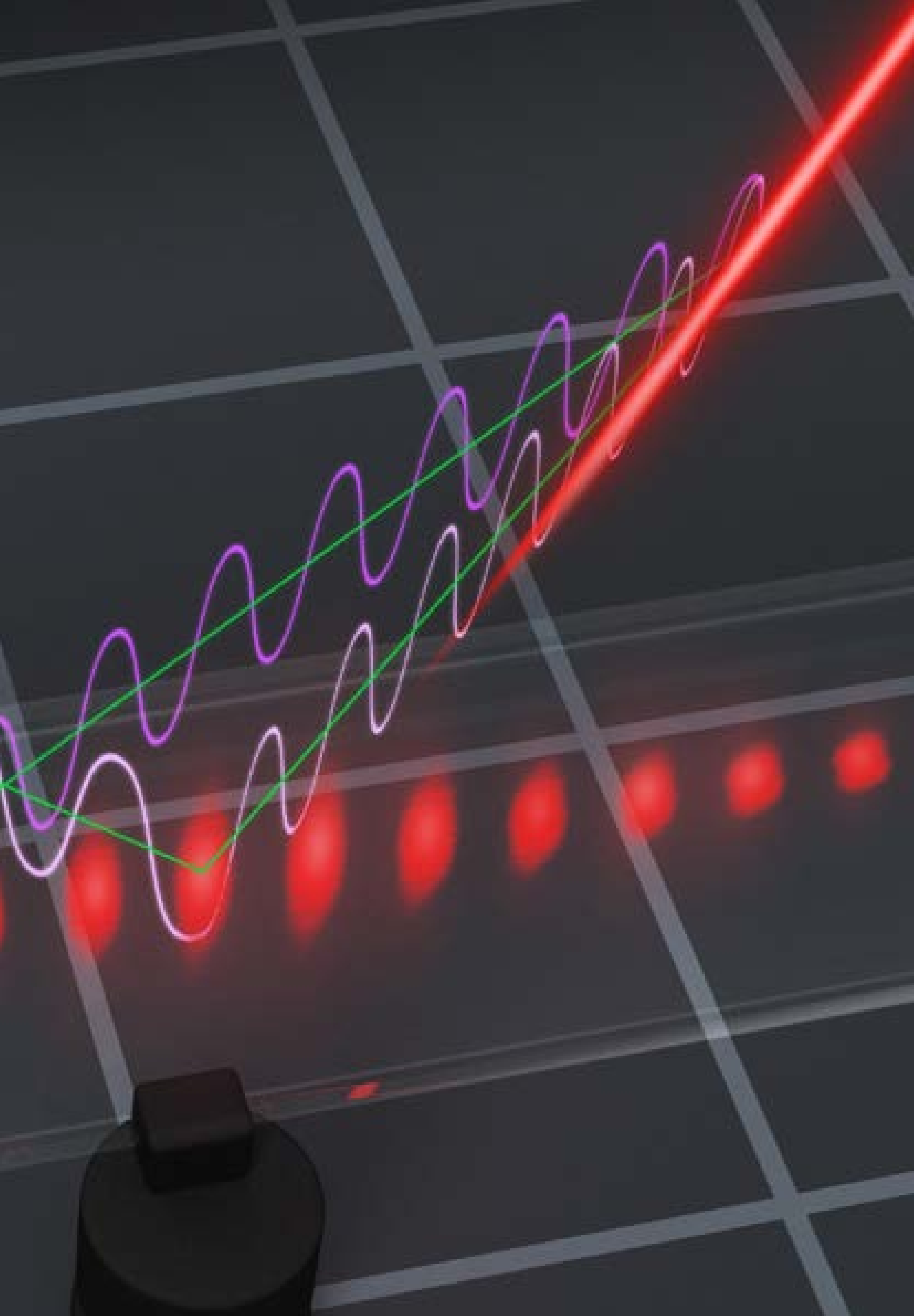
- 3.4. Apply the postulates of quantum mechanics
  - 3.4.1. Probability of Results Statistics
  - 3.4.2. Indeterminism
  - 3.4.3. Temporary Evolution of the Expected Values
  - 3.4.4. Compatibility and Commuting of Observables
  - 3.4.5. Pauli Matrices
- 3.5. Quantum Mechanics Dynamics
  - 3.5.1. Representation 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. Instrumentation
  - 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, its Consequences

