

Research group Extragalactic Astrophysics



**Contacts for Bachelor thesis
topic requests:**

Dr. Sebastian Grandis
sebastian.grandis@uibk.ac.at

Dr. Laila Linke
laila.linke@uibk.ac.at

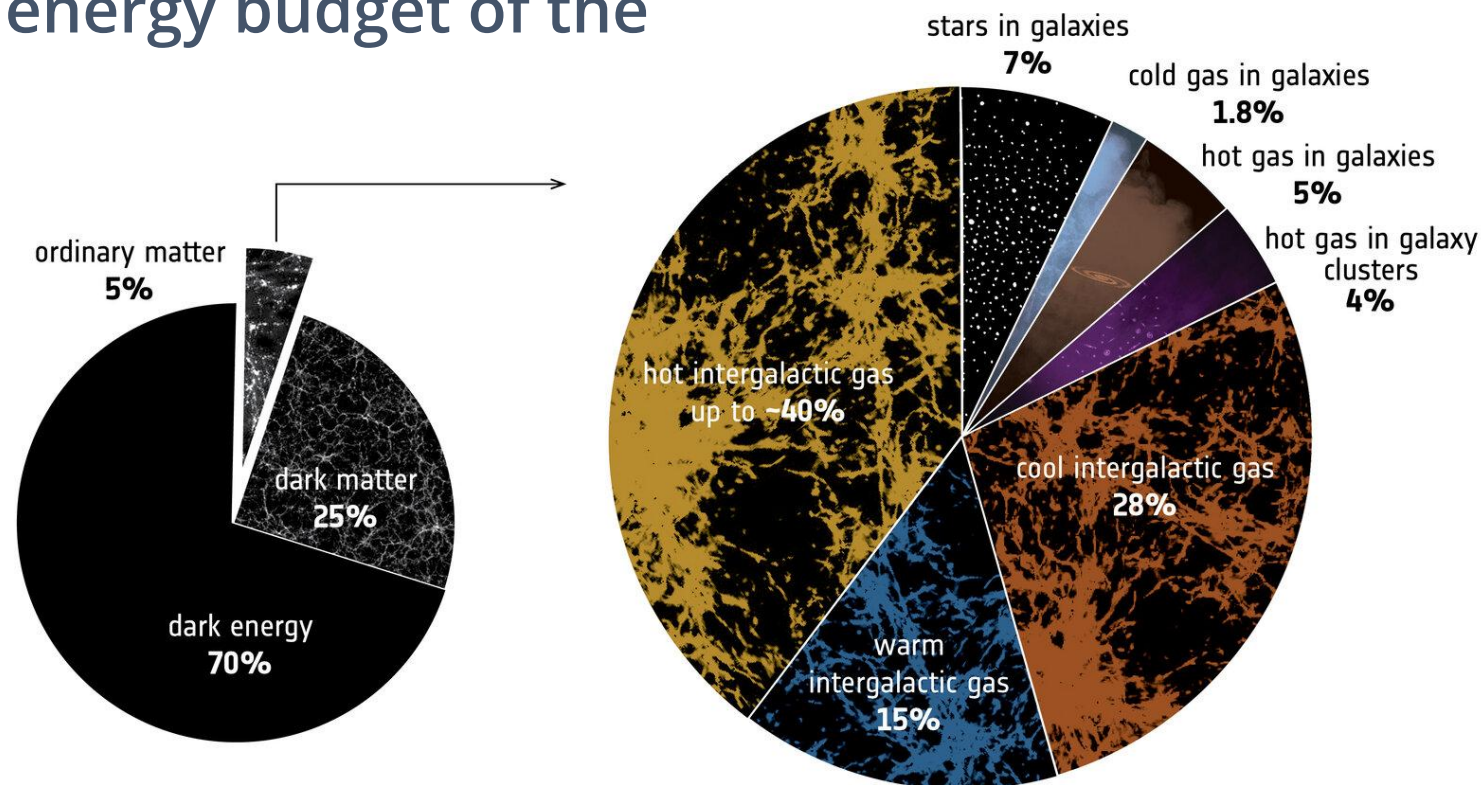
Benjamin Csizi
benjamin.csizi@uibk.ac.at

