

II. semester report

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Thesis title: Advanced morphological analysis of spiral galaxies in the LSST era

Research activities in the semester

In the second semester, I worked on further developing the Python-based morphological analysis library.

At this time, the main focus was primarily on making it more modular and more robust. The modular nature makes it easier to adapt the code to new sources of data; while the robustness aims to reduce the amount of cases where it could yield inaccurate morphological metrics across the various data sources.

The upgraded library was evaluated by integrating it against the Rubin Science Platform [1], and evaluating it on the data previews so far released by the LSST [2] survey.

This involved figuring out a reliable way to query their preview catalog for galaxies (i.e., filtering for extended light sources and eliminating false positive matches that merely appear to be extended, such as overexposed foreground stars). The resulting query strategy will also be useful for extending the galaxy catalog used in the LIGO collaboration for localizing gravitational wave sources [3], once regular LSST data releases become available.

Additionally, new features were also added to the library:

- A more automated approach was introduced to various procedures which previously relied on some parameter's value being assumed or manually provided.
- The concentration index [4] was implemented as another morphological metric calculated by the code.
- Improvements were made in the way galaxy images are displayed: the displayed pixel brightness values are automatically scaled (in a non-linear way, if needed) to better map to the range of values where a human eye can appreciate the fainter features while also keeping the central bright bulge area from being overblown. Also, a histogram of the pixel intensities can also be displayed, e.g., to aid in manually optimizing the display parameters, if required.

Publications

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Completed courses

- [FIZ/5/021] Gravitational wave astrophysics (Gravitációshullám-asztrófizika)
- [csgalcsi12g17em] Galactic astronomy 2 (Galaktikus csillagászat 2)
- [apextgal17em] Extragalactic astrophysics (Extragalaktikus asztrófizika)

Participation in conferences

- Talked at: Konkoly Extragalactic Workshop 2026, Konkoly Observatory, Budapest, Hungary. (Presentation title: “Advanced morphological analysis of spiral galaxies in the LSST era”)
- Attended: LSST Workshop on Rubin Science Platform, Konkoly Observatory, Budapest, Hungary
- Attended (online): Rubin Galaxies Science Collaboration meeting, Paris, France

References

- [1] William O’Mullane et. al. “Rubin Science Platform on Google: the story so far”. In: *Proceedings of ADASS XXXI 2021, ASP Conference Series 535* (May 2024), pp. 227–230. DOI: 10.48550/ARXIV.2111.15030. arXiv: 10.48550/arXiv.2111.15030.
- [2] Željko Ivezić. “LSST: From Science Drivers to Reference Design and Anticipated Data Products”. In: *The Astrophysical Journal* 873.2, 111 (Mar. 2019), p. 111. DOI: 10.3847/1538-4357/ab042c. arXiv: 0805.2366 [astro-ph].
- [3] Gergely Dályá et. al. “GLADE+: An Extended Galaxy Catalogue for Multimessenger Searches with Advanced Gravitational-wave Detectors”. In: *Monthly Notices of the Royal Astronomical Society* 514 (July 2022), pp. 1403–1411. DOI: 10.1093/MNRAS/STAC1443. arXiv: 10.48550/arXiv.2110.06184.
- [4] Stephen M. Kent. “CCD Surface Photometry of Field Galaxies. II. Bulge/Disk Decompositions”. In: *Astrophysical Journal Supplement* 59 (Oct. 1985), p. 115–159. DOI: 10.1086/191066.