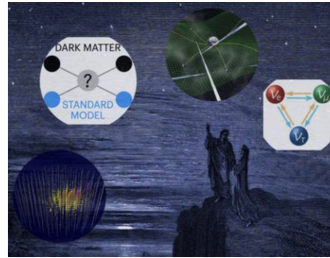


Research Lines

Suggested Courses

Astroparticle Theory

Why do neutrinos have mass? How do they oscillate?
What is dark matter?
Why is there so much more matter than antimatter?
What is the origin of masses?
And of the approximate fundamental symmetries?



Group 1	Quantum Field Theory 2
Group 2 (2 choices)	Theory of the Standard Model & Theoretical Astroparticle Physics
Group 3	Gravitational Wave Physics or Astroparticle Physics
Group 4	student's choice
Group 5	Beyond the Standard Model
Free choice 1	Theory of the Standard Model: Advanced Topics or Supersymmetry or Quantum Cosmology
Free choice 2	student's choice



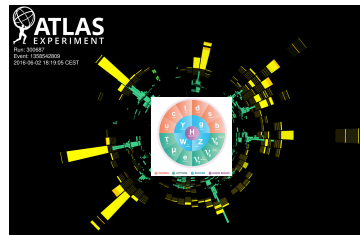
Gravitation and Cosmology

How do we quantise gravity as the theory of space-time events?
What are astrophysical black holes and how do they form?
How did our universe start out and will evolve?
What plays the role of dark matter and dark energy?

Group 1	Quantum Field Theory 2
Group 2 (2 choices)	Black Holes & Quantum Cosmology
Group 3	Gravitational Wave Physics
Group 4	student's choice
Group 5	Advanced Quantum Field Theory
Free choice 1	Advanced Mathematical Methods for Physics
Free choice 2	student's choice

Phenomenology of Fundamental Interactions

What is the nature of the Higgs boson?
Is there new physics beyond the Standard Model?
How can we look for its imprints at colliders?
Do fundamental forces unify at very high energies?
How can we make precise predictions for high energy processes?



Group 1	Quantum Field Theory 2
Group 2 (2 choices)	Standard Model & student's choice (Theoretical Astroparticle Physics)
Group 3	student's choice
Group 4	Nuclear Physics / Theoretical Nuclear Physics
Group 5	QCD or Standard Model: Advanced Topics or Beyond the Standard Model
Free choice 1	QCD or Standard Model: Advanced Topics or Beyond the Standard Model
Free choice 2	QCD or Standard Model: Advanced Topics or Beyond the Standard Model or Supersymmetry or Advanced Quantum Field Theory



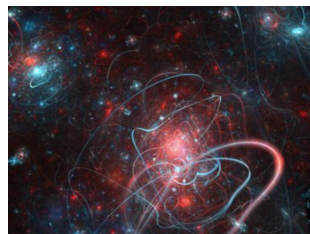
Quantum Field Theory

What is the rôle of QFT for encompassing all together Statistical Phenomena, Particles&Interactions, Gravity&Strings?
How can we fully and non-perturbatively chart the space of consistent QFTs?
What are the perturbative/non-perturbative methods for disentangling the spectrum and the observables?
What are the use and meaning of symmetry and integrability in the real world?

Group 1	Quantum Field Theory 2 or Statistical Field Theory
Group 2 (2 choices)	Advanced Mathematical Methods for Physics or Theory of the Standard Model or Group Theory
Group 3	student's choice
Group 4	student's choice
Group 5	Advanced Quantum Field Theory
Free choice 1	Quantum Field Theory 2 or Statistical Field Theory
Free choice 2	Supersymmetry or String Theory or Advanced Methods in Quantum Many-Body Theory

String Theory

How can we unify general relativity and quantum mechanics?
What are cosmological signatures of string theory?
Where do symmetries come from?
How do geometry and topology encode features of quantum field theory?
And what does string theory and quantum gravity teach us about new mathematics?



Group 1	Quantum Field Theory 2
Group 2 (2 choices)	Quantum Cosmology or Standard Model or Group Theory
Group 3	student's choice
Group 4	student's choice
Group 5	String Theory or Supersymmetry
Free choice 1	String theory or Supersymmetry
Free choice 2	student's choice

Theory of Quantum Many-Body Systems, Quantum Information & Computation



What new phenomena can emerge due to the presence of many particles? ("more is different")
How can we understand universal behavior of very different systems?
How does quantum entanglement manifests itself in many-body systems?
Can we harness the properties of quantum systems to store and process information? ("information is physical")
How can we simulate fundamental physics on a quantum processor?

Group 1	Statistical Field Theory
Group 2 (2 choices)	Theory of Quantum Information & Introduction to Quantum Many-Body Systems
Group 3	Dynamical Systems and Ergodic Theory
Group 4	Interactions and Correlations in Condensed Matter or Quantum Sciences and Technologies
Group 5	Quantum Computing or Advanced Methods in QMBT
Free choice 1	Quantum Computing or Advanced Methods in QMBT
Free choice 2	Advanced Mathematical Methods in Physics or Group Theory or Theoretical Nuclear Physics or any course on Quantum information

