PHY-M-VF 10

Effective WS 2011/12

1. Module title:	**Quantum Chromodynamics**
2. Field / responsibility of:	Physics / the faculty, the Dean of Studies
3. Module contents:	**PHY-M-VF 10.1** **Perturbative QCD** • Non-abelian gauge theories • Long-range formalism for quantum fields • Gauge invariance and ghost fields • Feynman rules of QCD • DGLAP evolution equations • Renormalization of the running coupling constant • The Drell-Yan process • Operator product expansion • Non-perturbative phenomena: Confinement, chiral symmetry breaking, vacuum structure • Fundamentals of path integrals and lattice QCD **PHY-M-VF 10.2** **Lattice Quantum Field Theory I** • Path integral quantization • Scalar field theory on the lattice • Monte Carlo methods • Gauge theories • Strong-coupling expansion • Continuum limit and phase transitions • Fermions on the lattice • Chiral symmetry on the lattice • Hybrid Monte Carlo • Hadron spectroscopy
4. Qualification objectives of the module / competencies to be	Acquiring a fundamental knowledge of the modern theory of the strong interaction
5. Prerequisites for participation:	
a) Recommended knowledge:	Quantum mechanics II, quantum electrodynamics. Students of the degree program Computational Science may substitute quantum electrodynamics with knowledge acquired in Computational Physics (Modul PHY-M-VF8).
b) Prerequisite courses:	None
6. Module can be used for:	MSc. in Physics, MSc. in Nanoscience, MSc. in Computational Science; BSc. in Computational Science
7. Module is offered:	On a yearly basis
8. Module can be completed in:	1 semester
9. Recommended semester of study:	Minimum: 1
10. Overall module workload / number of credit points:	**Workload:** **Total number of hours: 240** **Allocation: 1. Attendance: 6 credit hours**

	2. Independent study (including exam preparation / exam): 150 hours **Credit points: 8**

11. The module is successfully completed when the requirements below have been met.

12. Module components:

Nr.	Req./req. elective	Form of teaching	Subject area / topic	Credit hours	Coursework
PHY-M -VF 1 0.1	Required elective	Lecture Practical course	Perturbative QCD	6	Practical exercises
PHY-M -VF 1 0.2	Required elective	Lecture Practical course	Lattice quantum field theory I	6	Practical exercises

13. Module exam:

Nr.	Competence / topic	Type of exam	Duration	Time / notes	Weighting for module grade
PHY-M -VF 1 0.1-2	Perturbative QCD OR lattice quantum field theory I			Type of exam: Oral or written or term paper; duration: 20 min, or 105 min, 135 min or 210 min (if it consists of two parts); time: Lecture period to end of semester	1

14. Notes:

If the exams in both module elements are passed, the course that was not counted may be applied towards electives with 8 credit points. The information on "duration" (exam) refers to the oral or written exam. Further information will be provided by the instructors at the beginning of the course.