

# DC2 stellar masks

LSST France – CPPM Marseille

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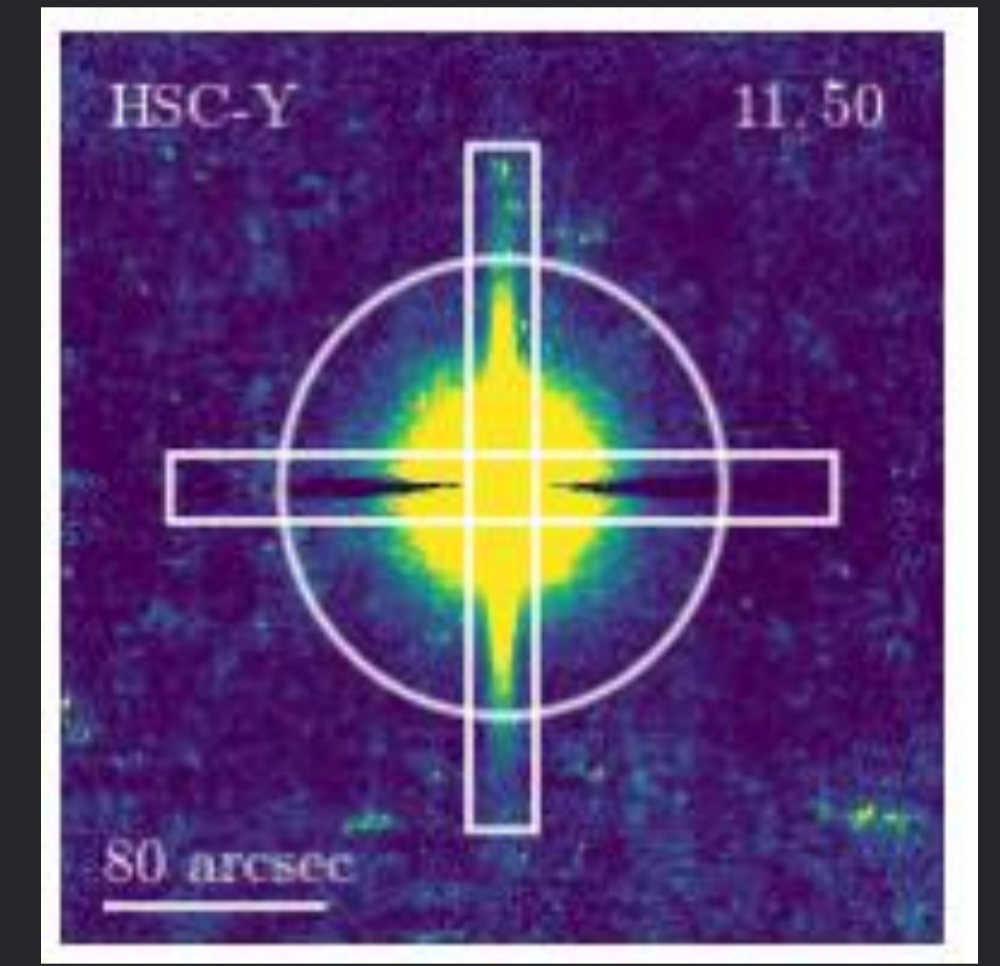
# The bright stars issue

Optical point of view

Bright stars reduce image quality by introducing optical/electronic effects such as :

- Satellite/plane trails
- Diffraction spikes
- Ghosts
- Crosstalk
- Etc...

[Coupon et al. 2017](#)



Example of a saturated star and its mask in HSC-SSP

Can introduce systematics in galaxy identification, photometry, shear measurement

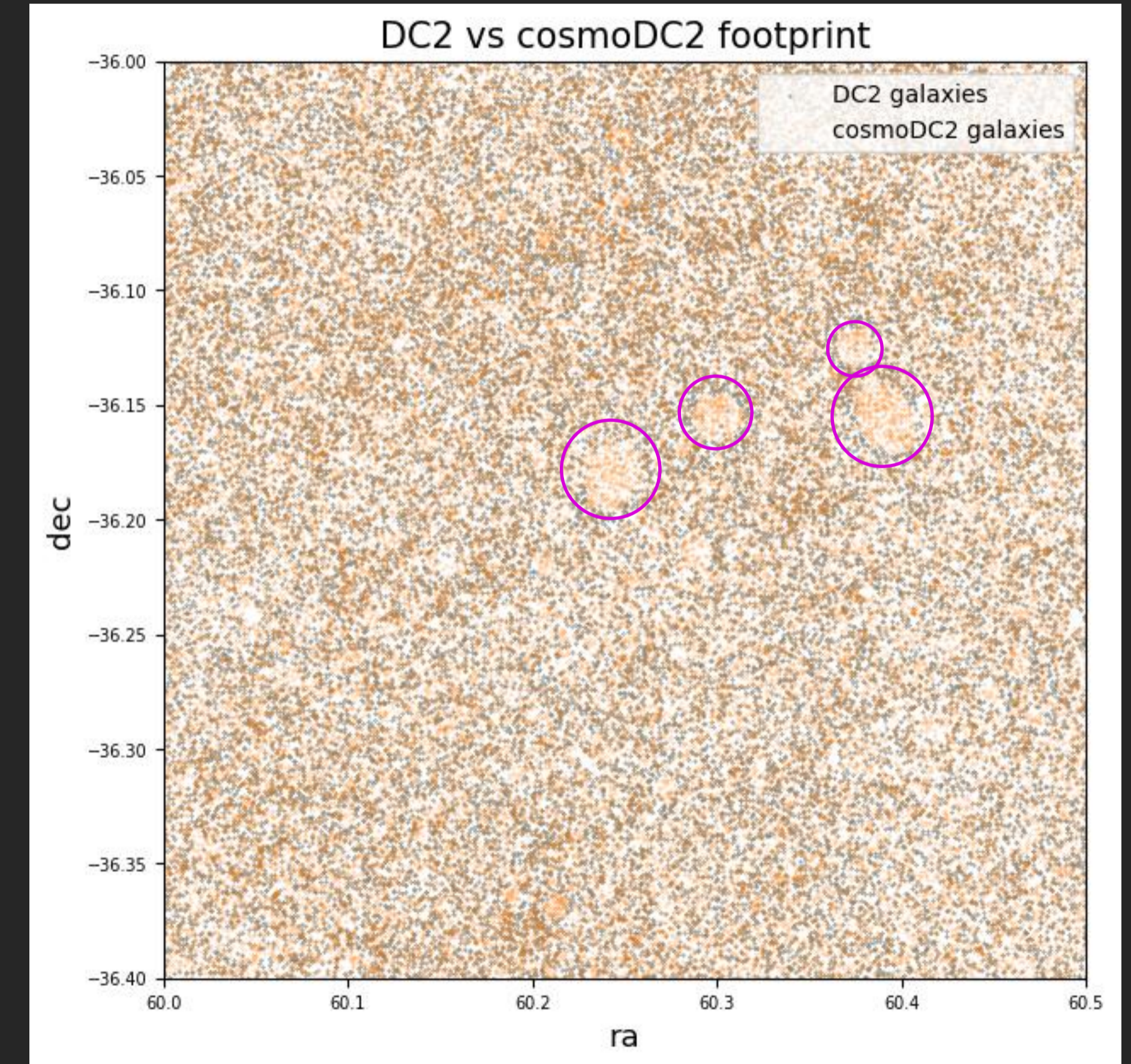
→ Concerns different working groups

# The bright stars issue

## DC2 object catalog point of view

Issues :

