

Ruprecht-Karls-Universität

**Detection and characterisation of open clusters  
in the Milky Way with *Gaia***

Emily Lauren Hunt



Dissertation

submitted to the  
Combined Faculty of Mathematics, Engineering and Natural Sciences  
of Heidelberg University, Germany  
for the degree of

Doctor of Natural Sciences

Put forward by

Emily Lauren Hunt  
born in: Coventry, United Kingdom

Oral examination: July 5th, 2023



# Detection and characterisation of open clusters in the Milky Way with *Gaia*

Referees: PD Dr. Sabine Reffert  
Prof. Dr. Hans-Walter Rix

**Emily Lauren Hunt**

*Detection and characterisation of open clusters in the Milky Way with Gaia*

Ruprecht-Karls-Universität, April 24th, 2023

Reviewers: PD Dr. Sabine Reffert and Prof. Dr. Hans-Walter Rix

Supervisor: PD Dr. Sabine Reffert

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Landessternwarte Königstuhl

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69117 Heidelberg

# Abstract

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## Abstract (different language)

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# Acknowledgement

Even after eight years at university, it still feels *surprising* to see myself writing this PhD thesis and reaching this stage in my life. As a child, I looked up at the planets and the stars and I saw a universe of wonder. But as a teenager, I looked around me (here on the Earth) and I felt different, outcast, and fundamentally undeserving of the future I have managed to have. This thesis is for every LGBTQ+ child who grew up thinking the world is not for them.

I will forever be eternally indebted and grateful to the many, many people without whom I would never be here.

Dr. Michelle Cuthbert, your phenomenal commitment and passion for teaching had an impact on me that I will carry with me for the rest of my life. I still remember my first lesson of Year 12 physics, where you asked those of us intending to study physics at university to raise our hands. I think one or two hands were raised, of which I was not one. You proudly remarked that you would change our minds in just eight months. By the end of Year 13, a majority of our class went on to study physics, in no small part thanks to your teaching. This thesis would never have happened had I never been exposed to your infectious passionate physics teaching.

I next thank those I know from the University of Bath where I did my undergraduate degree. Dr. Vicky Scowcroft, the summer project I did with you and your



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# Introduction

# 1

” *You can’t do better design with a computer, but  
you can speed up your work enormously.*

— **Wim Crouwel**  
(Graphic designer and typographer)

## 1.1 An observational history of open clusters

## 1.2 Open clusters in the *Gaia* era

## 1.3 Thesis Structure

### Chapter 1

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## Comparison of clustering algorithms applied to *Gaia* DR2 data

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### 2.1 System Section 1

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Fig. 2.1.: Figure example: (a) example part one, (c) example part two; (c) example part three

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## 2.3 System Section 3

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## 2.4 Conclusion

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## A census of star clusters with *Gaia* EDR3

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Fig. 3.1.: Figure example: (a) example part one, (c) example part two; (c) example part three

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## 3.2 System Section 2

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### 3.4 Conclusion

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# The dynamics of Milky Way star clusters

” *Innovation distinguishes between a leader and a follower.*

— **Steve Jobs**  
(CEO Apple Inc.)

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## 4.1 System Section 1

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information.

Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.



Fig. 4.1.: Figure example: (a) example part one, (c) example part two; (c) example part three

This is the second paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

## 4.2 System Section 2

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Fig. 4.2.: Another Figure example: (a) example part one, (c) example part two; (c) example part three

After this fourth paragraph, we start a new paragraph sequence. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A

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## 4.3 System Section 3

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### 5.1 System Section 1

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## 5.2 System Section 2

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## 5.3 Future Work

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## List of Listings



## Example Appendix

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Alpha	Beta	Gamma
0	1	2
3	4	5

Tab. A.1.: This is a caption text.

### A.2 Appendix Section 2

And after the second paragraph follows the third paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like

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## Colophon

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# Declaration

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*Heidelberg, April 24th, 2023*

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Emily Lauren Hunt