Module 5. Quantum Physics II

- 5.1. Quantum Mechanics Description: 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. Case of Photons: 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 Degerate 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 Desexcitation
  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. Linked 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. Klein-Gordon Field Lorentz Invariance
- 7.2.4. Vacuum Vacuum and Fock States
- 7.2.5. Vacuum Energy
- 7.2.6. Normal Ordering: Convention
- 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 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? Standards. 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 Amplituides
- 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. Principle of Weak Equivalence
  - 8.2.2. Experiments on the Weak Equivalence Principle
  - 8.2.3. Locally Inertial Reference Systems
  - 8.2.4. Equivalence Principle
  - 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: Required 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's 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. First Equation of Friedmann
- 8.10.2. second Equation of Friedmann
- 8.10.3. Densities and Scale Factor
- 8.10.4. Consequences of Friedmann Equations. Curvature of the Universe
- 8.10.5. Thermodynamics of the Early Universe

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), 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 Calculations: Introduction
- 9.3.1. Mean Lifetime
- 9.3.2. Cross Section
- 9.3.3. Fermi's Golden Rule for Decays
- 9.3.4. Fermi's Golden Rule for Scattering
- 9.3.5. Two-Body Scattering in the Center-of-Mass Reference Frame

9.4. Application of Feynman Calculations: Toy Model
- 9.4.1. Toy Model: Introduction
- 9.4.2. Feynman Rules
- 9.4.3. Mean 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 Unification
- 9.10.3. Matter-Antimatter Asymmetry
- 9.10.4. Supersymmetry, Strings, and Extra Dimensions
- 9.10.5. Dark Matter and Energy

Module 10. Quantum Information and Computing

10.1. Introduction: Mathematics and Quantum Physics
- 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. Accesible 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. Factorizatión: 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 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 Traps
- 10.10.4. Superconducting Cubits

Master key concepts of atmospheric physics, meteorology, and their link to climate change”

04

Teaching Objectives

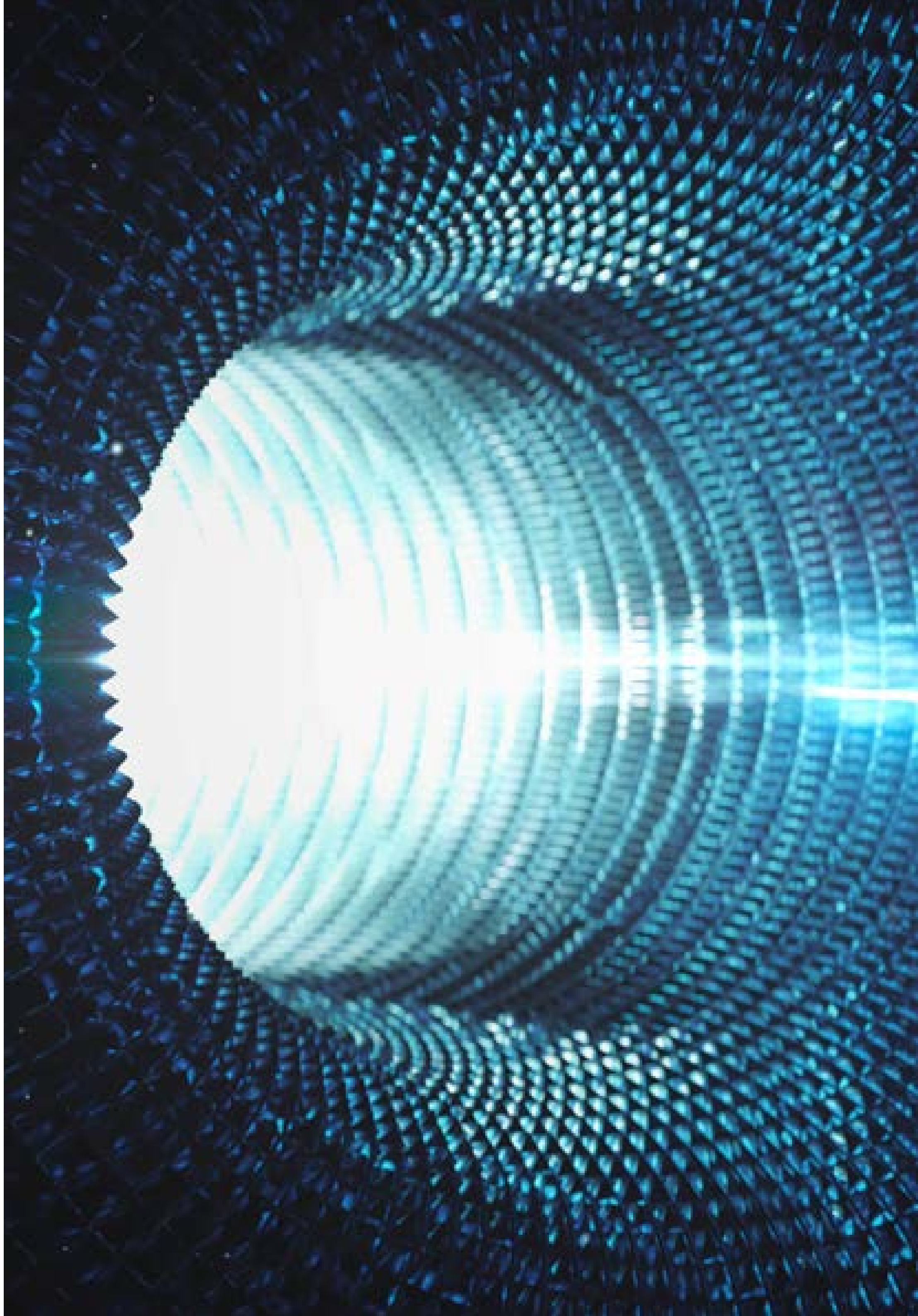
This university program from TECH is designed to provide engineers and specialists in the physical sciences with the most advanced knowledge in quantum physics. To this end, the degree program covers everything from the fundamentals of quantum mechanics to the latest advances in quantum field theory, quantum computing, and cosmology. Students will be able to master the concepts and tools that explain the universe at subatomic and cosmological scales, supported by a solid mathematical foundation. As such, the teaching objectives of this Master's Degree ensure that graduates develop skills in the analysis and modeling of physical phenomena.

