Synergies
between
Gaia, ground observations & ML

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Before we begin…

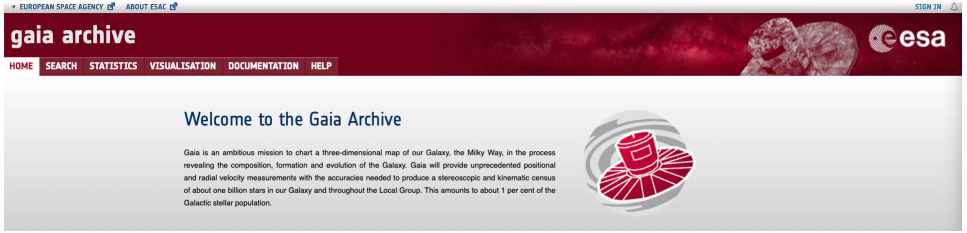
Who am I?

Gaia Archive Support Scientist(s):

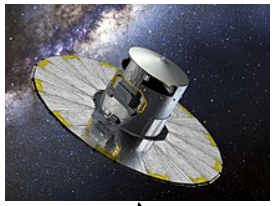
- 50% Alcione Mora
- 50% Héctor Cánovas (since January 1st)

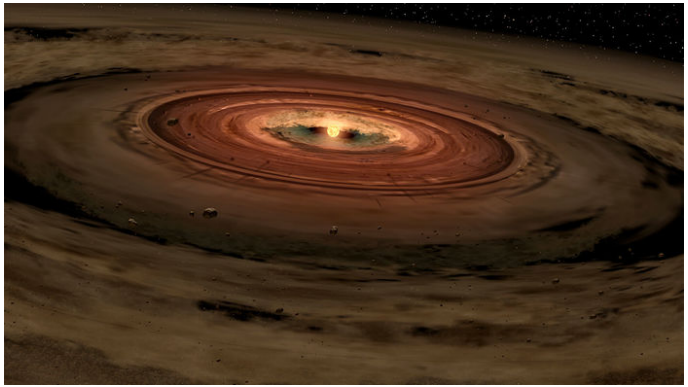
What do I want from you?

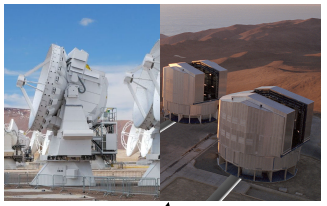
Suggestions and feedback for the Gaia Archive **(> hcanovas@sciops.esa.int)**



Case study: ProtoPlanetary Discs







Layout

What is a Protoplanetary Disc?

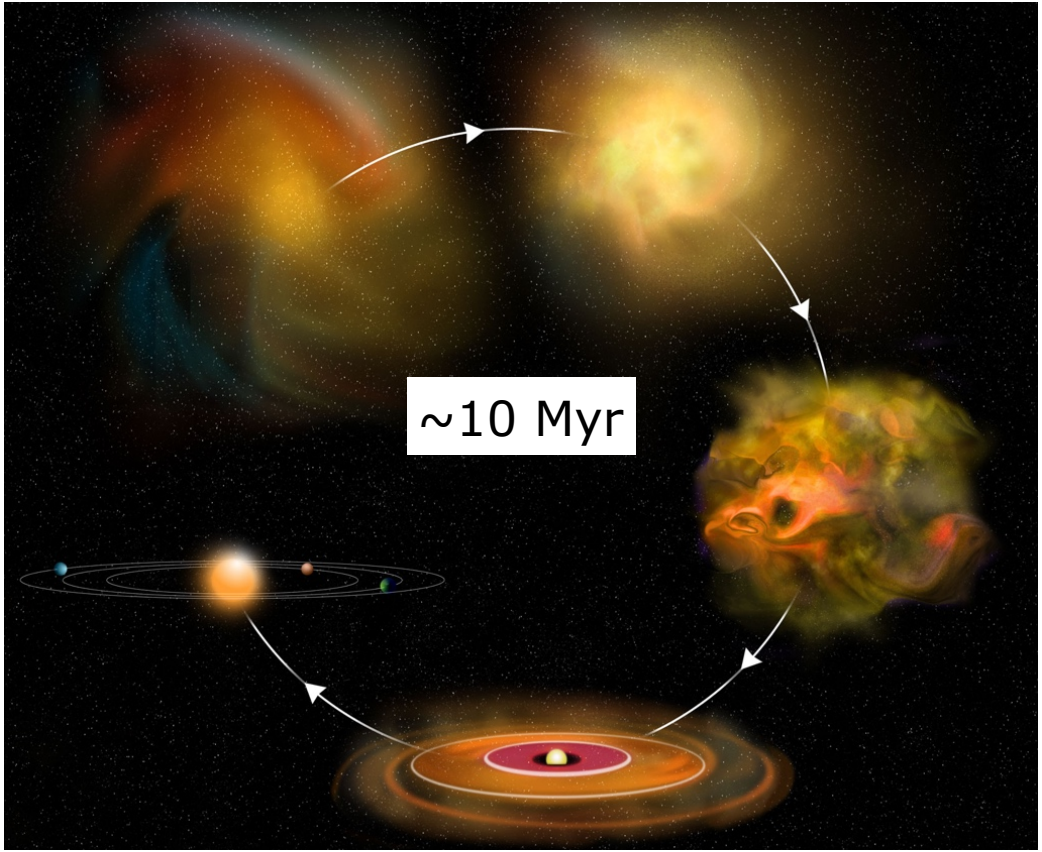
How can we study them (Gaia + Ground. Obs)

How can we find them (Gaia + ML)