- Misclassification of objects
  - Holes in galaxies' footprint : no detection
  - Artifacts might be present near those holes : fake/bad detections
- May induce biases in science results

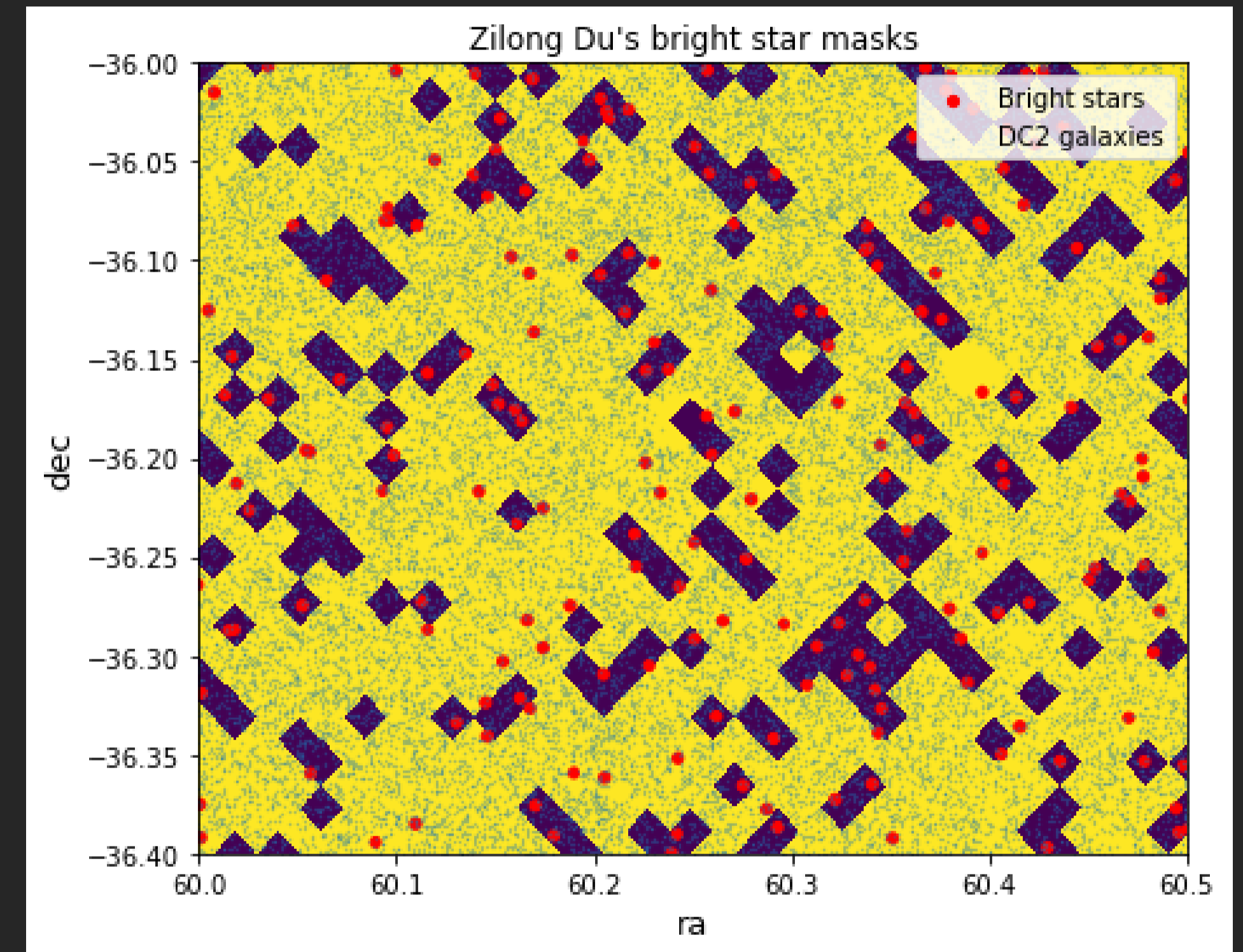


Part of DC2 tract 3830

# First DC2 masks in DESC

## Zilong Du's approach

- Context : LSS analysis
- Method based on HSC-SSP survey article [1] : adapted and described in [2]
- Masks cover  $\sim 10\%$  of DC2 area
- Low resolution
- No code available to change parameters
  - We want to build our own
- We don't expect masks to cover all visible holes : cosmoDC2 has inhomogeneities too



$N_{\text{side}} = 4096 \Leftrightarrow$  resolution  $\sim 50''/\text{pixel}$   
DC2 res  $\sim 0,2''/\text{px}$

# Building our samples

Bright objects sample : stars

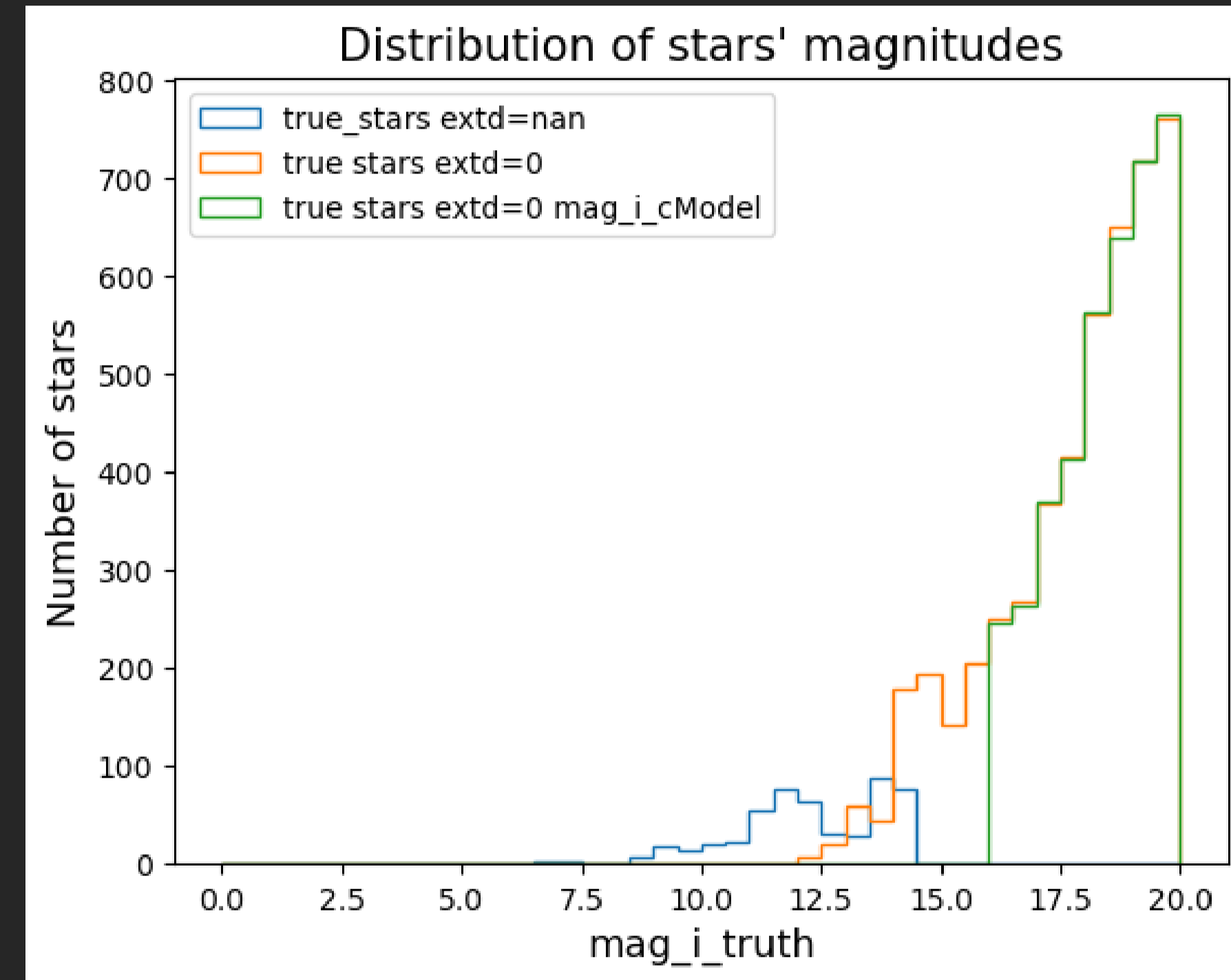
Star classification :