Discover the behavior of crystalline solids, soft matter, and states of aggregation"

General Objectives

- Acquire basic concepts of astrophysics
- Develop basic notions of Feynman diagrams, how they are drawn, and their applications
- Learn and apply approximate methods for the study of quantum systems
- Master the Klein–Gordon, Dirac, and electromagnetic fields

> *Learn to design quantum programs and understand the operation of quantum computers"*



Specific Objectives

Module 1. Introduction to Modern Physics
- Identify and assess the presence of physical processes in daily life and in both specific and common scenarios
- Develop communication skills to write reports and documents, or to deliver effective presentations

Module 2. Mathematical Methods
- Acquire knowledge of the characteristics of linear operators and Sturm–Liouville theory
- Understand group theory, group representations, tensor calculus, and their applications to physics

Module 3. Quantum Physics I
- Apply the fundamental concepts of quantum physics and their articulation into laws and theories
- Become familiar with the mathematical tools characteristic of quantum physics to solve problems in quantum mechanics

Module 4. Astrophysics
- Understand and use mathematical and numerical methods commonly employed in astrophysics
- Become familiar with new developments and advances in the field of astrophysics, both theoretical and experimental

Module 5. Quantum Physics II
- Understand atomic models using the variational method
- Master intrinsic angular momentum
- Understand the theory of time-dependent perturbations
- Understand and know how to apply the WKB method

Module 6. Nuclear and Particle Physics
- Acquire basic knowledge of nuclear and particle physics
- Distinguish between different nuclear decay processes
- Understand Feynman diagrams, their use, and how to draw them
- Perform relativistic collision calculations

Module 7. Quantum Field Theory
- Acquire basic notions of quantum field theory
- Understand the main problems associated with the quantization of certain fields and how they are resolved

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
- Understand Einstein's equations in tensor form
- Develop basic knowledge of cosmology and the early universe

Module 9. High-Energy Physics
- Apply knowledge of quantum field theory and the mathematics of group theory and representations to elementary particle physics
- Understand the mechanisms of spontaneous symmetry breaking and the Higgs mechanism

Module 10. Quantum Information and Computing
- Acquire basic notions of classical and quantum information
- Identify the most common algorithms for quantum information encryption
- Acquire basic notions of the semiclassical and quantum theories of light–matter interaction
- Understand the most common implementations of quantum information

05

Career Opportunities

As this discipline transforms sectors such as computing, cryptography, medicine, and artificial intelligence, the demand for profiles with advanced training and specialized competencies continues to grow. For this reason, this academic program opens the door to opportunities in research centers, technology companies, innovation laboratories, or space agencies, among other fields. In addition, thanks to its multidisciplinary approach, it allows the application of the knowledge acquired in quantum development projects, physical modeling, or complex data analysis. As such, it is consolidated as a key option for those seeking to integrate into the core of the science and technology of the future.