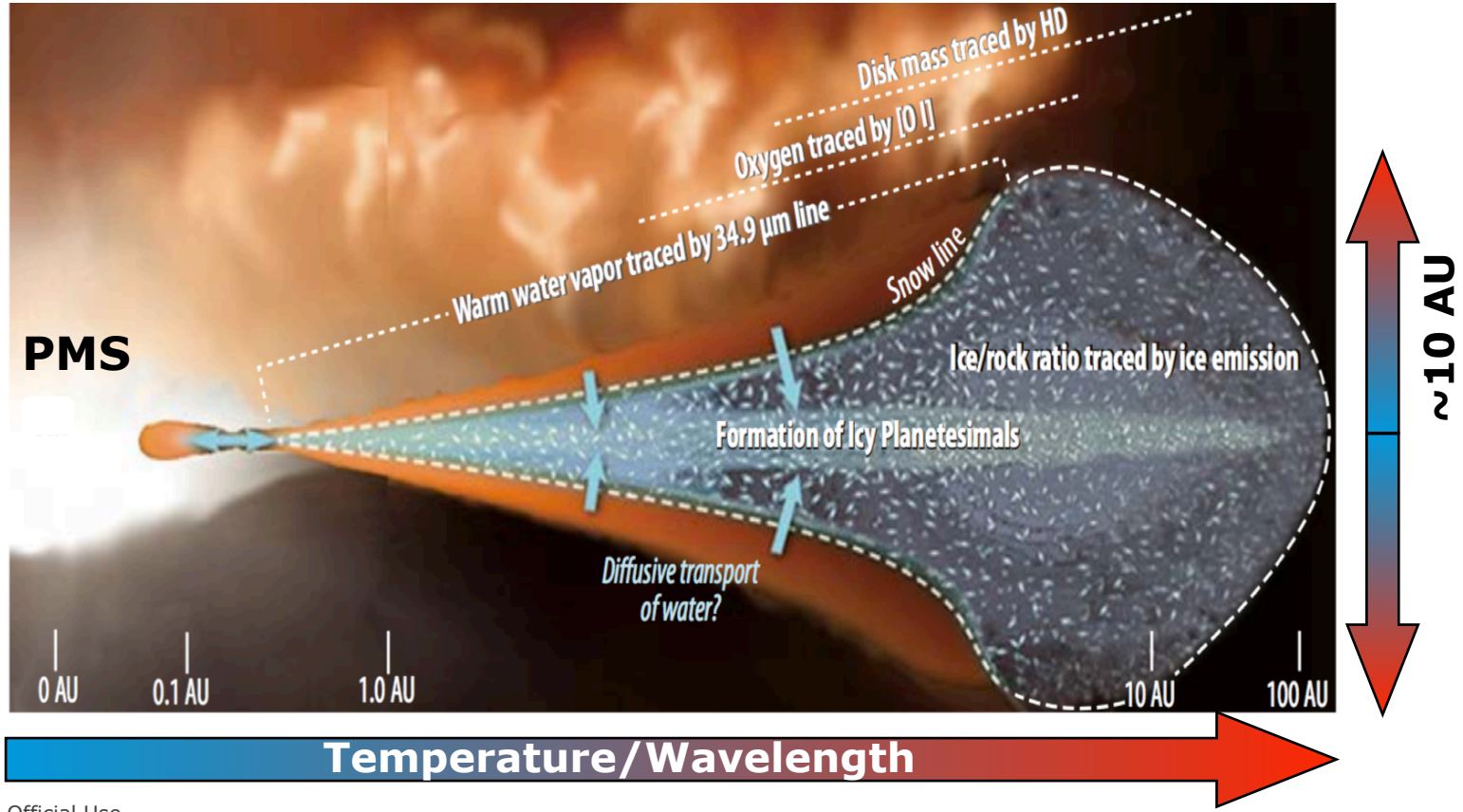
Closing the loop

What is a Protoplanetary Disc?

What is a PPdisc (I)?



What is a PPdisc (II)?

