Research Training Group
Graduiertenkolleg
Models of Gravity

RTG Models of Gravity – Online Colloquium	
Date:	15.06.2022
Time:	13:30 – 18:00
Location:	Zoom

Program

13:30 – 14:30	**Dr. Jan Steinhoff** AEI, Potsdam *“New perspectives on the relativistic binary problem”*
14:30 – 15:00	Discussion and break
15:00 – 16:00	**Prof. Dr. Robert Mann** Waterloo, Canada *“Black Holes: From Physics to Chemistry”*
16:00 – 16:30	Discussion and break
16:30 – 17:30	**Dr. Sebastian Ulbricht** PTB Braunschweig *“Investigating the influence of gravity on Earth-based laboratory experiments”*
17:30 – 18:00	Discussion and break

Abstracts

Talk 1: **Dr. Jan Steinhoff**
AEI, Potsdam

"New perspectives on the relativistic binary problem"

Continuing the success of gravitational wave observations requires a large effort on improving their theoretical predictions in the next decade, in order to keep their accuracy on par with improvements of the detectors. This requires innovations on the methods by which gravitational waves from compact binaries are calculated. In this talk, we focus on new approaches to analytic, perturbative predictions for relativistic binaries inspired by high-energy physics. In the latter area, scattering amplitudes are the primary observable and very efficient tools have revolutionized their calculation in recent years (generalized unitarity, spinor-helicity variables, color-kinematics duality, to name a few). These methods can indeed be applied to scattering black holes and ultimately also to the gravitational waves from binaries on bound orbits. We give a basic introduction to the ideas of this approach and the recent progress in this direction.

Talk 2: **Prof. Dr. Robert Mann**
Waterloo, Canada

"Black Holes: From Physics to Chemistry"

Black Holes are amongst the strangest objects in the universe. They form fromthe collapse of matter into an object whose gravitational pull is so strong, nothing can escape from them. Yet a black hole also radiates heat like a blackbody, with a temperature equal to its surface gravity, an entropy equal to its area, and an energy equal to its mass. I will describe recent work that is transforming our perspective on black hole thermodynamics, one that indicates black holes behave more like chemical systems. When vacuum energy is taken into account, mass becomes chemical enthalpy, the notion of a thermodynamic volume appears, and black holes exhibit a broad range of chemical phenomena, including liquid/gas phase transitions similar to a Van der Waals fluid, triple points similar to that of water, re-entrant phase transitions that appear in gels and heat engines. Under certain conditions they can even behave like superfluid helium! Even more recently, a holographic interpretation of these results has emerged and extensions to de Sitter spacetime have been carried out. I will outline the foundations of this "black hole chemistry", highlighting some of the interesting results that have emerged from this program and discuss recent developments in its holographic interpretation.

Talk 3: **Dr. Sebastian Ulbricht**
PTB Braunschweig

“Investigating the influence of gravity on Earth-based laboratory experiments”

During the previous decades a tremendous improvement of experimental accuracy and precision could be observed. This development resulted in the realization of high precision instruments such as optical atomic clocks, spectroscopes, electromagnetic particle traps, interferometers and gravitational wave detectors. The success story of these commonly Earth-based devices also gives rise to the question of when relativistic effects due to the gravitation of our own planet become relevant and start to influence measurements performed in a laboratory on its surface. In order investigate this question for a wide range of modern high precision experiments, we theoretically describe the interplay of electromagnetic fields and fermionic quantum particles within the spacetime of homogeneous gravity, i.e., homogeneous acceleration. We apply this framework to analyze the impact of gravity on an electron bound to a Penning trap and on light propagation in a high-finesse Fabry-Pérot cavity.