You will apply quantum principles to real-world contexts, participate in cutting-edge research, and master the foundations that govern the universe at the subatomic level"

Graduate Profile

Graduates of this Master's Degree from TECH will be professionals with in-depth knowledge of quantum mechanics, quantum field theory, and general relativity, capable of interpreting physical phenomena at both atomic and cosmological scales. They will be qualified to employ complex mathematical methods in solving advanced problems, develop theoretical models of elementary particles, and apply these tools in scientific or technological simulations and projects. This professional may join research teams, participate in the development of emerging technologies, or advance toward doctoral studies in theoretical or experimental physics.

Thanks to this 100% online academic pathway from TECH, you will acquire the competencies necessary to stand out in the most demanding scientific environments.

- **Scientific Application in Real Contexts:** Mastery of concepts such as supersymmetry, extra dimensions, and quantum systems applied to research or advanced teaching
- **Critical Reasoning and Mathematical Modeling:** Ability to formulate, analyze, and solve problems using mathematical formalisms such as the variational method or tensor calculus
- **Quantum Simulation and Experimentation:** Skill in performing simulations of complex physical processes and assessing their practical application in laboratories, industries, or academic institutions
- **Scientific Interdisciplinarity:** Aptitude for collaborating with teams from different areas of knowledge (engineering, mathematics, technology, or astronomy) in advanced research projects

After completing the university program, you will be able to apply your knowledge and skills in the following positions:

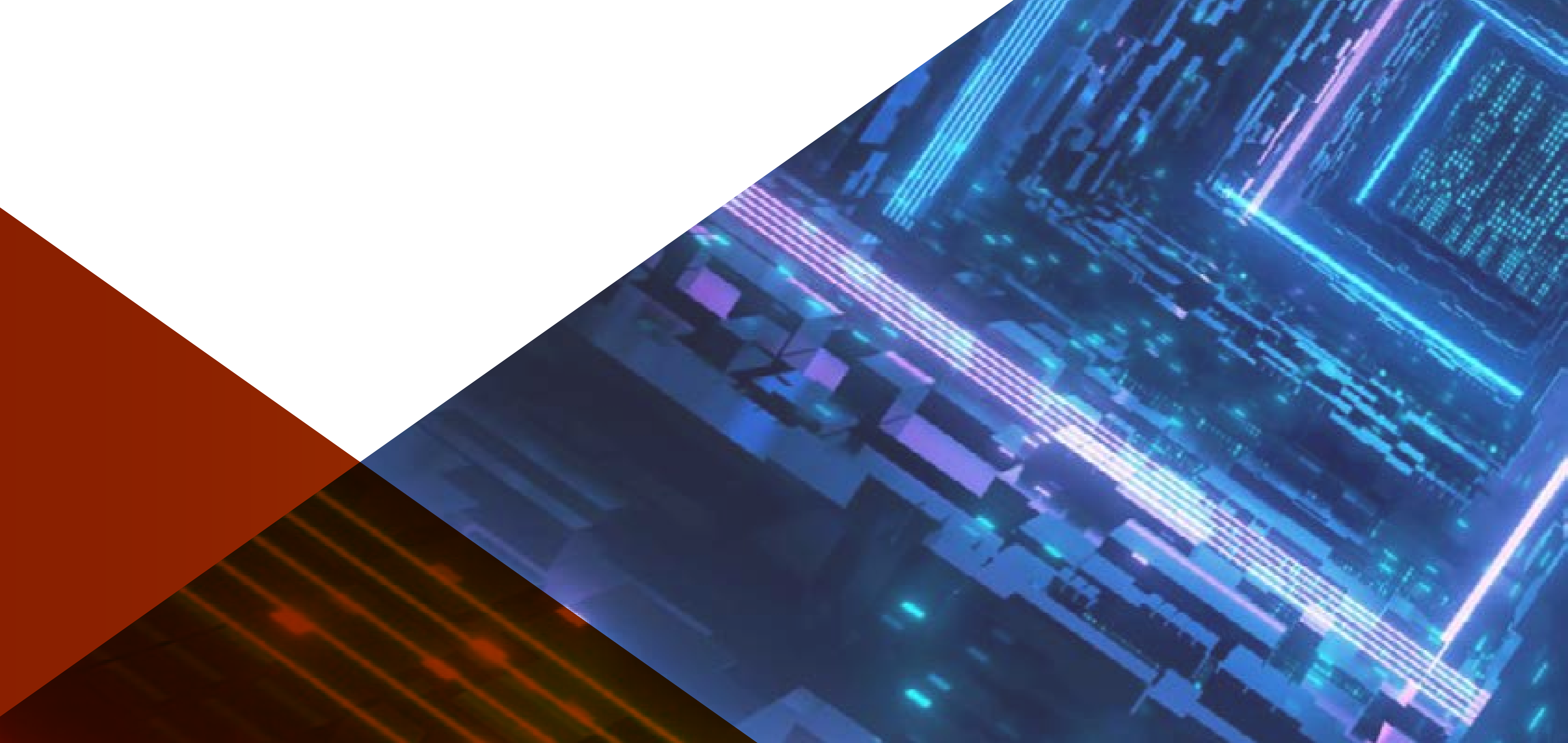
1. **Quantum Physics and Astrophysics Researcher:** Participation in scientific projects on quantum field theory, quantum mechanics, or the study of galaxies, stars, and black holes
2. **Quantum Technologies Analyst:** Professional dedicated to the evaluation and development of quantum devices, sensors, quantum computing, or emerging technologies
3. **Specialist in Mathematical Models and Physical Simulation:** Responsible for the development of models for complex physical phenomena and simulations applied to industrial or academic environments
4. **Lecturer or Science Communicator in Advanced Physics:** Professor in educational institutions or creator of content that explains complex concepts in an accessible manner
5. **Advisor in Multidisciplinary Scientific Projects:** Member of teams requiring knowledge of particle physics, relativity, or cosmology to address scientific or technological challenges
6. **Consultant in Technological and Scientific Innovation:** Professional who provides guidance in the design of new solutions based on quantum principles and field theories

