EP 10: Astrophysics II: Galaxies and Cosmology

Zeit: Freitag 11:00–12:30 Raum: HS 19

EP 10.1 Fr 11:00 HS 19

The Assembly of Galaxies in Dark Matter Haloes through Cosmic Time — •Benjamin Moster — Emmy Noether Group 'Galaxies and Dark Matter' — Universitäts-Sternwarte, LMU München — Max-Planck-Institut für Astrophysik, Garching

The field of galaxy formation is on the cusp of a tide of new data. To understand these in the context of an evolutionary picture, we need models that interpret the observed trends. Empirical galaxy formation models provide a unique and direct link between galaxies and dark matter haloes, and do not depend on model assumptions on unresolved physics. They are based on a parameterised relation between the properties of a galaxy and the properties of the halo in which it is embedded. I will present the latest generation of empirical models, which follow the formation histories of individual haloes. Focusing on three main pillars, I will then demonstrate how these models can be used. Firstly, they can be applied to make predictions for galaxies at high redshift, which will be useful for the design of future surveys. Secondly, the empirical models can be contrasted with hydrodynamical simulations, and in this way constrain the physical processes that drive galaxy formation. And thirdly, the empirical models can be used with N-body simulations using alternative cosmologies to test how observables such as galaxy clustering change. Finally, I will discuss the future of empirical models and how AI can help us to better understand the connection between the dark and light components of the Universe.

EP 10.2 Fr 11:15 HS 19

Dynamo amplification and magnetic driven outflows in disc galaxies — •Ulrich Steinwandel[1,2,3], Marcus Beck[3], Alexander Arth[2,4], Klaus Dolag[1,2], Benjamin Moster[1,2], and Peter Nielaba[3] — [1]Universitäts-Sternwarte, München — [2]Max Planck Institut für Astropyhsik, Garching — [3]Universität Konstanz — [4]Max Planck Institut für Extraterrestrische Physik, Garching

We carried out high resolution simulations of isolated Milky Way-like galaxies with a realistic circum galactic medium (CGM) to investigate the possibility to drive galactic outflows launched by the magnetic pressure. Our results indicate biconal (highly magnetised) outflows driven by the magnetic pressure that can reduce the mass of the galaxy by 10 per cent at the end of the simulation. Further, we investigate the amplification process of the magnetic field within our simulations. We find strong evidence for three different processes that amplify the magnetic fields in Milky Way-like galaxies. Amplification by adiabatic compression of the field lines, the alpha-omega dynamo (buoyant bubbles and large scale rotation of the disc) and the small scale turbulent dynamo (amplification by supernova induced turbulence). While adiabatic compression is dominating in the centre and the spiral arms over the whole simulation the small-scale turbulent dynamo is acting in the beginning of the simulation mostly in the inter arm regions and the centre. Once the small-scale turbulent dynamo is saturated we observe a transition towards the alpha-omega dynamo at later times leading to a non-linear growth phase of the magnetic field.

EP 10.3 Fr 11:30 HS 19

The galaxy merger rate from Emerge, an empirical model for galaxy formation — •Joseph A. O'Leary[1], Benjamin P. Moster[1,2], and Thorsten Naab[2] — [1]Universitäts-Sternwarte, Ludwig-Maximilians-Universität, München, Germany — [2]Max-Planck Institut für Astrophysik, Garching, Germany

The galaxy-galaxy merger rate is a critical component in constructing a complete picture of galaxy formation and evolution. We explore the galaxy-galaxy major merger rate in the frame work of the empirical model for galaxy formation, Emerge. Here we define the rate, R as the percentage of galaxies that will merge with another similar sized galaxy (mass ratio 1:4) within some time interval. We find that between 2% and 8% of large galaxies ($M_* > 10^{10} M_\odot$) will experience a major merger per Gyr. Generally, our results exhibit an increase in rate with increasing redshift up to $z \approx 1$, followed by a rapid decay at higher redshifts. The rates we determined through our model tend to be lower when compared with other theoretical models. However, we generally find very good agreement with recent observations, although the rates derived from our model tend to be flatter. Finally, we show that merger rates computed from close galaxy pairs, as done for observed rates, over predict the true intrinsic rates by a factor of 3. This discrepancy has direct consequences for the interpretation of observed galaxy merger rates.

EP 10.4 Fr 11:45 HS 19

A quest for Galaxy Clusters and distorted images — •Matteo Maturi[1], Fabio Bellagamba[2,3], Mario Radovich[4], Mauro Roncarelli[2,3], Mauro Sereno[2,3], Lauro Moscardini[2,3,6], Sandro Bardelli[3], Emanuella Puddu[5], Sebastian Stapelberg[1], and Mauricio Carrasco[1] — [1]ZAH/ITA, Philosophenweg 12, Heidelberg, Fermany — [2]Dipartimento di Fisica e Astronomia, Alma Mater Studiorum Universit'a di Bologna, via Gobetti 93/2, I-40129 Bologna, Italy — [3]INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, via Gobetti 93/3, I-40129 Bologna, Italy — [4]INAF - Osservatorio Astronomico di Padova, vicolo dell'Osservatorio 5, Padova 35122, Italy — [5]INAF - Osservatorio Astronomico di Capodimonte, Salita Moiariello 16, Napoli 80131, Italy — [6]INFN - Sezione di Bologna, Viale Berti Pichat 6/2, I-40127 Bologna, Italy

Galaxy clusters are fundamental probes to investigate the nature of dark matter, the complex phenomena involving their baryonic content and the nature of dark energy. To properly use them as a tool for cosmology, it is now of crucial importance to have large samples and a solid understanding of their observable and physical properties so as to obtain a reliable statistical sample and control over possible biases. Having this in mind, I will discuss how to detect galaxy clusters in optical photometric data sets and how to identify and characterize strong lensing features such as giant arcs in order to gain a deeper understanding of clusters.

Practical applications to the CHFTLens and KiDS-DR3 data will be presented.

Hauptvortrag EP 10.5 Fr 12:00 HS 19

Synthetic radiation simulations as a path to study the relativistic Kelvin-Helmholtz instability in interstellar jets — •Richard Pausch[1,2], Michael Bussmann[1], Axel Huebl[1,2], Ulrich Schramm[1,2], Klaus Steiniger[1], René Widera[1], and Alexander Debus[1] — [1]HZDR — [2]TU Dresden

The relativistic Kelvin-Helmholtz instability (KHI) is expected in shear flow regions of astrophysical plasma jets originating from AGNs and SNR. It generates magnetic fields that influence the jet dynamics significantly.

We present 3D3V particle-in-cell simulations of unprecedented resolution and extent that not only allow studying the plasma dynamics during the KHI but also making quantitative predictions on the emitted radiation. We present a diagnostic method that allows identifying the linear phase of the instability via a polarization anisotropy observable light years away on Earth and to quantify the growth rate of the instability.

A microscopic model, that describes the fundamental origin of the radiation signature, will be covered in detail during the talk. Technical aspects relevant for performing these large-scale simulations with the particle-in-cell code PIConGPU and for making quantitative predictions with synthetic radiation diagnostics, based on Liénard-Wiechert potentials, will be discussed, and observation limits both for interstellar jets and in lab astrophysics experiments will be covered.