- extendedness estimated with  $\text{mag}_{\text{PSF}} - \text{mag}_{\text{cModel}}$
- DC2 → No estimation of PSF for brightest stars
- magnitude = nan when magnitude is “ill defined”

⇒ Issue : in this region we don't know who are true stars and what is their magnitude

→ In HSC they use external catalogs such as Tycho-2

→ In LSST we will have **monster catalog** = Gaia catalog adapted to LSST



No more star at  $\text{mag}_{\text{i\_cModel}} \leq 16$

Harsh drop

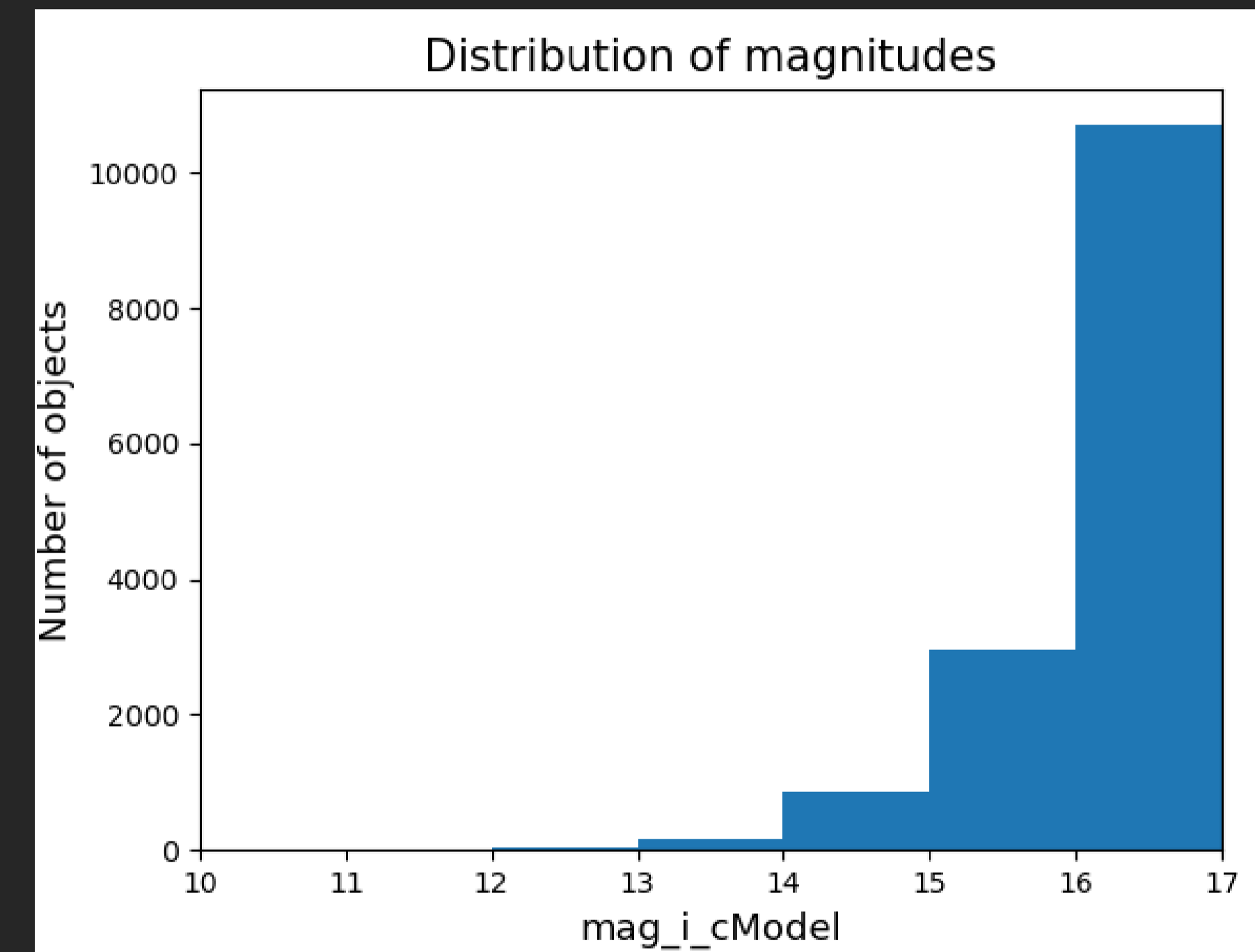
→ In DC2 we use truth quantities

# Building our samples

## Bright objects sample : galaxies

- Largest holes in DC2 footprint caused by bright galaxies.
- Bright galaxy classification :
  - Appear to be less chaotic than bright stars
  - Still has impurities
  - We won't have external bright galaxies catalog
- Bright galaxies may be indicators to the presence of a cluster

We have to be careful when using this sample for masks!