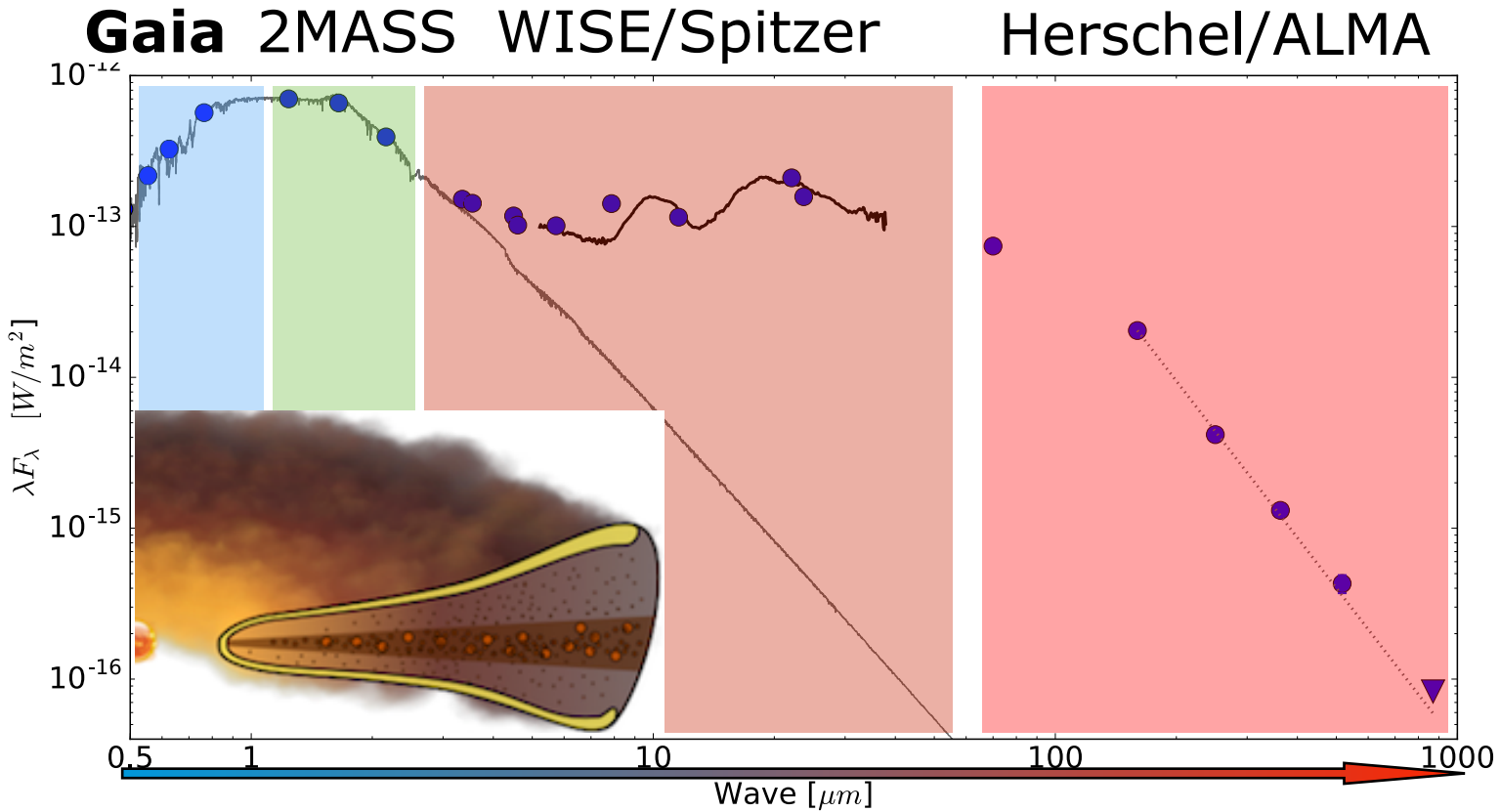


How can we study them?

PPDiscs are made of Gas (99%) & Dust (1%)

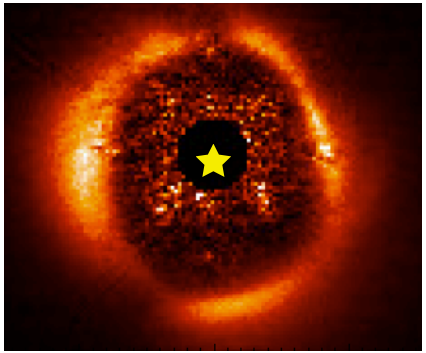
- Photometry across entire spectrum
- Spectra across the entire spectrum
- Direct Images (optical, NIR, Sub-MM, radio)

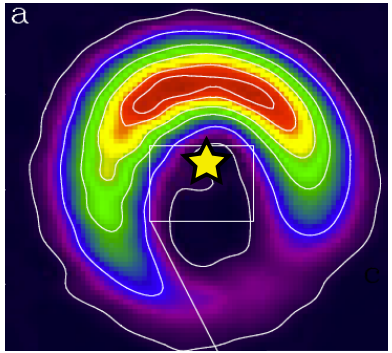
How can we study them (I)?

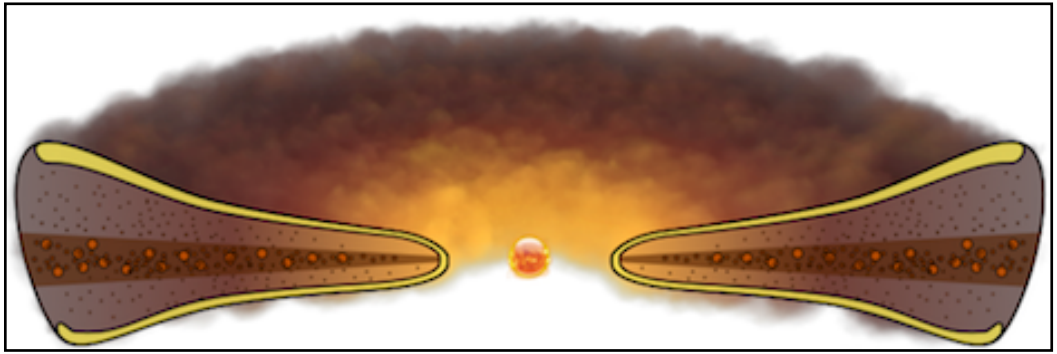


How can we study them (II)?

NIR (NaCo/VLT) Sub-mm (ALMA)