Univ.-Prof. Dr. Tim Schrabbach
tim.schrabbach@uibk.ac.at

Bachelor thesis topics 2025

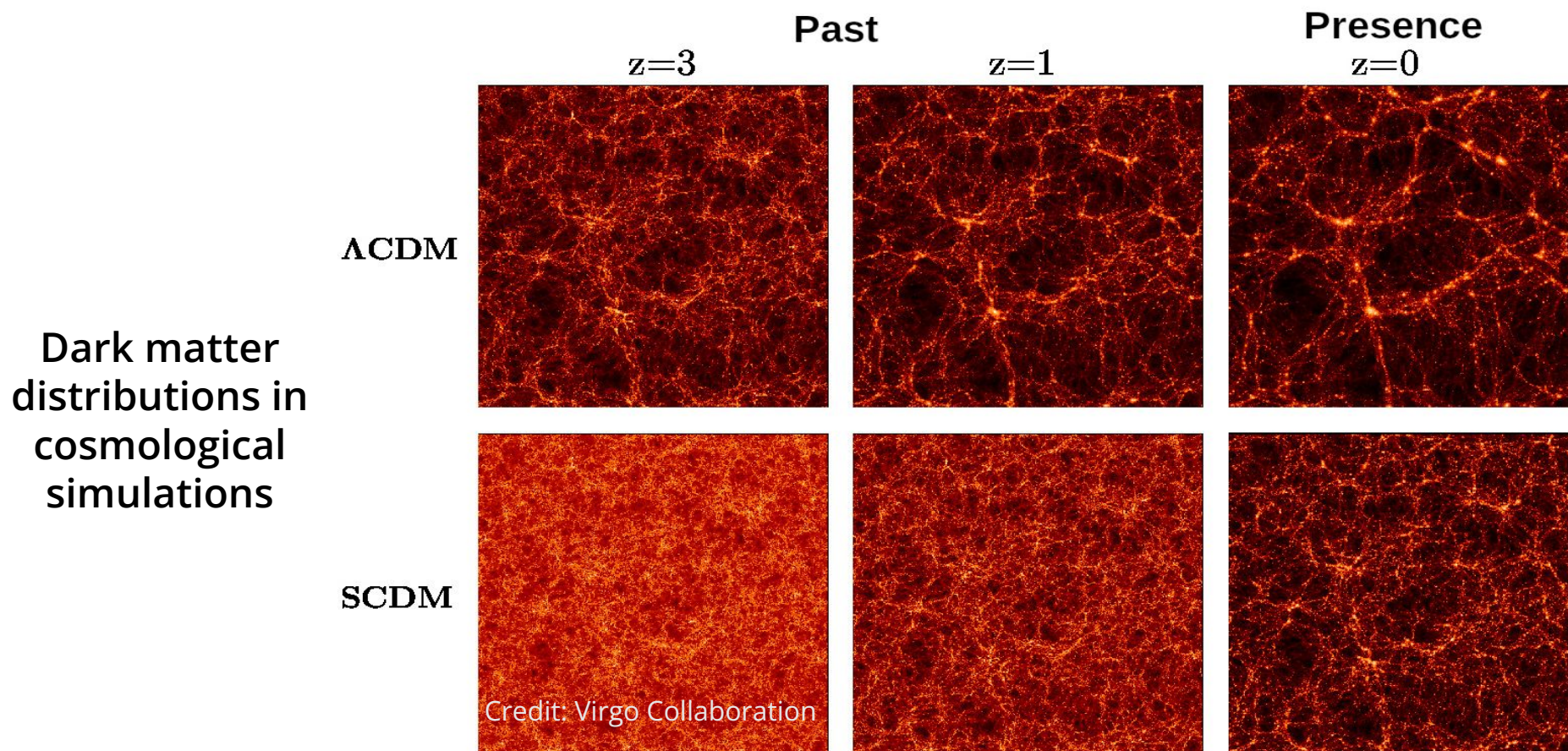
Main research field: Observational cosmology

The present-day energy budget of the Universe:



Main focus of the group: Probing cosmology via ...