# Building our samples

We want the brightest objects

## Galaxies :

- Keep selection efficiency  $> 95\%$   $\rightarrow \text{mag}_i \text{ cModel} \in [17, 25.3]$
- Using DC2 quality flag 'clean' : object has no flagged pixels
- extendedness = 1

## Bright objects :

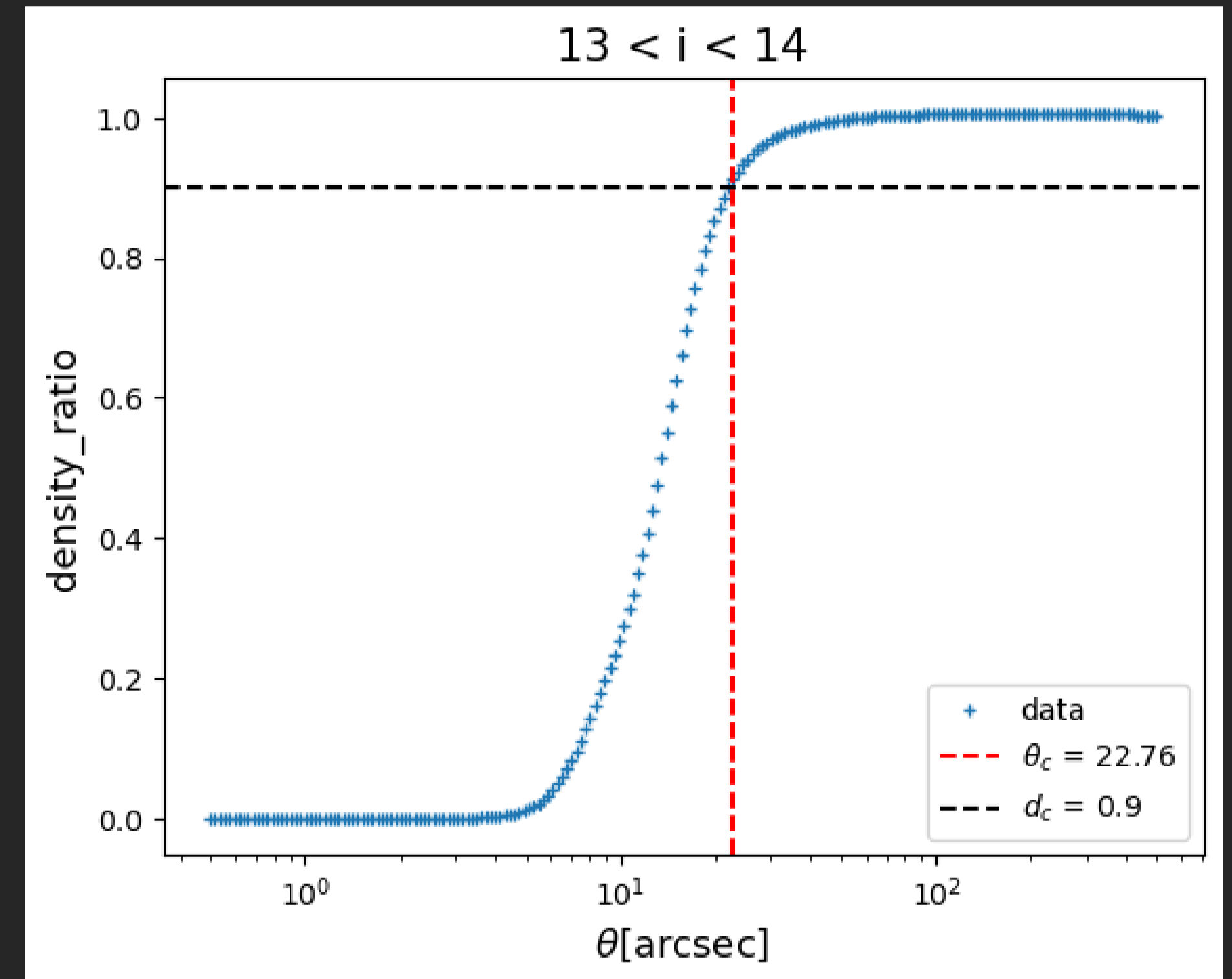
- Truth type = 2 for stars, 1 for galaxies
- bins of  $\text{mag}_i \text{ truth} = [<10, 10, 11, 12, 13, 14, 15, 16]$

# Determine critical radius

## Density ratio

Now : we need to know what disk radius should be used as circular mask radius around bright stars :