You will become a reference in the analysis of highly complex physical phenomena, thanks to a comprehensive vision of quantum physics and its relationship with astrophysics and relativity"

06

Software Licenses Included

TECH is a leading reference in the academic world for combining the latest technology with teaching methodologies to enhance the teaching-learning process. To achieve this, it has established a network of alliances that allows it to access the most advanced software tools used in the professional world.



Upon enrolling, you will receive, completely free of charge, academic credentials for the following professional software applications"

TECH has established a network of professional alliances with the leading providers of software applied to various professional fields. These alliances allow TECH to access hundreds of software applications and licenses, making them available to its students.

The academic software licenses will allow students to use the most advanced applications in their professional field, so they can become familiar with them and master their use without incurring additional costs. TECH will be responsible for managing the licensing process so that students may use the software without limitations throughout the entire duration of the Master's Degree in Quantum Physics, completely free of charge.

TECH will provide free access to the following software applications:

Google Career Launchpad

Google Career Launchpad is a solution for developing digital skills in technology and data analysis. With an estimated value of **5,000 dollars**, it is included **for free** in TECH's university program, providing access to interactive labs and certifications recognized in the industry.

This platform combines technical training with practical cases, using technologies such as BigQuery and Google AI. It offers simulated environments to work with real data, along with a network of experts for personalized guidance.

Key Features:

- **Specialized Courses:** Updated content in cloud computing, machine learning, and data analysis
- **Live Labs:** Hands-on practice with real Google Cloud tools, no additional configuration required
- **Integrated Certifications:** Preparation for official exams with international validity
- **Professional Mentoring:** Sessions with Google experts and technology partners
- **Collaborative Projects:** Challenges based on real-world problems from leading companies

In conclusion, **Google Career Launchpad** connects users with the latest market technologies, facilitating their entry into fields such as artificial intelligence and data science with industry-backed credentials.

Ansys

Ansys is engineering simulation software that models physical phenomena such as fluids, structures, and electromagnetism. With a commercial value of **26,400 euros**, it is offered free of charge during the university program at TECH, providing access to cutting-edge technology for industrial design.

This platform excels in its ability to integrate multiphysics analysis into a single environment. It combines scientific precision with automation through APIs, streamlining the iteration of complex prototypes in industries such as aerospace or energy.

