

Kraków, 1.09.2024

Dr hab. Dorota Koziel-Wierzbowska  
Instytut Obserwatorium Astronomiczne  
Wydział Fizyki, Astronomii i Informatyki Stosowanej  
Uniwersytet Jagielloński  
ul. Orła 171  
30-244 Kraków  
dorota.koziel@uj.edu.pl

## **Recenzja rozprawy doktorskiej mgr Luisa Eduardoo Suelvesa**

### **Referee's report on the PhD Thesis of Mr. Luis Eduardoo Suelves entitled "Search for galaxy mergers in big sky surveys"**

#### **1. Short Description**

The doctoral dissertation of Mr. Luis E. Suelves presents a new method for identifying galaxy mergers in photometric surveys, based on the premise that galaxy interactions influence their surroundings. The research results presented in the dissertation has been published in two papers: Suelves et al. (2023) and Pearson, Suelves et al. (2022). The dissertation also introduces original data, which is intended to be published in the future.

The thesis is divided into seven chapters and two appendices. It is supplemented by a table of contents, list of references, list of figures, and list of tables.

Chapter 1 provides an introduction, where Mr. Suelves summarizes the state of the art in the following areas: 1) galaxies—their structure, morphological types, evolution, and basic photometric parameters; 2) galaxy mergers—their characteristic features and identification procedures; and 3) the procedure for photometric data reduction. Chapter 2 describes the data used in the thesis, such as SDSS DR6, Subaru/HSC, and the Galaxy Zoo (GZ) projects. In Chapter 3, Mr. Suelves explains the methods used in the project, including neural network (NN) approaches, applied decision tree techniques, visual inspection, and the HSC sky error. Chapter 4 summarizes the results of applying NN methods to identify merger candidates from photometric data, with a focus on the utility of the sky error information. Chapter 5 compiles the results of applying the method to the entire GZ DR1 catalogue, while Chapter 6 discusses the application of the method to deeper Subaru/HSC data. Chapter 7 concludes the dissertation, summarizing the project's methods, outcomes, and potential future applications.

#### **2. Contribution to the field**

The thesis presents strong evidence for the contribution of interstellar medium (ISM) and stellar matter, spread out from merging galaxies to the sky error. The neural network (NN) applied to

the SDSS DR6 photometric data successfully recovers merger classifications as determined by visual inspection. The insight that the merging process can leave a trace in the sky background parameters provides a valuable tool for identifying galaxy mergers. In the era of large sky photometric surveys, such as the SDSS and the upcoming LSST, such tools are indispensable.

### 3. Comments

#### a) Major comments

- The neural network was trained on two samples with equal size: one consisting of mergers and the other of non-mergers matched in redshift and r-band magnitude. The accuracy of the method is high, although, as shown by Mr. Suelves, there are many contaminating sources in the merger area of the  $\text{skyErr}_r$  vs  $\text{skyErr}_g$  diagram (Figure 4.11). Nevertheless, the method can be used to select samples of merger candidates and significantly reduce the number of galaxies requiring visual inspection.  
However, it would be interesting to know the number of galaxies above and below the dashed line in Figure 5.1 to estimate the reduction factor.
- Some galaxies marked with green points in the upper-right part of Figure 5.1 may be mergers that cannot be identified by visual inspection or deep machine learning methods due to the too low brightness of the expelled material. These galaxies, after cleaning from the contaminating objects, may be an interesting subject of study.
- In his thesis Mr. Suelves used a NN with different sets of photometric parameters of the SDSS galaxies to demonstrate that the sky error is the most efficient parameter for retrieving galaxy mergers. However, as the author also showed through a comparison of results obtained from deeper SDSS Stripe 82 data, the method is survey-dependent. Given the expectation that the proposed method could be modified and applied to LSST data, it would be beneficial to analyze, based on the results for SDSS DR6, SDSS Stripe 82 and Subaru/HSC data, how the method would perform with data of different resolutions and sensitivities.

#### b) Minor comments

Below I point out some of the editorial issues I came across while reading the thesis with the aim of helping to improve the future work.

- There are multiple definitions of abbreviations present in the thesis, one is sufficient. In the case of a large number of abbreviations a table of abbreviations may be useful.
- It is a good practice to use one convention of creating abbreviations: AGN – AGNs, SMBH – SMBHs, etc.
- Barred spiral galaxies are marked as SB, non-barred spiral galaxies are marked with S, consistently with Figure 1.1.
- While showing examples of morphological types it is good to choose more typical representatives.
- In the SDSS-I spectroscopic galaxy targets are those with  $r < 17.77$  mag.
- Giving more specific and meaningful chapter and section titles is advisable.

#### **4. Conclusion**

My main criticism concerns aspect of the presentation of the work. The methods developed by Mr. Suelves to analyze subtle galaxy merger effects on the photometric parameters represent the valuable contribution to the identification of the galaxy mergers. My comments, presented above, do not diminish the value of the work.

In my opinion, the doctoral dissertation of Mr. Luis Eduardoo Suelves meets the formal and customary requirements for doctoral theses. I therefore make a formal request for admission of Mr. Luis E. Suelves to further stages of his doctoral procedure.

#### **Konkluzja**

Moja krytyka dotyczy aspektów związanych z prezentacją pracy. Opracowane przez mgr Suelvesa metody do analizy danych fotometrycznych pod kątem subtelnych efektów związanych z oddziaływaniem przedstawiają cenny wkład do identyfikacji scalających się galaktyk. Moje uwagi, przedstawione powyżej, nie umniejszają wartości pracy.

W mojej opinii, praca doktorska mgra Luisa Eduardoo Suelvesa spełnia formalne i zwyczajowe wymagania stawiane rozprawom doktorskim. Wnoszę zatem o dopuszczenie mgra Luisa E. Suelvesa do dalszych etapów postępowania doktorskiego.

dr hab. Dorota Kozieł-Wierzbowska