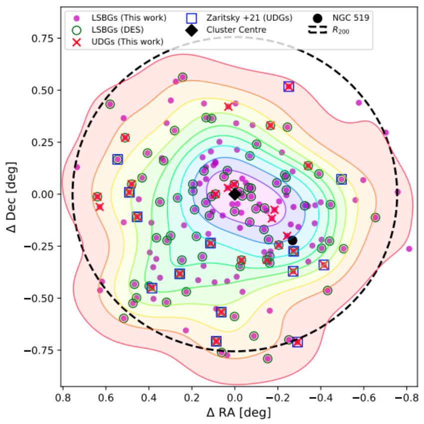
Undercovering low surface brightness galaxies



Spatial distribution of LSBGs and Ultra Difuse Galaxies in the Abell 194 cluster from Thuruthipilly et al. 2025.

SUMMARY.

The star formation history (SFH) of galaxies is characterised by the current rate of formation of young stars and the mass of already mature individuals. However, there are very faint galaxies that are almost invisible (darker than the night sky), and we cannot study their SFH. These galaxies are very diffuse and usually much larger than the well-known galaxies we observe in the beautiful images from the Hubble Telescope or the new James Webb Space Telescope.
This project focuses on estimating the physical properties of LSBGs. It involves machine learning algorithms for selections, visual inspection and broadband photometry fitting, also using spectroscopy to calculate redshift, and lines.

`$ make package`

OBJECTIVES

- The student will learn the physical properties of LSBGs.
- The student will learn how to run machine learning algorithms on the sky survey images, fit the spectral energy distribution (SED) of galaxies using the Code Investigating GALaxy Emission (CIGALE, Boquien et al. 2019) tool, and reduce and analyse spectral information.

INSTITUTE

- National Centre for Nuclear Research, Astrophysics Division
- Institute URL
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THEORY

by Katarzyna Małek

The project focuses on the physical analysis of galaxies - from detection to uncovering their physical properties. The student will learn what information about galaxies is hidden in different wavelength ranges and what can be measured using galaxy spectra (both from broadband photometry and spectroscopy).

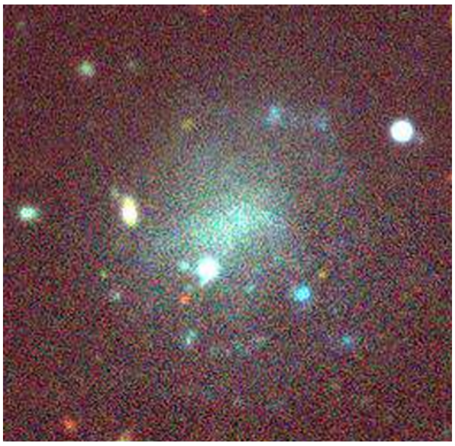
APPLICATIONS

by Hareesh Thuruthipilly & Antonio Vanzanella

How can we use machine learning algorithms to detect LSBGs? How important is visual inspection?

The student will visually classify a set of LSBGs. If available, in the next step, the student will use spectra to calculate redshift and confirm the classification. From the spectra, the student will use emission lines to estimate the star formation rate. In the final step, the student will use information from broadband photometry to construct the SED and model it using the CIGALE tool.

If the spectra is not available for newly classifed LSBs - we will use already obtained spectra to teach the student how to reduce spectra and how to measure spectrosopic redshift, and fluxes of emission lines.



An exemplary LSBG found by Thuruthipilly et al. 2024 using a Transformer machine learning model based on the DES data.

MAIN PROGRESSION STEPS

- `Tier 1`: introductions to the galaxy morphology and evolution, and machine learning + runs Visual Inspection of LSBs
- `Tier 2`: introduction to the galaxy spectral energy distribution fitting + first runs with CIGALE for LSBs
- `Tier 3`: introduction to spectra reduction + redshift measurements for LSBs

EVALUATION

- `Theory grade [30%]`
  - Presentation of article during internal Journal Club (30%)
- `Practice grade [30%]`
  - seminar for Astrophysics Division or the PhD seminar (40%): the main goal of the project, main results, future perspectives
  - Project (60%): evaluation of the project based on the weekly reports, meetings
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- Thuruthipilly et al. 2024
- Małek et al. 2024
- Junais et al. 2023
- Boquien et al. 2019

CONTACT

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