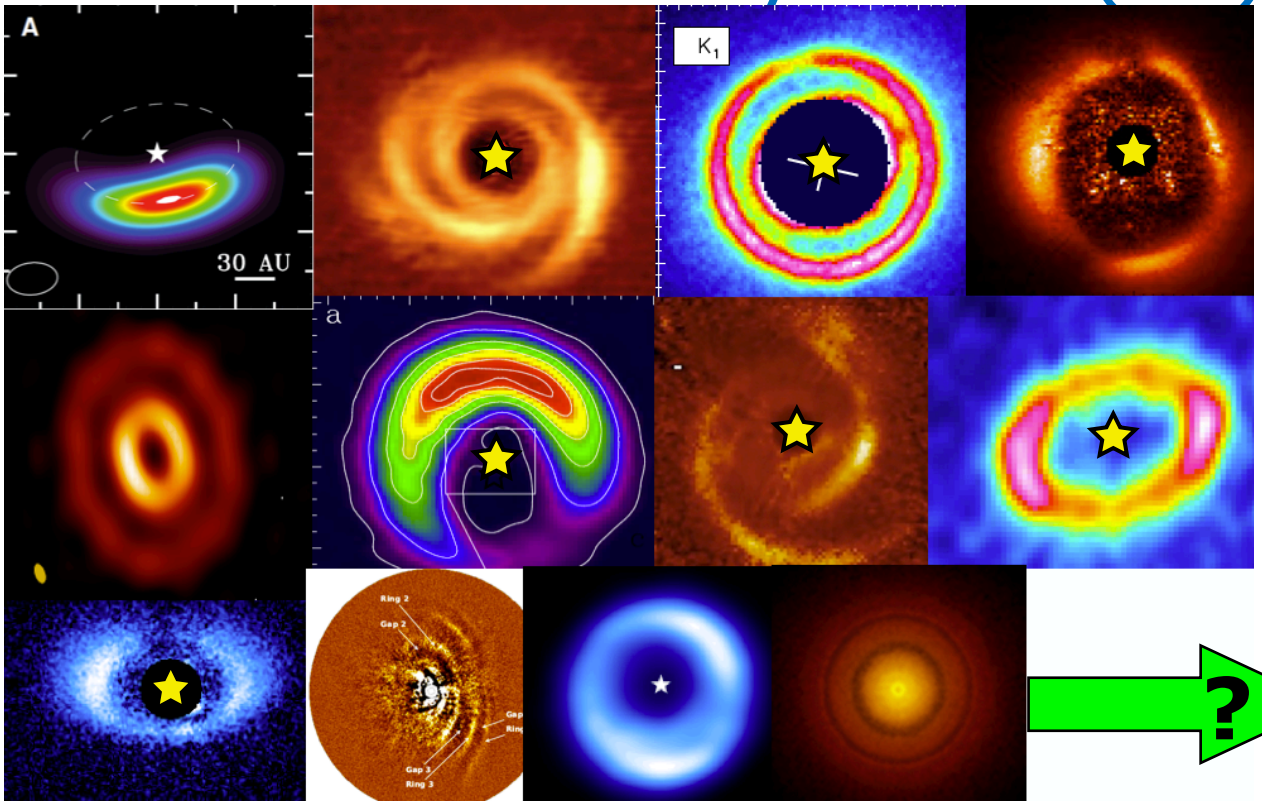


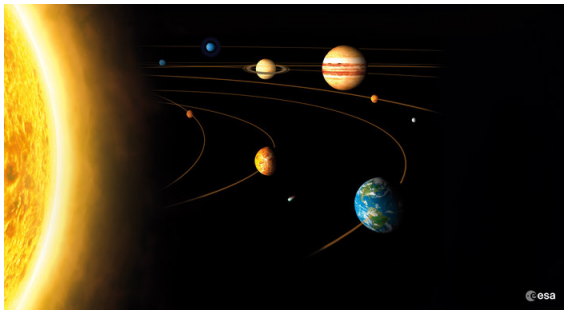
ALMA Gaia

$$M\,(\text{gas} + \text{dust}) = \frac{F_\nu d^2}{\kappa_\nu B_\nu(T)}$$

Canovas+2013, Casassus+2013

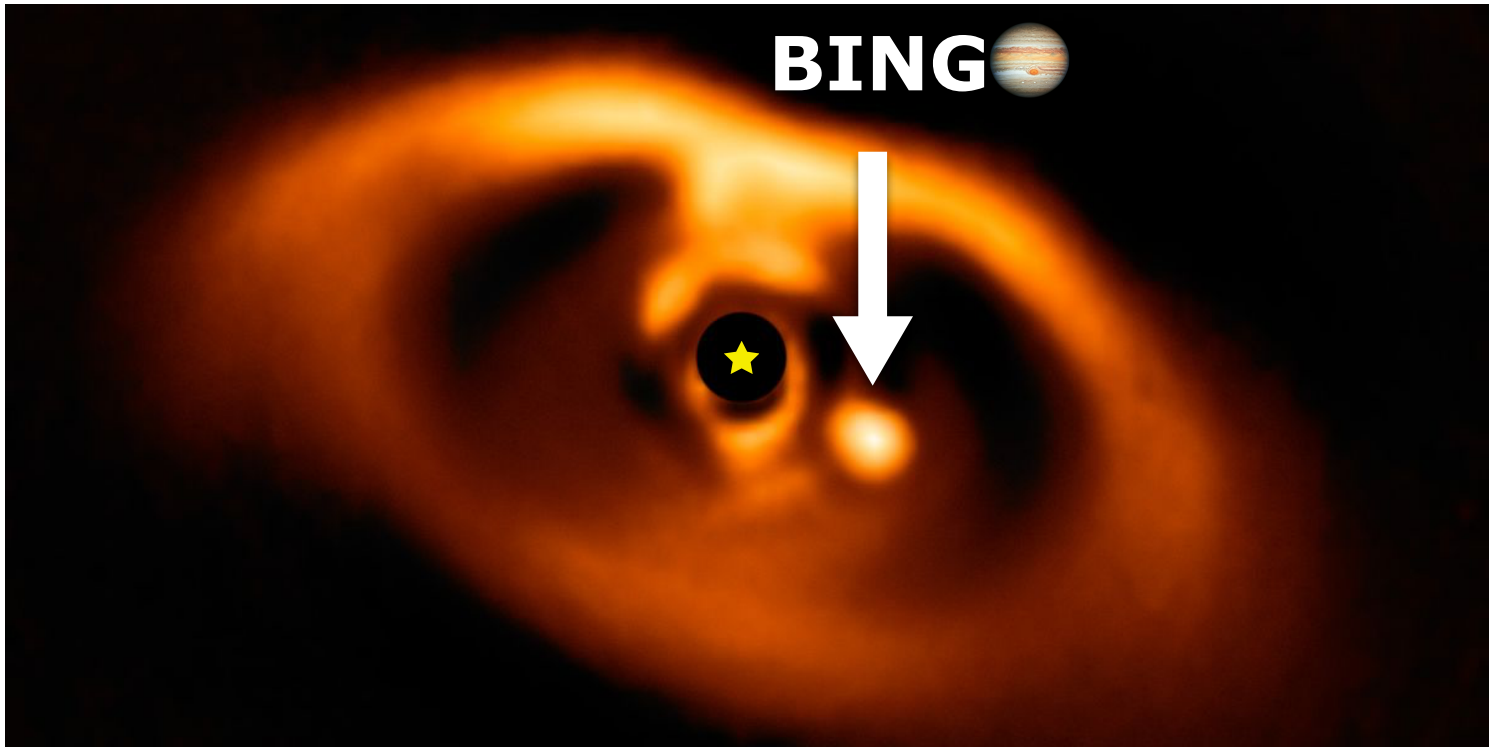
How can we study them (III)?