Key Features:

- **Integrated multiphysics simulation:** analyze structures, fluids, electromagnetism, and thermals in a single environment
- **Workbench:** a unified platform to manage simulations, automate processes, and customize workflows with Python
- **Discovery:** prototype in real-time with simulations accelerated by GPU
- **Automation:** create macros and scripts with APIs in Python, C++, and JavaScript
- **High Performance:** solvers optimized for CPU/GPU and cloud scalability on demand

In conclusion, **Ansys** is the ultimate tool to transform ideas into technical solutions, offering power, flexibility, and an unparalleled simulation ecosystem.

Thanks to TECH, you will have free access to the best software applications in your professional field”

07

Study Methodology

TECH is the first university in the world to combine case study methodology with Relearning, a 100% online learning system based on guided repetition.

This innovative pedagogical strategy has been conceived to offer professionals the opportunity to update knowledge and develop skills in an intensive and rigorous way. A learning model that places the student at the center of the academic process and gives them the leading role, adapting to their needs and leaving aside the more conventional methodologies.

TECH prepares you to face new challenges in uncertain environments and achieve success in your career"

The student: the priority of all TECH programs

In TECH's study methodology, the student is the absolute protagonist.
The pedagogical tools of each program have been selected taking into account the demands of time, availability and academic rigor that, today, not only students demand but also the most competitive positions in the market.

With TECH's asynchronous educational model, it is the student who chooses the time they spend studying, how they decide to establish their routines and all this from the comfort of the electronic device of their choice. The student will not have to attend live classes, which many times they cannot attend. The learning activities will be done when it is convenient for them. You will always be able to decide when and from where to study.

At TECH you will NOT have in person classes (which you might not be able to attend)"

The most comprehensive academic programs worldwide

TECH is distinguished by offering the most complete academic pathways within the higher education landscape. This level of comprehensiveness is achieved through the development of curricula that not only encompass essential knowledge but also integrate the latest innovations in each area of study.

By being constantly updated, these programs allow students to keep up with market changes and acquire the skills most valued by employers. In this way, those who complete their studies at TECH receive a comprehensive preparation that provides them with a notable competitive advantage to advance in their careers.

And what's more, they will be able to do so from any device, PC, tablet or smartphone.

TECH's model is asynchronous, so it allows you to study with your PC, tablet or smartphone wherever you want, whenever you want and for as long as you want"

Case Studies or Case Method

The case method has been the learning system most used by the best business schools in the world. Developed in 1912 so that law students would not only learn the law based on theoretical content, its function was also to present them with real complex situations. In this way, they could make informed decisions and value judgments about how to solve them. In 1924 it was established as a standard teaching method at Harvard.

With this teaching model, it is the student who builds their professional competence through strategies such as Learning by Doing or Design Thinking, which are used by other renowned institutions such as Yale or Stanford.

This action-oriented method will be applied throughout the entire academic itinerary that the student undertakes with TECH. Students will be confronted with multiple real-life situations and will have to integrate knowledge, research, argue and defend their ideas and decisions. All this with the premise of answering the question of how they would act when facing specific events of complexity in their daily work.

Relearning **Method**

At TECH, case studies are enhanced with the best 100% online teaching method: Relearning.

This method breaks with traditional teaching techniques to put the student at the center of the equation, providing the best content in different formats. In this way, they are able to review and reiterate the key concepts of each subject and learn to apply them in a real environment.

Along the same lines, and according to multiple scientific researches, repetition is the best way to learn. For this reason, TECH offers between 8 and 16 repetitions of each key concept within the same lesson, presented in a different way, with the objective of ensuring that the knowledge is completely consolidated during the study process.

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

A 100% online Virtual Campus with the best teaching resources

To apply its methodology effectively, TECH focuses on providing graduates with teaching materials in different formats: texts, interactive videos, illustrations and knowledge maps, among others. All of them are designed by qualified teachers who focus their work on combining real cases with the resolution of complex situations through simulation, the study of contexts applied to each professional career and learning based on reiteration, through audios, presentations, animations, images, etc.

The latest scientific evidence in the field of Neurosciences points to the importance of taking into account the place and context where the content is accessed before starting a new learning process. Being able to adjust these variables in a personalized way helps people to remember and store knowledge in the hippocampus for long-term retention. This is a model called Neurocognitive Context-Dependent E-Learning that is consciously applied in this university program.

Furthermore, in order to maximize tutor-student contact, a wide range of communication possibilities are provided, both in real time and deferred (internal messaging, discussion forums, telephone answering service, e-mail contact with the technical secretary, chat and videoconferencing).

