

# Posudek práce

předložené na Matematicko-fyzikální fakultě  
Univerzity Karlovy

- posudek vedoucího  posudek oponenta  
 bakalářské práce  diplomové práce

Autor: Bc. Vojtěch Partík  
Název práce: Exploring Galaxy Evolution in the Virgo Cluster  
Studijní program a obor: Physics, Astronomy and Astrophysics  
Rok odevzdání: 2024

Jméno a tituly oponenta: doc. Michal Švanda  
Pracoviště: Astronomical Institute of Charles University  
Kontaktní e-mail: svanda@asu.cas.cz

## Odborná úroveň práce:

- vynikající  velmi dobrá  průměrná  podprůměrná  nevyhovující

## Věcné chyby:

- téměř žádné  vzhledem k rozsahu přiměřený počet  méně podstatné četné  závažné

## Výsledky:

- originální  původní i převzaté  netriviální kompilace  citované z literatury  
 opsané

## Rozsah práce:

- veliký  standardní  dostatečný  nedostatečný

## Grafická, jazyková a formální úroveň:

- vynikající  velmi dobrá  průměrná  podprůměrná  nevyhovující

## Tiskové chyby:

- téměř žádné  vzhledem k rozsahu a tématu přiměřený počet  četné

## Celková úroveň práce:

- vynikající  velmi dobrá  průměrná  podprůměrná  nevyhovující

### **Slovní vyjádření, komentáře a připomínky oponenta:**

This master's thesis investigates galaxy evolution within the Virgo Cluster, focusing on the role of neutral hydrogen (HI) in this process. The study utilises data from the Widefield Arecibo Virgo Environment Survey (WAVES) and compares it with another region in the Virgo Cluster, VC1. Key findings indicate that the WAVES region is more relaxed, with indications of dwarf irregular galaxies evolving into dwarf ellipticals due to gas loss. The research also establishes constraints on the HI mass of early-type galaxies in the studied area.

The thesis covers 126 numbered pages and is structured into 5 chapters, also including an appendix with HI spectra and renzograms for all discussed objects. The text opens with a comprehensive introduction, outlining the properties, classification, and evolution of galaxies. The next chapter describes the observations available to the candidate, emphasizing the radio observations by the Arecibo radiotelescope. The methodology used is also briefly described. In section 3, the principal results are presented. These results are discussed in section 4, and the thesis concludes with section 5.

I find the thesis well and concisely written, despite the focus on data processing and analysis, which means that the thesis consists of "selected chapters from Virgo-cluster observations." The author examines the data from different viewpoints, attempting to create a comprehensive picture of galaxy evolution within the Virgo Cluster. Such a goal is very ambitious and, in my opinion, not entirely achievable within a master's thesis.

#### **Strengths:**

- **Comprehensive data analysis:** The thesis stands out for its extensive use of observational data from both radio and optical sources, combining information from the Arecibo telescope and surveys like SDSS and NED. This comprehensive approach allows for a detailed examination of the HI content in various galaxy types within the cluster.
- **Detailed cataloguing:** The creation of a catalog of HI sources, including detected and non-detected objects, is a significant contribution. This catalog provides a foundation for future studies and helps contextualize the findings within the broader framework of galaxy evolution.
- **Clear presentation of results:** The results section is well-organized, presenting clear statistical analyses of the spatial, velocity, and morphological distributions of galaxies. The inclusion of specific case studies and peculiar objects enriches the discussion, offering examples of the broader trends observed. The comparison between the WAVES and VC1 regions is particularly insightful, highlighting the possibly different evolutionary stages and environmental conditions within these subclusters, which are driven by galaxy evolution.

#### **Weaknesses:**

- **Uncertainties:** One of the primary weaknesses is the uncertainty in distance measurements, which may impact the accuracy of the HI deficiency trends. The scatter in HI deficiency-distance plots in figure 3.21 suggests that there is more complexity behind the scatter than a simple relation emerging from ram-pressure stripping.
- **Potential misclassification:** The potential misclassification of certain dwarf galaxies, specifically gas-rich dwarf elliptical galaxies, could skew the results. A more rigorous classification method is needed to ensure the accuracy of the proposed evolutionary models. From an outsider's point of view, the classification scheme used is not sufficiently

explained. While the author spends some time discussing the Hubble tuning fork, which he does not use, the linear classification is given only in table 1.1. A figure showing examples might help the reader a lot.

- Evidence for gas stripping processes: While the thesis suggests that gas stripping is a significant process in the evolution of investigated galaxies, the evidence provided is not entirely convincing. Some galaxies show marginal signs of gas disturbance, requiring deeper imaging or additional studies to confirm the gas removal scenarios. Fingers crossed for the indicated ALMA observing proposal.
- Methodological limitations: It is properly pointed out by the candidate in the thesis that ideally, the identification of HI sources should be done objectively using a well-elaborated automatic method. However, the candidate uses a subjective visually-manual method, which he finds more powerful. Perhaps the use of machine-learning methods would better meet the needs and requirements.

In summary, I believe that the master's thesis of Vojtěch Partík safely satisfies the requirements for a master's thesis. Therefore, I recommend it for defense and suggest grading it as excellent (výborně).

#### **Případné otázky při obhajobě a náměty do diskuze:**

The spectra stacking procedure is somewhat unclear to me. It seems to me that it might be successful only if the majority of the representatives in the sample indeed contain the sought spectral line and the Doppler shift is determined accurately. Those representatives that do not contain the HI line only lower the value of the possible signal above the rms level. Could a Monte Carlo-like selection of subsamples actually help increase the chance of a positive detection?

#### **Práci**

doporučuji

nedoporučuji

uznat jako diplomovou.

#### **Navrhuji hodnocení stupněm:**

výborně  velmi dobře  dobře  neprospěl

Místo, datum a podpis oponenta: Praha, 22. 5. 2024