Canovas+2013, 2016a,b, Casassus+2013, van der Plas+2016...

How can we study them (III)?



Haffert+2019, Keppler+, Benisty+2018

How can we find them?

Or

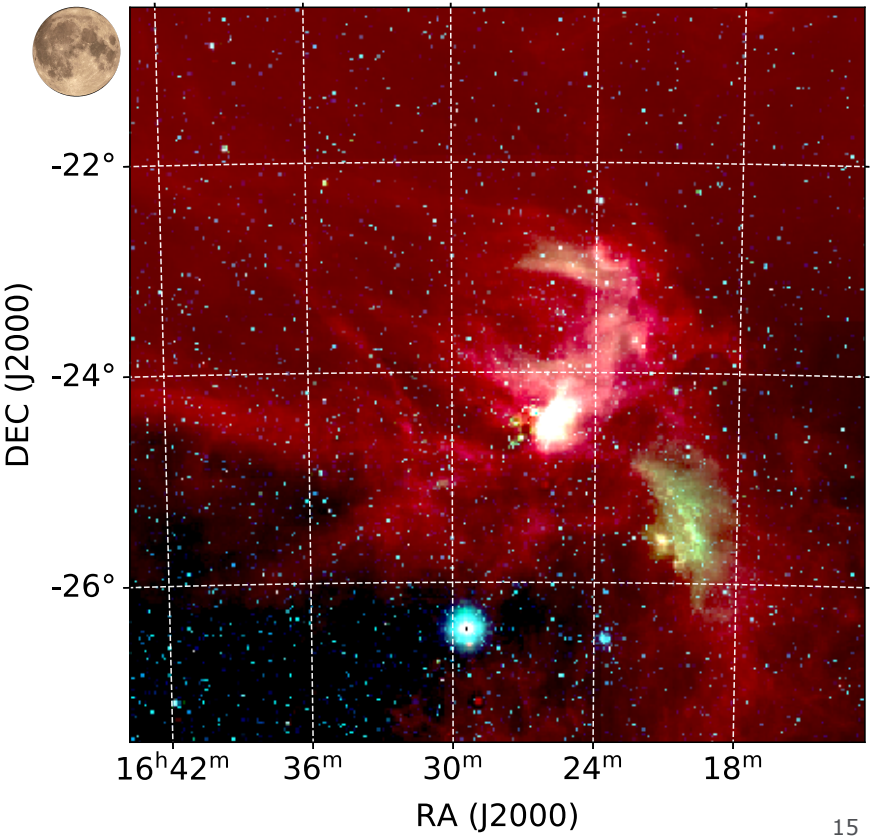
Can We find more? **YES, GAIA CAN**

How can we find them (I)?

traditionally detected via:

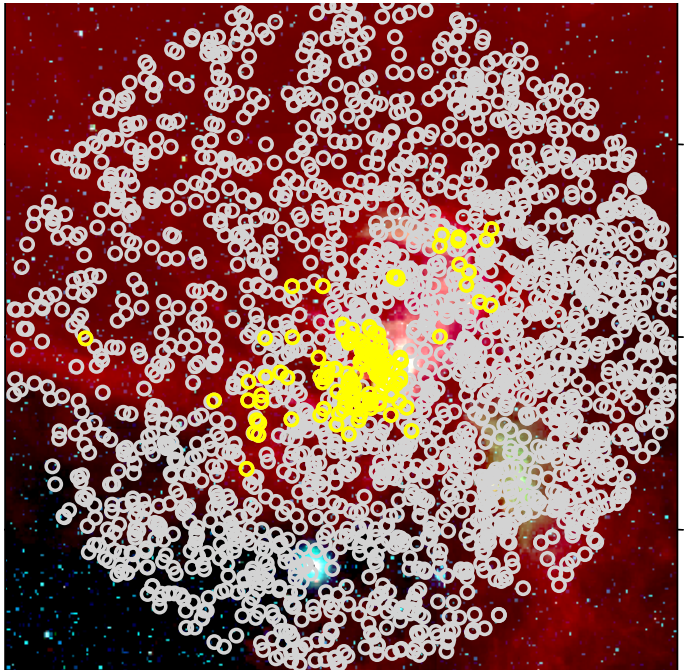
- X-rays
- Optical Spectroscopy
- IR Emission

