GR 12: Didaktische Aspekte der Relativitätstheorie

Zeit: Donnerstag 8:30–10:30 Raum: SFG 0140

Hauptvortrag GR 12.1 Do 8:30 SFG 0140

Relatively complicated? Teaching general relativity at different levels — •Markus Pössel — Haus der Astronomie und Max Planck Institut für Astronomie, MPIA-Campus, Königstuhl 17, 69117 Heidelberg

Can a bowling ball in a rubber sheet properly represent Einstein's description of gravity? Is space really expanding in an expanding universe? In an interferometric gravitational wave detector, do light waves play the role of a ruler?

Simplifications and analogies are unavoidable whenever teaching Einstein's theory of general relativity to a wider audience, such as undergraduate students, high school students, or the general public. The talk presents examples for such simplifications and analogies at different levels, including a critical discussion of misleading examples and potential pitfalls.

GR 12.2 Do 9:10 SFG 0140

Empirical exploration of spacetimes with bundles of light rays — •Thomas Müller — Haus der Astronomie / MPIA, Heidelberg

Studying the trajectories of light rays around black hole spacetimes is a standard task in an introductory course to general relativity. Based on this knowledge, students can already implement a simple ray tracing algorithm to visualize how a black hole geometrically distorts the Milky Way background.

For more advanced explorations of how curved spacetime influences light, a whole bundle of light rays has to be traced. This can be realized for example by additionally integrating the Jacobian equation and the equation for the parallel transport of a Sachs basis. In this talk I discuss how interactive visualization of these bundles can help to empirical explore gravitational lensing effects in different spacetimes.

GR 12.3 Do 9:30 SFG 0140

General Theory of Relativity on the Computer - An Interactive Lecture — •Matthias Hanauske — Institut für Theoretische Physik, Max-von-Laue-Straße 1 — Frankfurt Institute for Advanced Studies, Ruth-Moufang-Straße 1, Frankfurt, Germany

The concept, the content and the implementation of an interactive lecture held at the Goethe University in SS2016 will be discussed in this talk. The main focus of the course is general relativity theory as well as the imparting of special programming knowledge, whereby the lecture took place in the PC pool of the institute and the students should apply the learned concepts directly during the lecture. In the first part of the course, students learn the use of computer algebra systems (Maple and Mathematica). Various applications of the Einstein and geodetic equations were implemented in Maple, quasi-analytic calculations were carried out and corresponding solutions were calculated and visualized. The second part of the course focused on the numerical calculation of neutron stars and white dwarfs using a C/C++ program. In addition, the basic concepts of parallel programming were introduced and an MPI and OpenMP version of these programs where created. In the third part of the course, time-dependent numerical simulations of GR were carried out using the Einstein Toolkit. (For more information, see http://fias.uni-frankfurt.de/~hanauske/VARTC/)

GR 12.4 Do 9:50 SFG 0140

Derivation of the Deflection of Light near a Mass from Huygen's Principle — •Carmesin Hans-Otto — Gymnasium Athenaeum, 21680 Stade, Harsefelder Straße 40 — Studienseminar Stade, Bahnhodstraße 5, 21682 Stade — Universität Bremen, Fachbereich 1, Pf 330440, 28334

In the vicinity of a mass the space time is curved. As a consequence the wavelength of light is relatively short near the mass. So the wave front exhibits Huygen's elementary waves with relatively small radius near the mass. Consequently the wave front moves towards the mass and the light is deflected. From this I derive the formula for the deflection of light near a mass.

GR 12.5 Do 10:10 SFG 0140

Big Bang Observation and Theory at School — •Hans-Otto Carmesin — Gymnasium Athenaeum, 21680 Stade, Harsefelder Straße 40 — Studienseminar Stade, Bahnhodstraße 5, 21682 Stade — Universität Bremen, Fachbereich 1, Pf 330440, 28334

Students discovered the age of the universe by their own and understood the observation by elementary methods.

Students of age 12 and older took photographs with an 11 inch telescope at the school observatory. With these photographs, the students achieved an overview of the visible universe and concluded the Big Bang. In an alternative observation the students determined the age of the universe spectroscopically.

The students modelled the expansion of the universe with Newtonian cosmology and with quantum gravity.