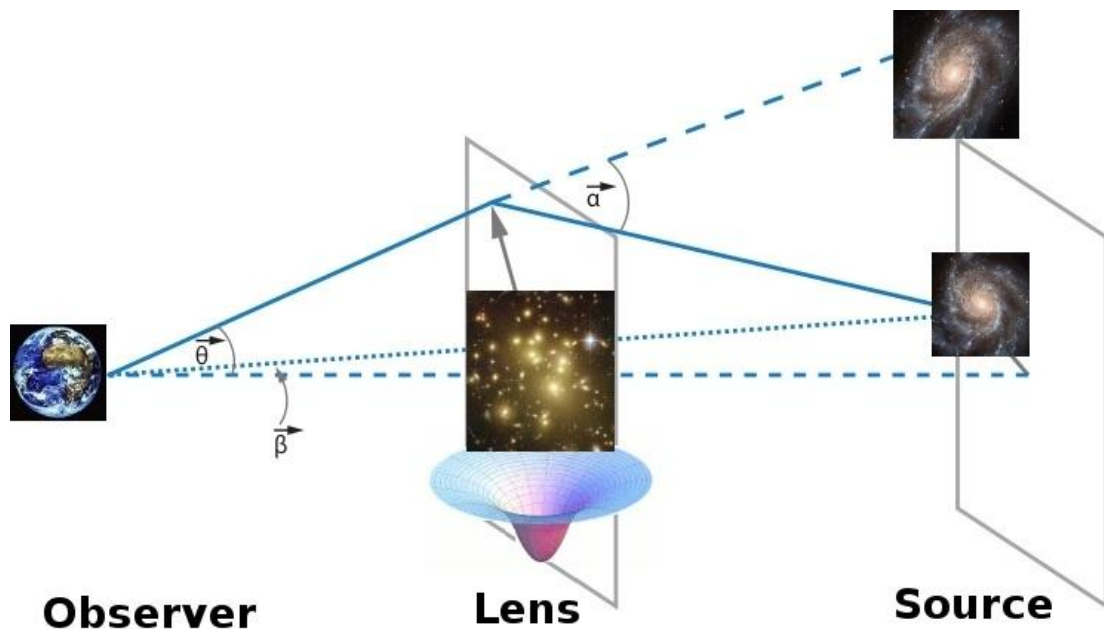
... the growth of structure



Main focus of the group: Probing cosmology via ...

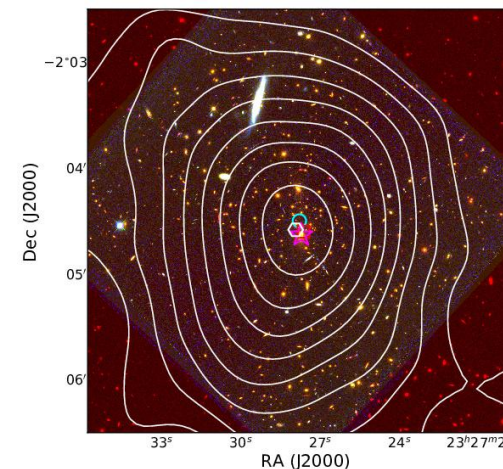
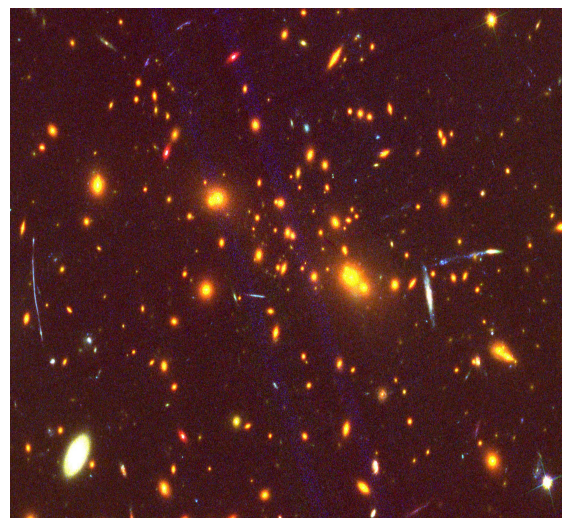
... the growth of structure