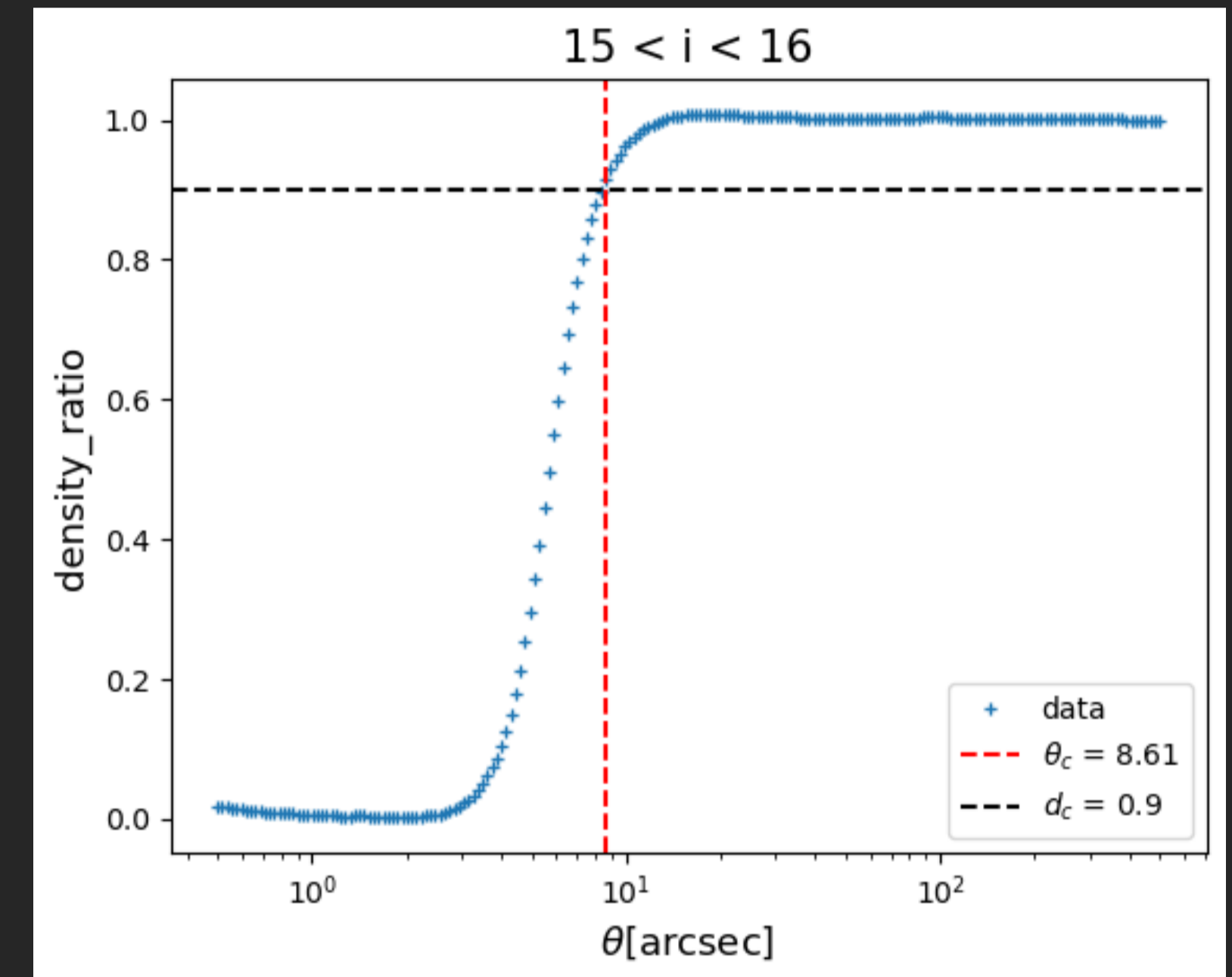
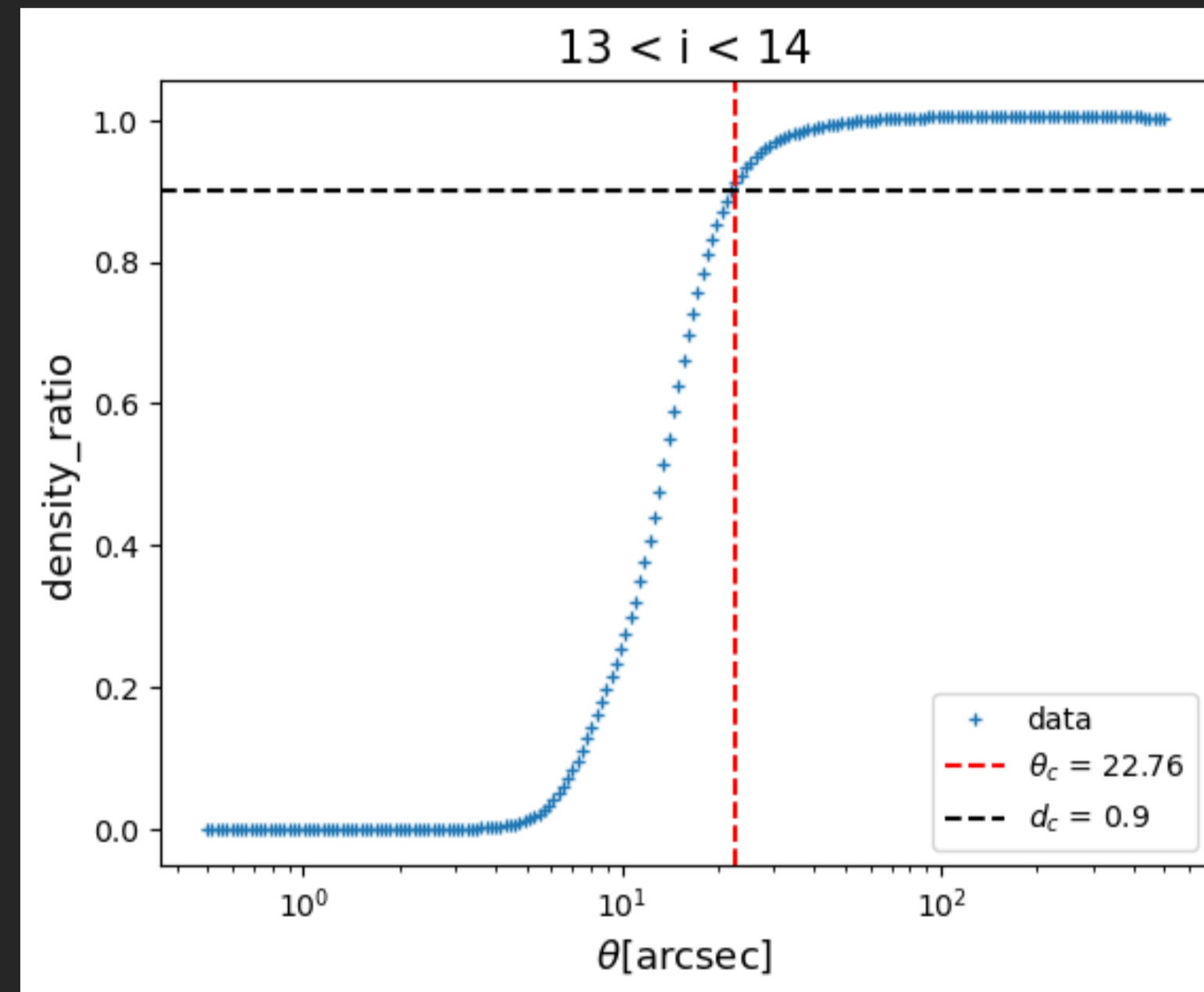
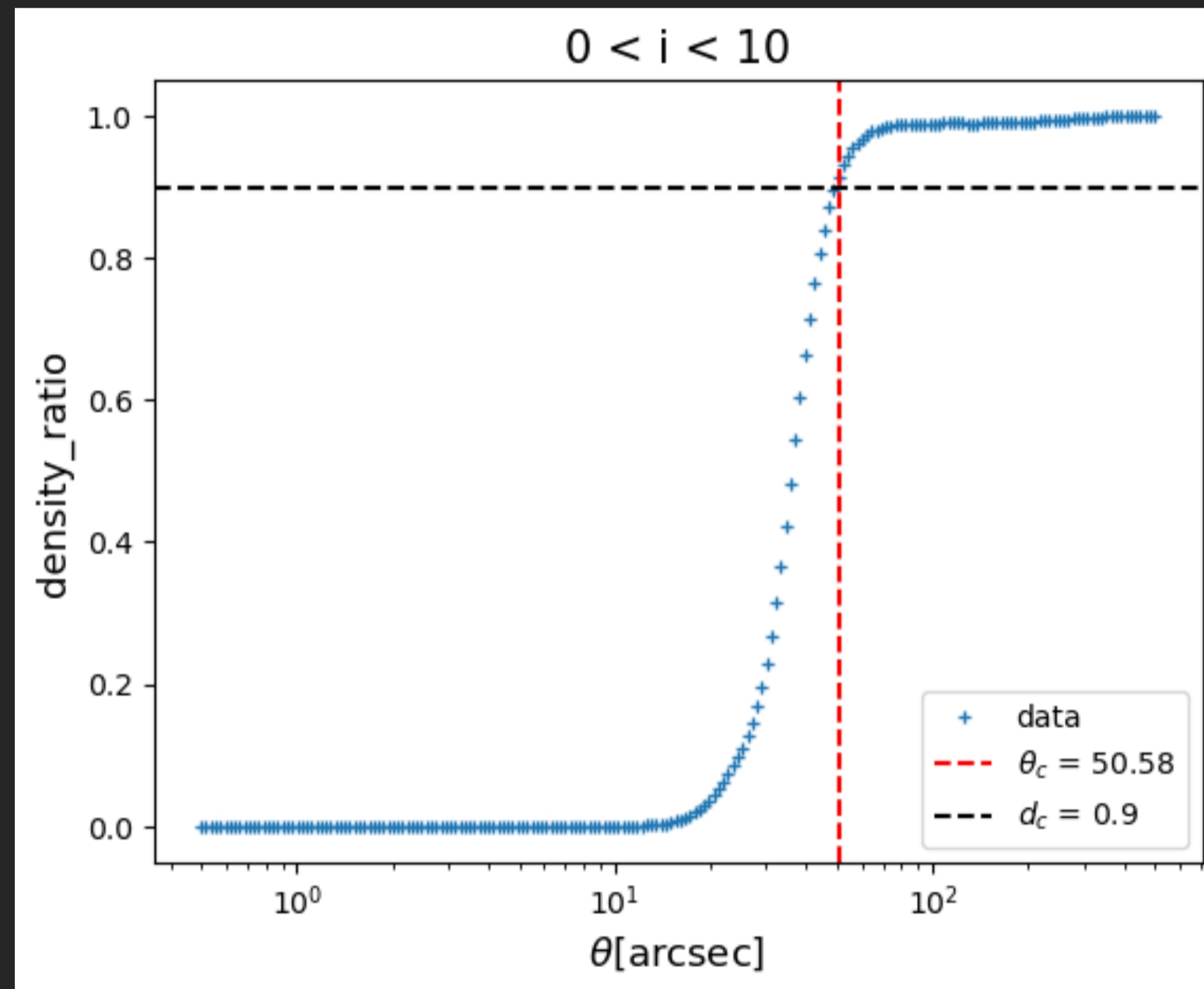
- 1) Divide bright stars by mag\_i bins
- 2) Compute object density for each stars in bins of radius
- 3) Normalize with full survey density