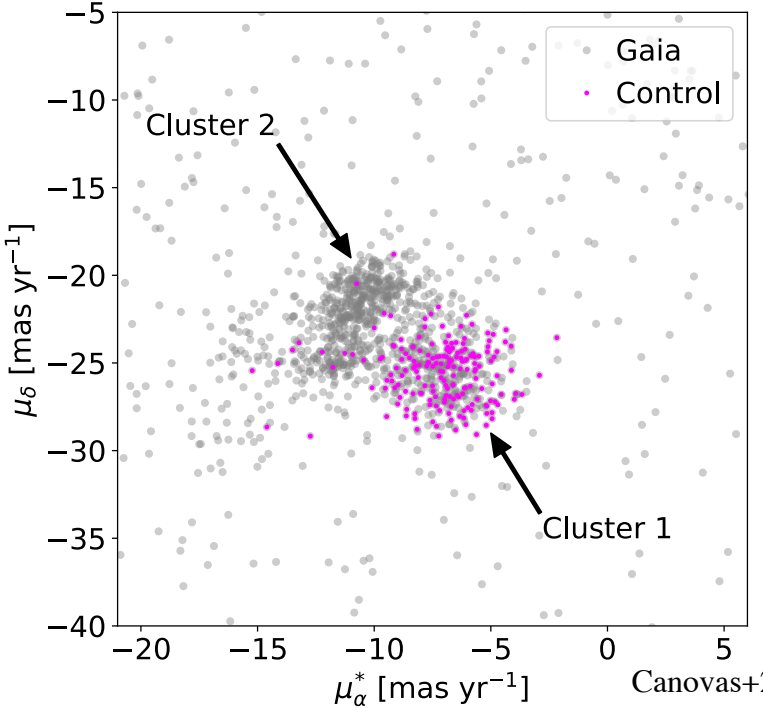
$$$ expensive $$$



How can we find them (II)?

PMS's from the same cloud are kinematically and spatially **clustered**





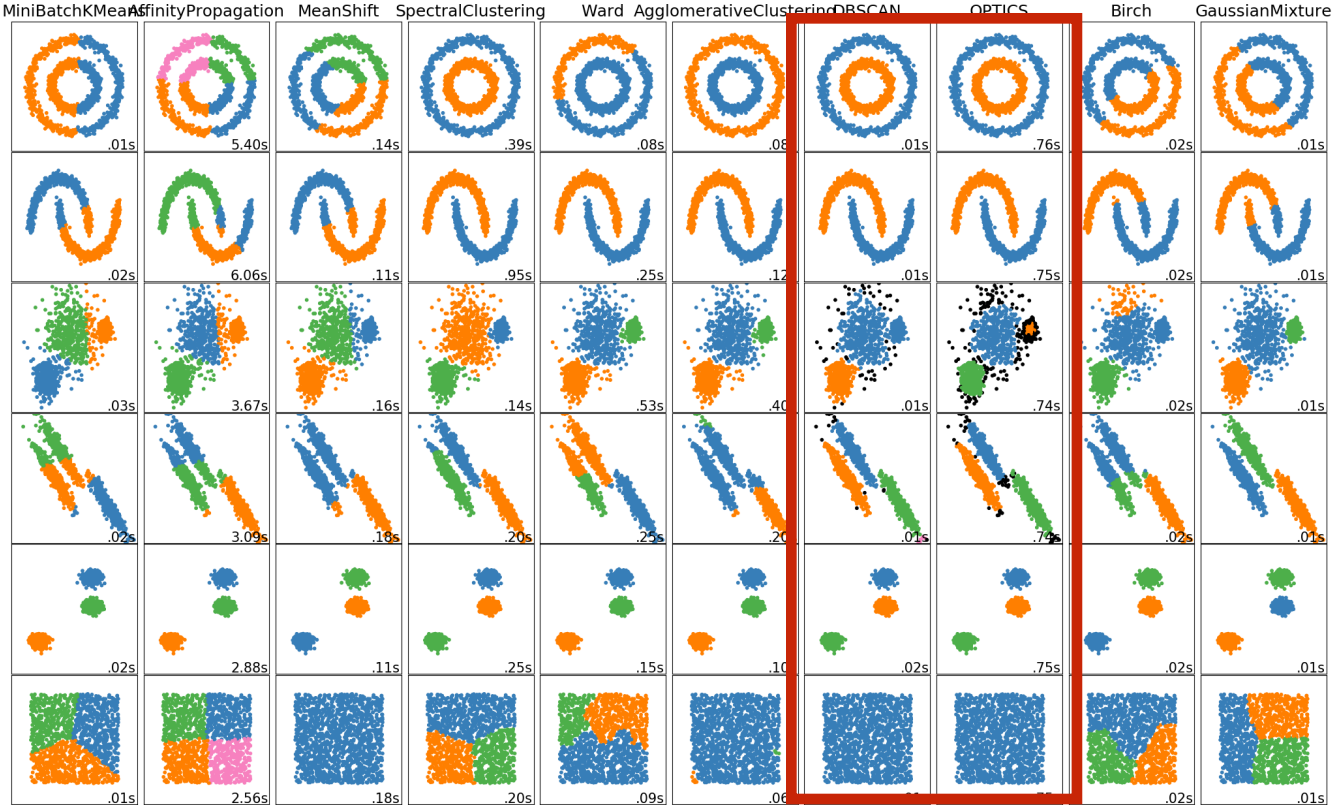
Canovas+2019

How can we find them (ML I)?

- Supervised machine learning (e.g., Neural Networks/ Random Forest) >> Recognise complex patterns (e.g., human faces)
- **Unsupervised** machine learning (e.g., Clustering Algorithms/ K-means) >> Data Mining/Cluster detection / Outliers detection