+ weak gravitational lensing

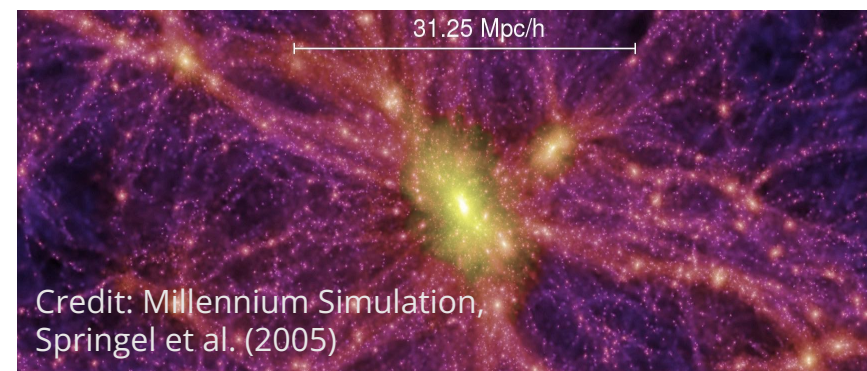


Credit: Treu 2011, NASA, Meteosat, C. Mc Allen

Galaxy cluster RCS2327-03 + lensing mass reconstruction

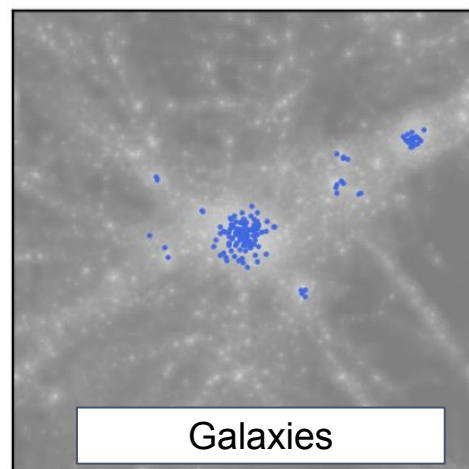
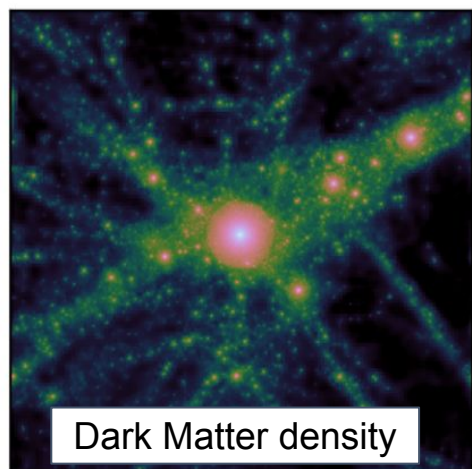


Credit: ESO / NASA / ESA / Schrabback et al. (2018b) A&A 610, A85



Credit: Millennium Simulation, Springel et al. (2005)

Topic 1: Accelerating models of the connection of dark matter and galaxies with AI

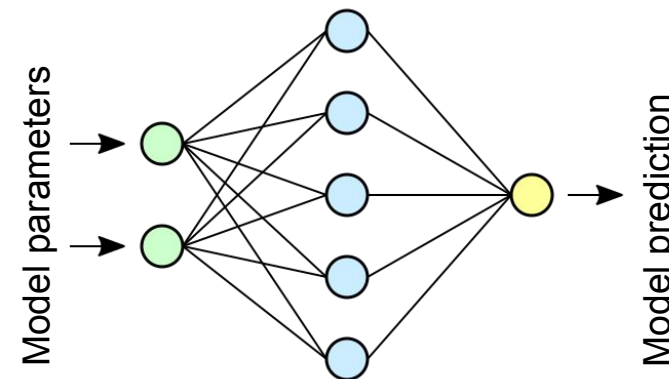


Asgari+ (2023)

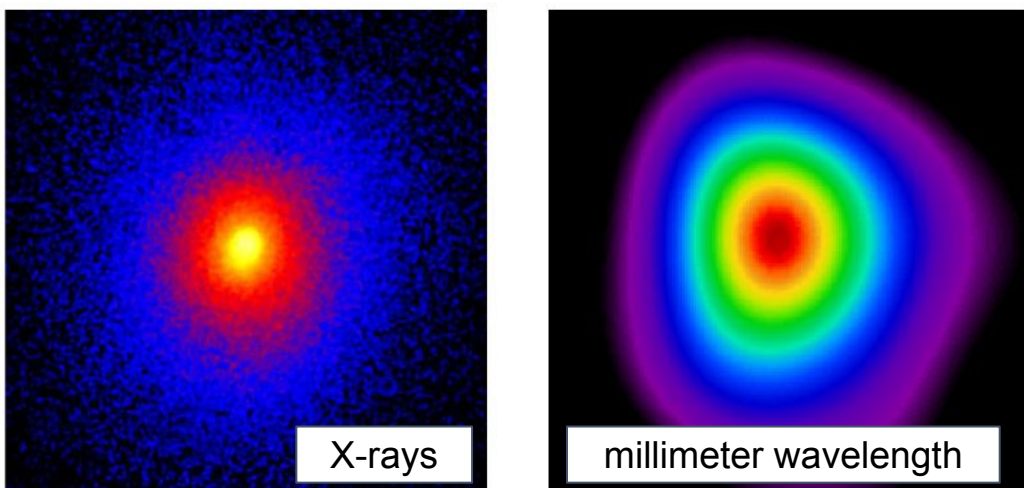
We can predict the **spatial distribution of galaxies within the dark matter distribution** and their properties with so-called **halo models**. But these models are **computationally expensive and too slow for upcoming surveys**.

In this project you will use **machine learning methods** to accelerate the modelling with **neural-network-based emulators**.