# Critical radius with full sample

## Density ratio profiles



Brightest stars :  $\theta_c \sim 50''$

# Mask map creation

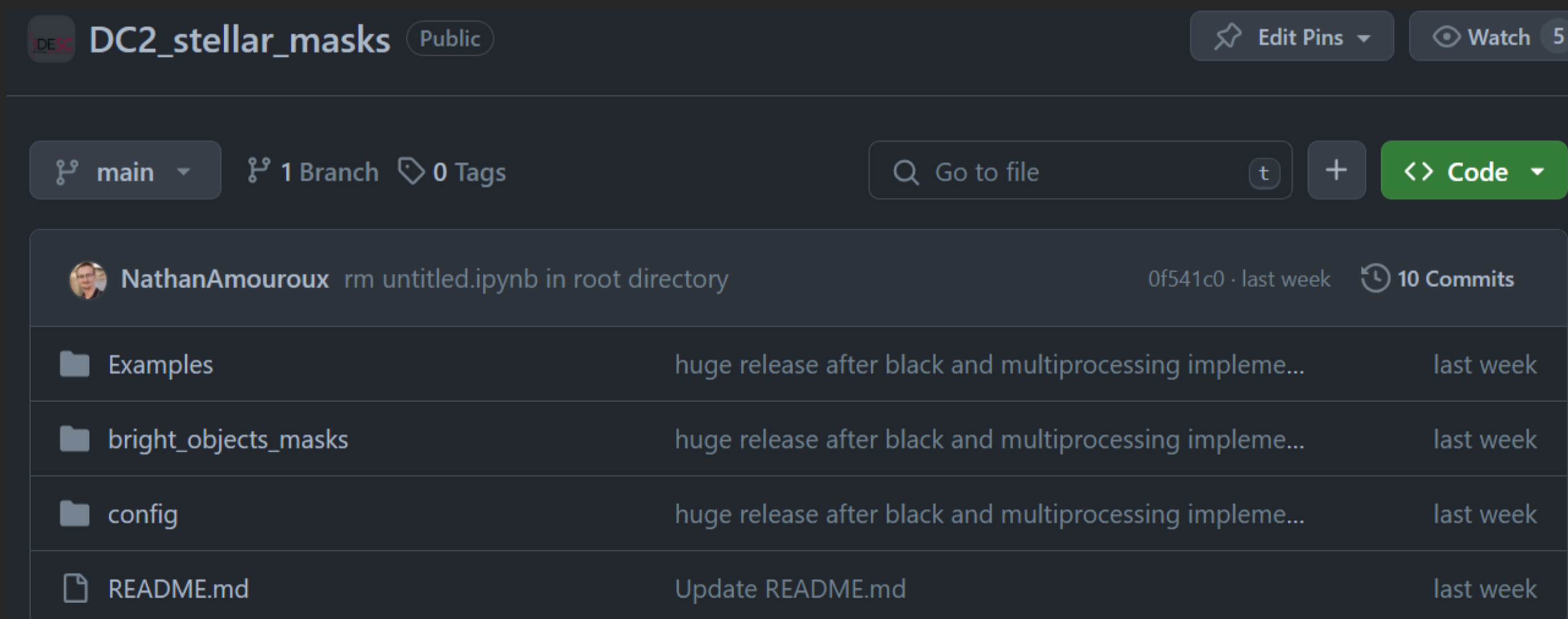
Then :

- 1) Create empty high resolution [healsparse](#) map (Nside = 131,072)
- 2) Remove all pixels whose center lie within the disk around each bright star
- 3) Remove all Galaxy sample objects contained in those pixels

# DESC DC2 bright star masks project

- Project in Science Release and Validation WG
- WGs have different needs for masks (quality cuts, resolution, ...)
- Masks need to be studied
- We want them to be customizable.