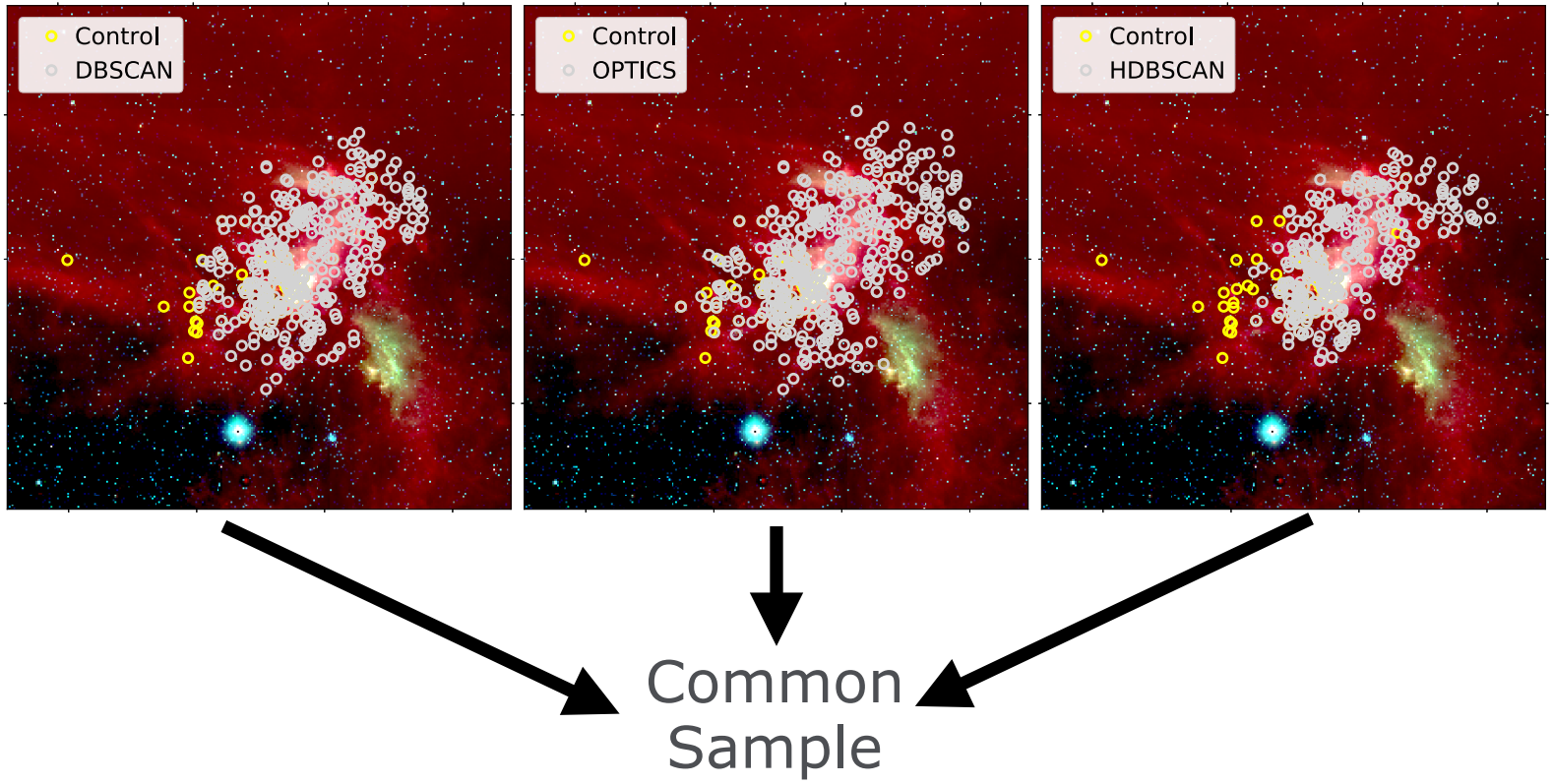
See also e.g. Cantat-Gaudin 2018, Vioque et al. (submitted), Torres et al. 2019

How can we find them (ML II)?



SciKit Learn: https://scikit-learn.org/stable

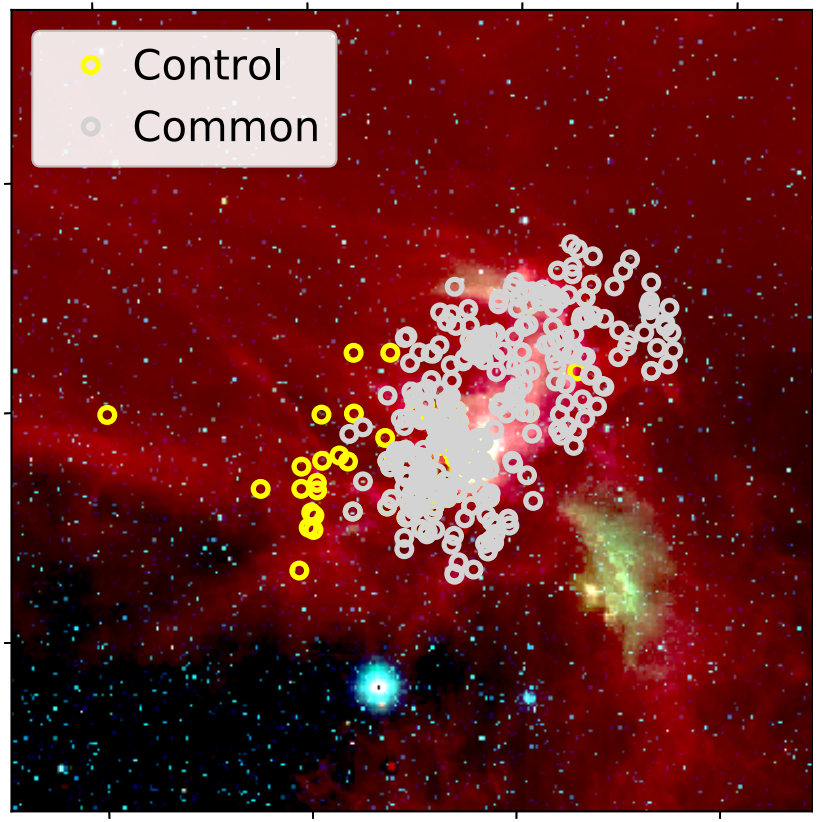
How can we find them (ML III)?



