

Black Holes

Module type elective	Recommended for 6 th / 7 th / 8 th semester	Module availability irregular cycle	Module number and ECTS 12-PHY-MWPMMP1
Workload 300 h	Tutorial hours 90 h	Private study hours 210 h	10 CP
Responsibility Head of the Department Mathematical Physics			
Teaching units (SWS / tutorial hours / private study hours) - Lecture "Black Holes" (4 SWS / 60 h / 80 h) - Exercise "Black Holes" (2 SWS / 30 h / 130 h)			
Participation requirements None			
Examinations (duration; weighting) and pre-examination requirements Written exam (120 min; ×1) <i>Pre-examination requirements: Weekly exercises with tasks related to the module content. Points are awarded for solutions. 50% of the total points for the entire semester have to be achieved as prerequisite for admission to the exam.</i>			

Objectives After active participation in the module, students will be able to

- articulate and demonstrate a thorough understanding of the essential principles and techniques concerning the properties of black holes in the theory of general relativity,
- derive geometrical and analytical key features of the Einstein's equations of general relativity,
- independently work on and solve relevant model problems and justify their approach.

Content

- geometric properties of key special black hole solutions of the Einstein equations, including the Schwarzschild, Reissner-Nordström and Kerr solutions;
- fundamentals of causality theory, Lorentzian geometry and Penrose diagrams;
- the initial value problem in general relativity;
- asymptotic flatness and conservation variables;
- the incompleteness theorems of Penrose and Hawking;
- the Cosmic Censorship conjectures;
- the laws of black hole mechanics;
- dynamic properties of black holes.

References

- S. W. Hawking and G.F.R. Ellis, The large scale structure of space-time, Cambridge University Press, 1973;
- R.M. Wald: General Relativity, University of Chicago Press, 1984