→ DC2\_stellar\_masks package

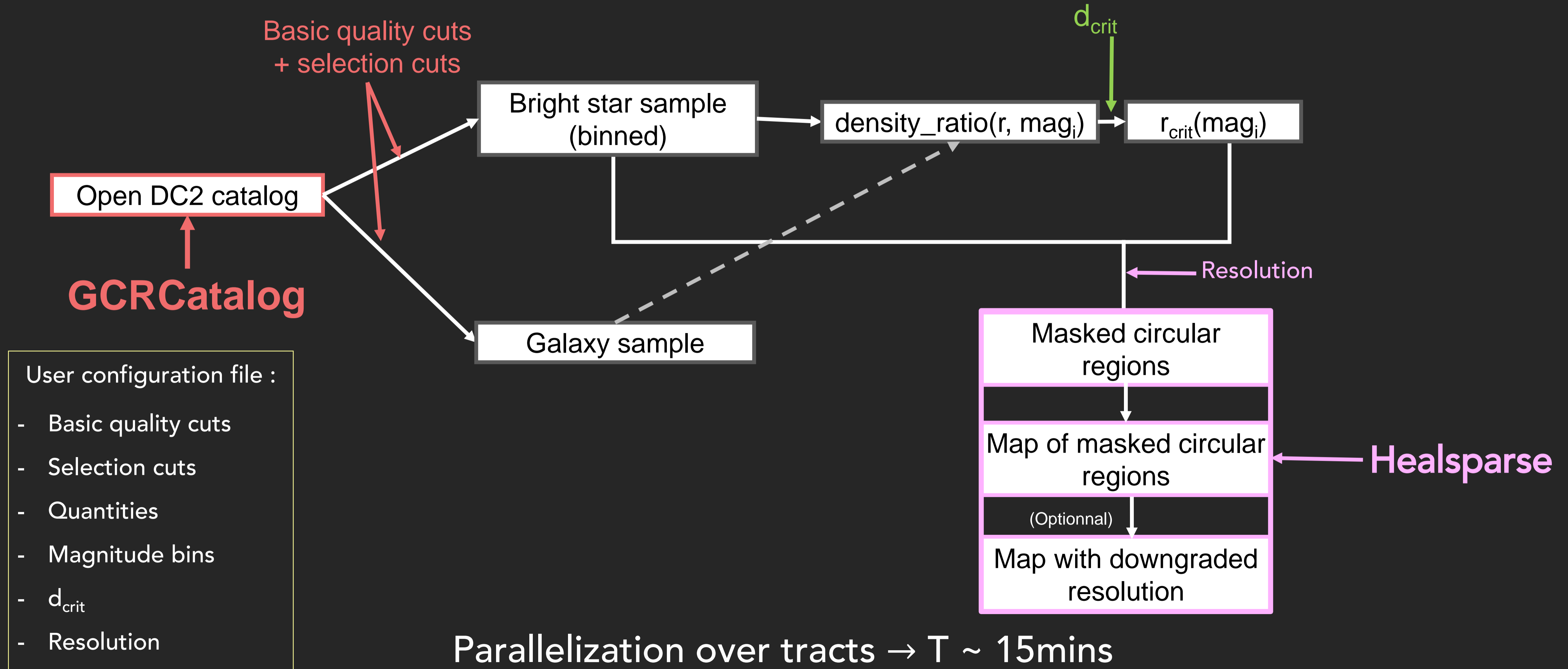


The screenshot shows the GitHub repository page for 'DC2\_stellar\_masks'. The repository is public and has 5 watchers. It features a 'main' branch with 1 branch and 0 tags. A search bar is present with the text 'Go to file'. A green 'Code' button is visible. The commit history shows a commit by NathanAmouroux titled 'rm untitled.ipynb in root directory' with commit hash 0f541c0, made last week, and 10 commits in total. The file list includes 'Examples', 'bright\_objects\_masks', 'config', and 'README.md', all updated last week.

File/Folder	Commit Message	Commit Hash	Time
Examples	huge release after black and multiprocessing impleme...	0f541c0	last week
bright_objects_masks	huge release after black and multiprocessing impleme...	0f541c0	last week
config	huge release after black and multiprocessing impleme...	0f541c0	last week
README.md	Update README.md	0f541c0	last week

