universität innsbruck

Faculty of Mathematics, Computer Science and Physics

# Inaugural Lectures

**Lukas Einkemmer**

Department of Mathematics University of Innsbruck, Austria

## Solving high-dimensional plasma physics problems with dynamical low-rank approximation

Gaining a better understanding of plasma systems is essential in applications ranging from magnetically confined nuclear fusion to radiation therapy. However, solving high-dimensional kinetic equations (such as the Vlasov equation or the Boltzmann equations) numerically is extremely challenging. Methods that discretize phase space suffer from the exponential growth of the number of degrees of freedom, the so-called curse of dimensionality, while Monte Carlo methods converge slowly and suffer from numerical noise. In addition, standard complexity reduction techniques (such as sparse grids) usually perform rather poorly due to the lack of smoothness for such problems. Dynamical low-rank techniques approximate the dynamics by a set of lower-dimensional objects. For those low-rank factors, partial differential equations are derived that can then be solved numerically. We will show that such dynamical low-rank approximations work well for a range of kinetic equations due to their capacity to handle non-smooth solutions and the fact that in many situations important physical limit regimes are represented very efficiently by such an approximation (e.g. fluid or diffusive limits).

**Tim Schrabback**

Institute of Astro and Particle Physics, University of Innsbruck, Austria

## Constraining the cosmological model with weak gravitational lensing

The expected statistical properties of the cosmic large-scale matter distribution depend sensitively on the cosmological model. As a result, accurate measurements of such statistics can be used to constrain cosmological parameters including the average matter density in the Universe, the amplitude of cosmic density fluctuations, the species-summed neutrino mass, and the properties of dark energy. As the main observational challenge, the matter distribution is dominated by invisible dark matter. The most direct approach allowing us to probe its distribution is provided by weak gravitational lensing. This effect describes image distortions which were imprinted onto the observed shapes of distant galaxies while their light passed through the gravitational potential of foreground matter fluctuations. After introducing this subject, results from current observing programs will be summarized, followed by an outlook to upcoming experiments.

**Tuesday, 21.11.2023 at 17:00 h**

**HS C (Technik)**