Likewise, this very complete Virtual Campus will allow TECH students to organize their study schedules according to their personal availability or work obligations. In this way, they will have global control of the academic content and teaching tools, in accordance with their accelerated professional updating.

“The online mode of study of this program will allow you to organize your time and your learning pace, adapting it to your schedule”

The effectiveness of the method is justified by four fundamental achievements:

1. Students who follow this method not only achieve the assimilation of concepts, but also a development of their mental capacity, through exercises that assess real situations and the application of knowledge.
2. Learning is solidly translated into practical skills that allow the student to better integrate into the real world.
3. Ideas and concepts are understood more efficiently, given that the example situations are based on real-life.
4. Students like to feel that the effort they put into their studies is worthwhile. This then translates into a greater interest in learning and more time dedicated to working on the course.

The university methodology best rated by its students

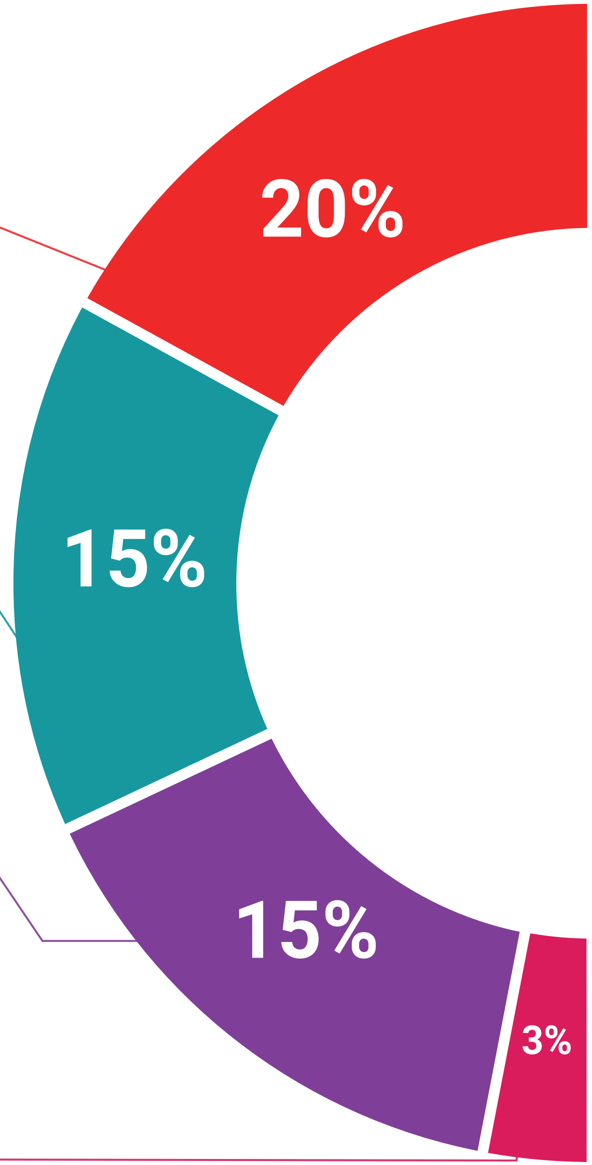
The results of this innovative academic model can be seen in the overall satisfaction levels of TECH graduates.

The students' assessment of the teaching quality, the quality of the materials, the structure of the program and its objectives is excellent. Not surprisingly, the institution has become the top-rated university by its students according to the global score index, obtaining a 4.9 out of 5.

Access the study contents from any device with an Internet connection (computer, tablet, smartphone) thanks to the fact that TECH is up to date with the technological and pedagogical vanguard.

You will be able to learn with the advantages of access to simulated learning environments and the learning by observation approach, that is, the "Learning from an Expert" approach.

Therefore, the best educational materials, thoroughly prepared, will be available in this program:



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.

This content is then adapted in an audiovisual format that will create our way of working online, with the latest techniques that allow us to offer you high quality in all of the material that we provide you with.

Practicing Skills and Abilities

You will carry out activities to develop specific skills and abilities in each thematic area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop within the context of the globalization in which we live.

