

# PHY-M-VF 14

Effective WS 2011/12

| <b>1. Module title:</b>  |                    | <b>Nonlinearity in Classical and Quantum Physics</b>  |   |              |                     |
|--|--------------------|---|---|--------------|---------------------|
| <b>2. Field / responsibility of:</b>   |                    | Physics / the faculty, the Dean of Studies  |   |              |                     |
| <b>3. Module contents:</b>   |                    | <ul style="list-style-type: none"> <li>• Introduction: Phenomena, examples and fundamental concepts</li> <li>• Hamiltonian dynamics and classical perturbation theory</li> <li>• Chaos in Hamiltonian systems</li> <li>• One-dimensional representations, bifurcations, paths to chaos</li> <li>• Chaos in non-linear oscillators</li> <li>• Quantum chaos: Phenomena and examples</li> <li>• Semiclassical theory: WKB approach, EBK quantization and Gutzwiller's trace formula</li> <li>• Applications in nuclear physics, atomic physics and mesoscopic physics</li> <li>• Random matrix theory and applications</li> </ul> |   |              |                     |
| <b>4. Qualification objectives of the module / competencies to be acquired:</b>            |                    | Acquiring knowledge of fundamental terminology, phenomena and concepts of non-linear dynamics and quantum chaos   |   |              |                     |
| <b>5. Prerequisites for participation:</b>   |                    |   |   |              |                     |
| <b>a) Recommended knowledge:</b>   |                    | Theoretical mechanics   |   |              |                     |
| <b>b) Prerequisite courses:</b>  |                    | None  |   |              |                     |
| <b>6. Module can be used for:</b>  |                    | MSc. in Physics, MSc. in Nanoscience, MSc. in Comp. Science; BSc. in Comp. Science  |   |              |                     |
| <b>7. Module is offered:</b>   |                    | On a yearly basis   |   |              |                     |
| <b>8. Module can be completed in:</b>  |                    | 1 semester  |   |              |                     |
| <b>9. Recommended semester of study:</b>   |                    | Minimum: 1  |   |              |                     |
| <b>10. Overall module workload / number of credit points:</b>                              |                    | <b>Workload:</b><br><b>Total number of hours: 240</b><br><b>Allocation:</b><br><b>1. Attendance: 6 credit hours</b><br><b>2. Independent study (including exam preparation/ exam): 150 hours</b><br><b>Credit points: 8</b>   |   |              |                     |
| <b>11. The module is successfully completed when the requirements below have been met.</b> |                    |   |   |              |                     |
| <b>12. Module components:</b>  |                    |   |   |              |                     |
| Nr.  | Req./req. elective | Form of teaching  | Subject area / topic                          | Credit hours | Coursework          |
| PHY-M-VF 14.1  | Required elective  | Lecture<br>Practical course   | Nonlinearity in classical and quantum physics | 6            | Practical exercises |

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| <b>13. Module exam:</b>   |   |                     |                 |  |                                   |
|---|---|---------------------|-----------------|--|-----------------------------------|
| <b>Nr.</b>  | <b>Competence / topic</b>                     | <b>Type of exam</b> | <b>Duration</b> | <b>Time / notes</b>  | <b>Weighting for module grade</b> |
| PHY-M-VF<br>1 4.1   | Nonlinearity in classical and quantum physics |                     |                 | Type of exam: Oral or written; 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                                 |
| <b>14. Notes:</b>   |   |                     |                 |  |                                   |
| Further information will be provided by the instructors at the beginning of the course. |   |                     |                 |  |                                   |