How can we find them (ML IV)?

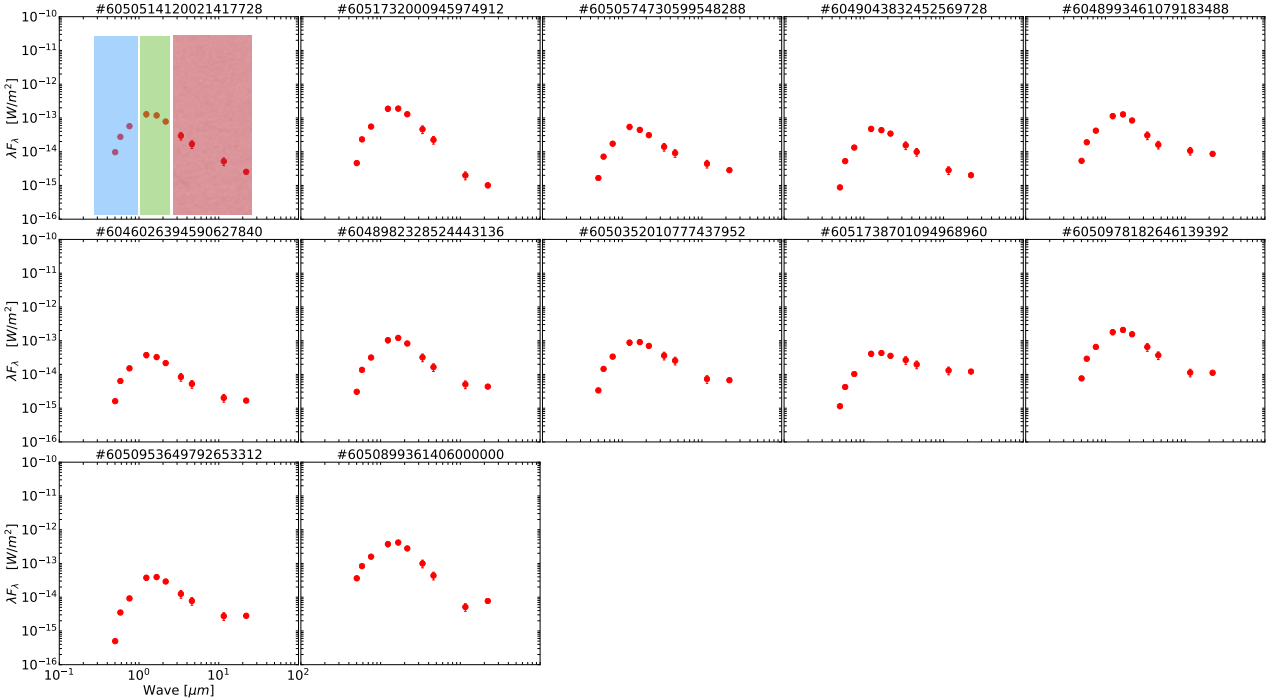
The common sample:

- 391 sources:
  - 148 > Control sample (188)
  - 243 > potential members
    - 166 > **new ones**



Closing the loop (I)

Gaia + 2MASS + WISE: 12 new discs (!!!)



Closing the loop (II)

jupyter 02_3D_distribution Last Checkpoint: 2 minutes ago (autosaved)

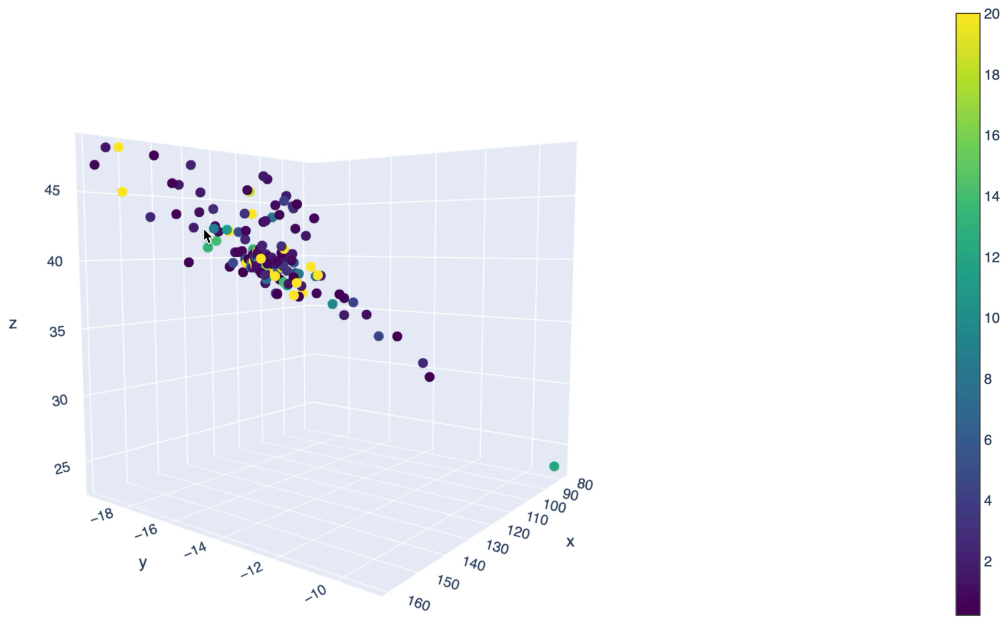
Logout

File Edit View Insert Cell Kernel Navigate Widgets Help

Trusted Python 3

Run Code

```
14 fig.show()
```



… obvious future steps…

- Obtain optical spectra from new candidates to characterise them
- Observe with ALMA (sub-mm) and/or VLT's (NIR) the new discs
- Repeat this exercise with other SFR’s…

Thanks…

And do not forget: suggestions for the Archive are more than welcome!