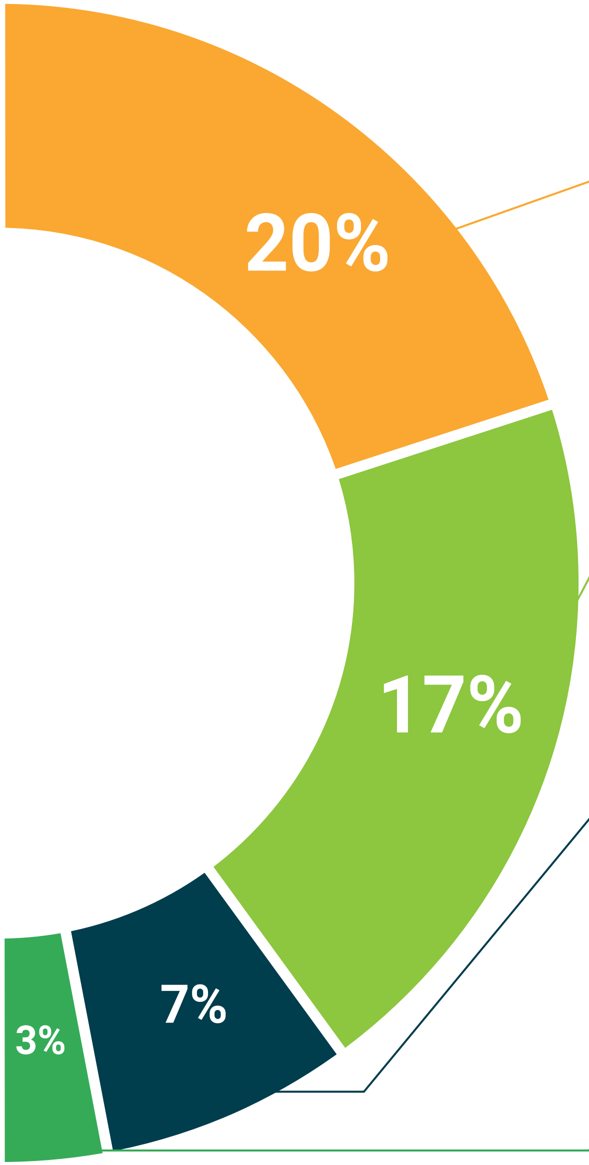
Interactive Summaries

We present the contents in an attractive and dynamic way in multimedia pills that include audio, videos, images, diagrams and concept maps in order to reinforce knowledge.

This unique educational system for the presentation of multimedia content was awarded by Microsoft as "Successful Case in Europe."

Additional Reading

Recent articles, consensus documents, international guidelines... In our virtual library you will have access to everything you need to complete your course.



Case Studies

You will complete a selection of the best case studies in the field. Cases presented, analyzed and tutored by the best specialists in the world.

Testing & Retesting

We periodically evaluate and re-evaluate your knowledge throughout the program. We do this on 3 of the 4 levels of Miller's Pyramid.

Masterclasses

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

Learning from an expert strengthens knowledge and recall, and generates confidence in our future difficult decisions.

Quick Action Guides

TECH offers the most relevant contents of the course in the form of worksheets or quick action guides. A synthetic, practical and effective way to help students progress in their learning.

08

Teaching Staff

The professionals who deliver this program from TECH are true leaders in the field of quantum physics. These experts have accumulated significant research achievements and are frequently cited in academic publications by scientists from the international community. Through their practical experience and the most up-to-date theoretical knowledge, the members of this faculty have developed a comprehensive program, ideally suited for physicists seeking to update their competencies. As such, thanks to the highly personalized guidance provided by this academic staff, graduates achieve an exceptionally high level of specialization.

You will complete this exclusive program under the guidance of experts thoroughly trained in the latest innovations in Quantum Physics”

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"

09
Certificate

The Master's Degree in Quantum Physics guarantees students, in addition to the most rigorous and up-to-date education, access to a diploma for the 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 private qualification will allow you to obtain a diploma for the **Master's Degree 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 private qualification from **TECH Global University** is a European continuing education and professional development program that guarantees the acquisition of competencies in its area of expertise, providing significant curricular value to the student who successfully completes the program.

Title: **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:

Master's Degree in Quantum Physics

This is a private qualification of 1,800 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
Dean

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

Master's Degree in Quantum Physics

General Structure of the Syllabus

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	Introduction to Modern Physics	6	CO
1º	Mathematical Methods	6	CO
1º	Quantum Physics I	6	CO
1º	Astrophysics 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	Quantum Information and Computing	6	CO

Dr. Pedro Navarro Illana
Dean

tech global university

*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.

Master's Degree
Quantum Physics

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

Master's Degree
Quantum Physics

tech global university