Requirements: some python experience, experience with AI and (extragalactic) astrophysics welcome



Topic 2: Comparing the cluster selection in X-ray and millimeter wavelength

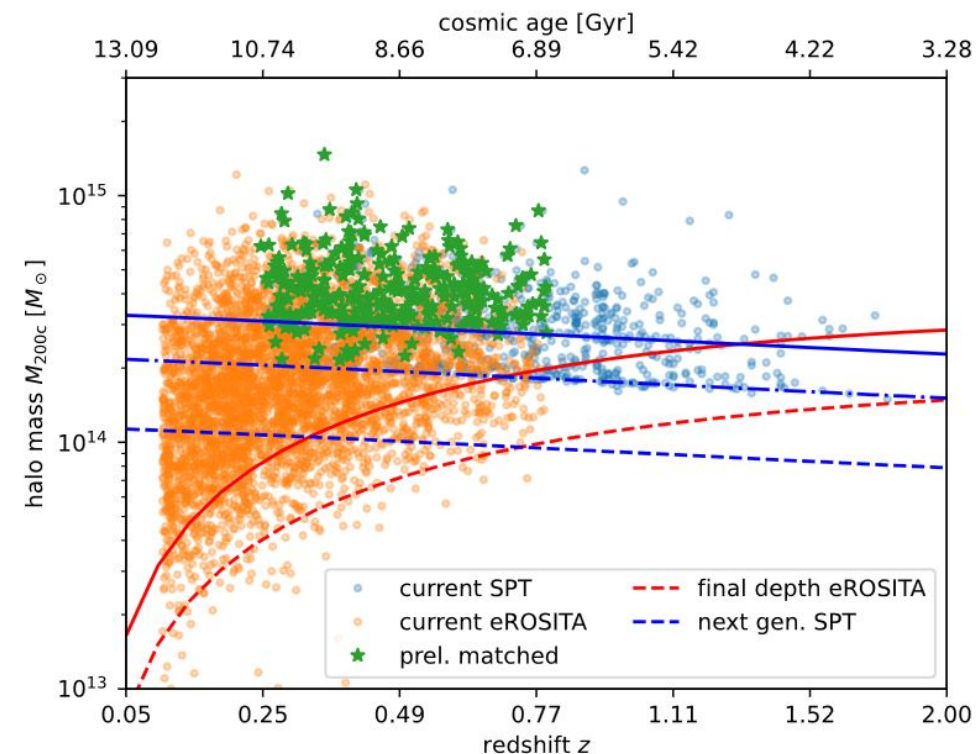


cluster Abell 1835 at redshift $z = 0.25$, viewed – from left to right – in X-ray emission, optical light, and sub-millimeter wavelength Allen+(2011, Fig. 7)

Galaxy Clusters are visible via the **hot ($>1e7$ K) plasma** they contain – both in emission in **X-rays**, and in absorption in **millimeter wavelength**.

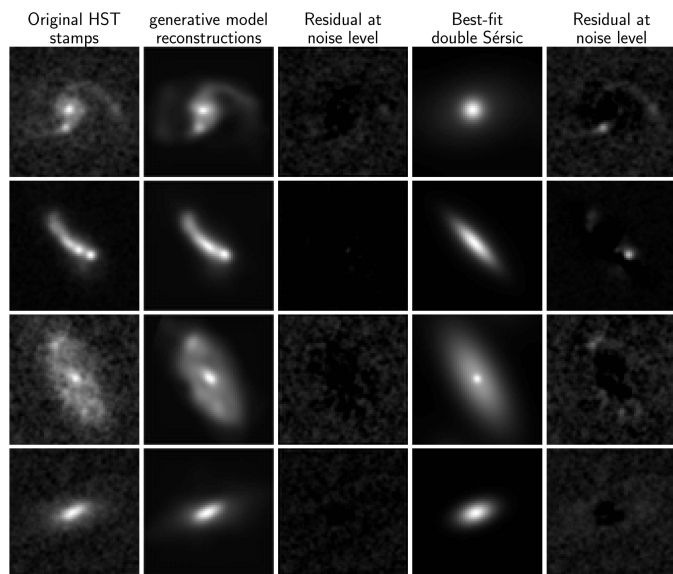
In this project you will use **Bayesian population modelling**, a generative AI algorithm used for inference

Requirements: some python experience, experience with AI, (extragalactic) astrophysics, and statistical inference welcome



Topic 3: Determining the impact of visual+infrared galaxy morphology on color distributions with AI

The **morphology of galaxies** varies with wavelength -> this impacts how distributions of **galaxy colors** are measured, which has to be accurately **simulated** for next generation cosmological surveys.



Csizi et al. 2024
<https://arxiv.org/pdf/2409.07528>

In this project you will use a **deep learning generative model** to create **simulated images of galaxies** in multiple filter bands and measure their colors.

Requirements: some python experience, experience with AI and (extragalactic) astrophysics welcome