# DESC DC2 bright star masks project

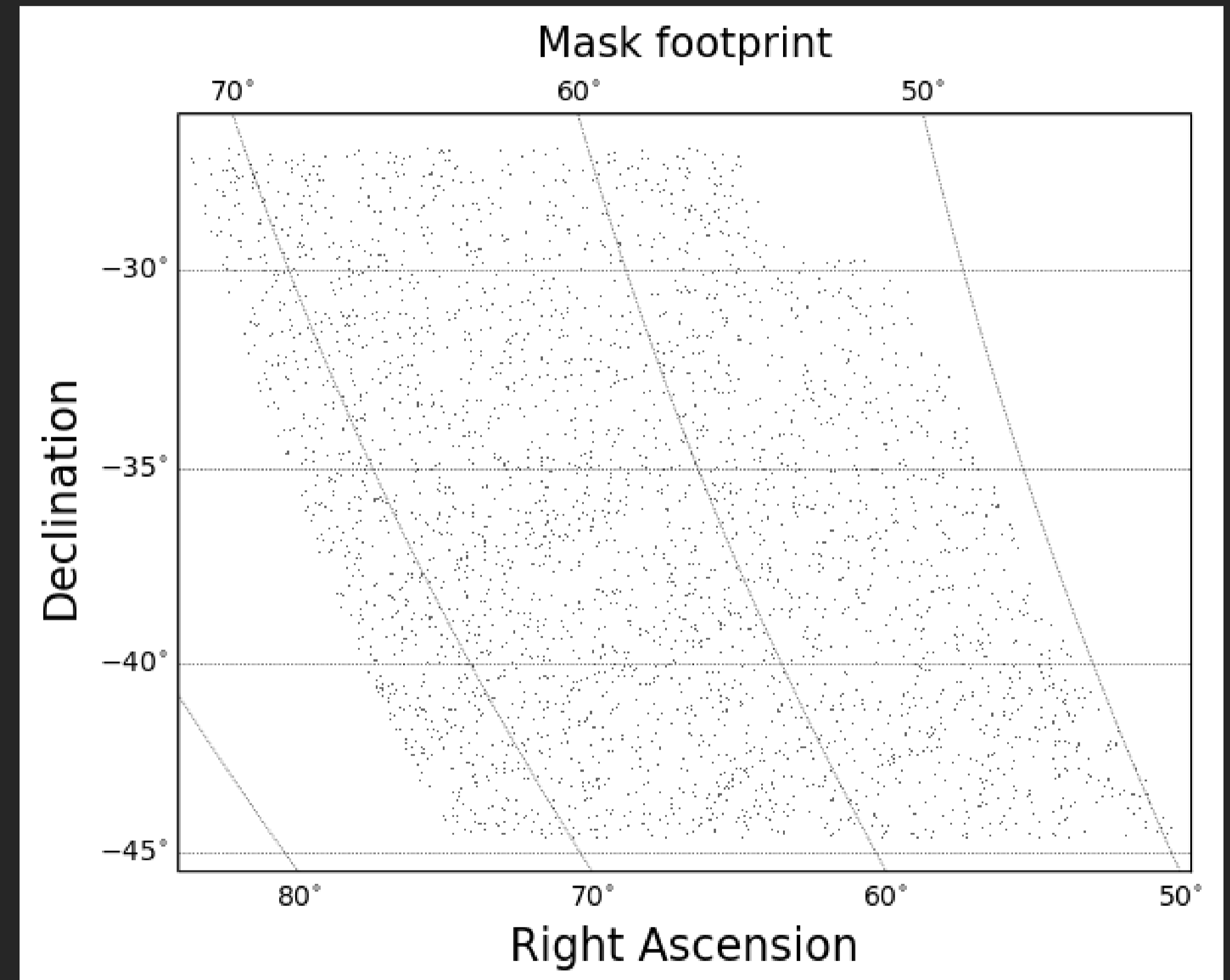
How it works



# DESC DC2 bright star masks

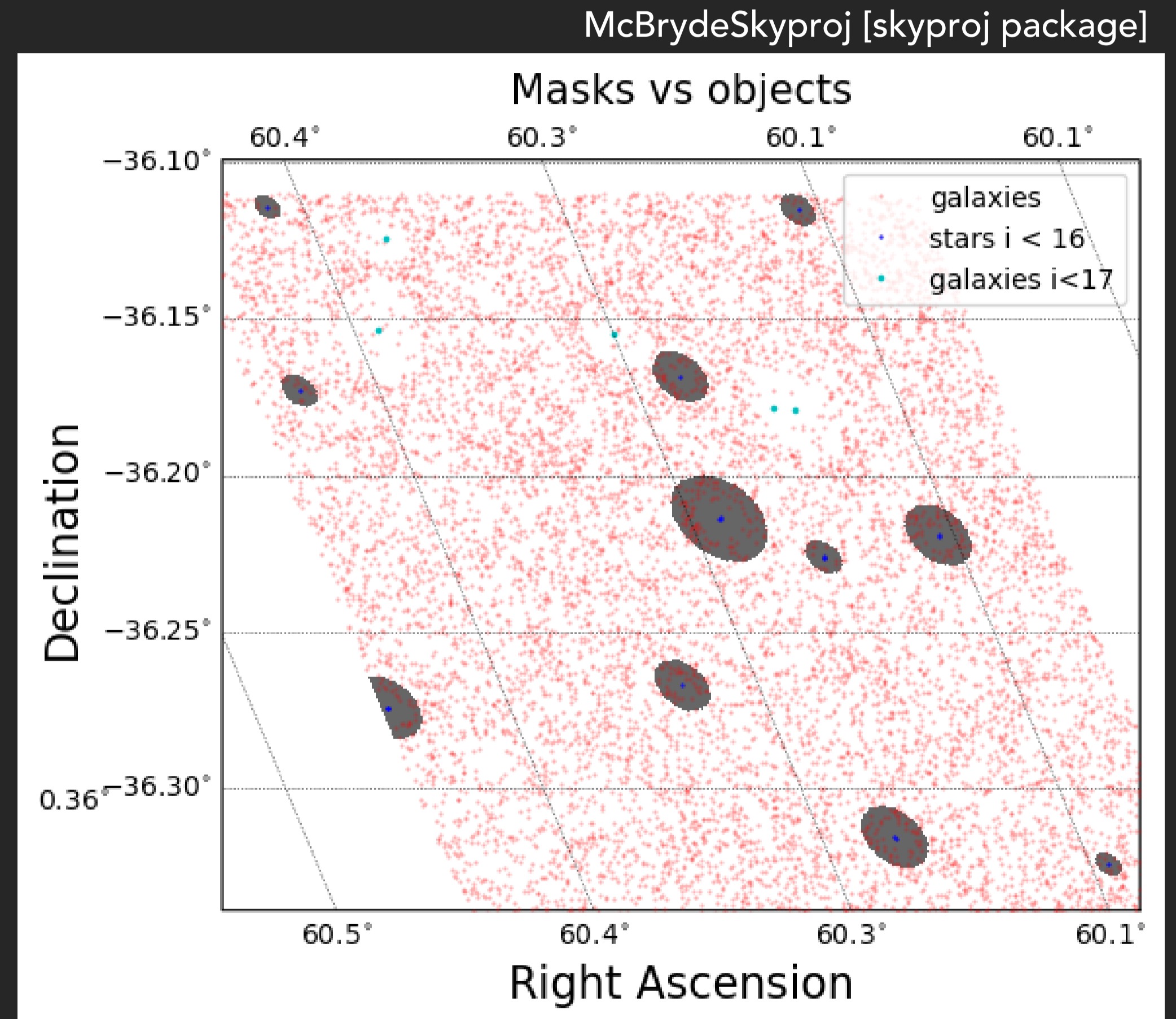
McBrydeSkyproj [skyproj package]

- Dark regions are masked pixels
- High resolution ( $\sim 0.45''$ )
- Masked surface  $\sim 2\%$
- Bright stars do not cover every hole
- There are bright galaxies too



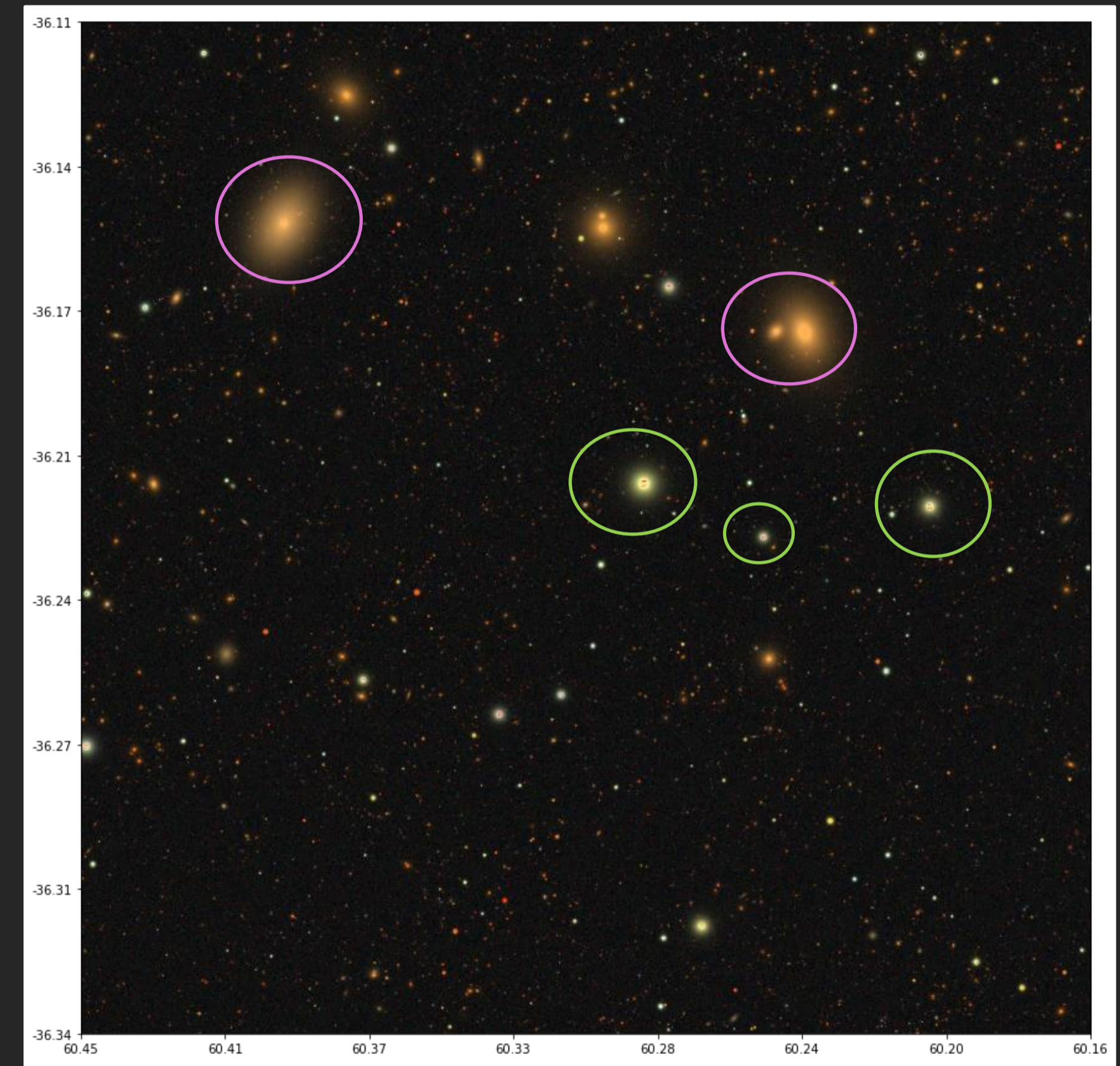
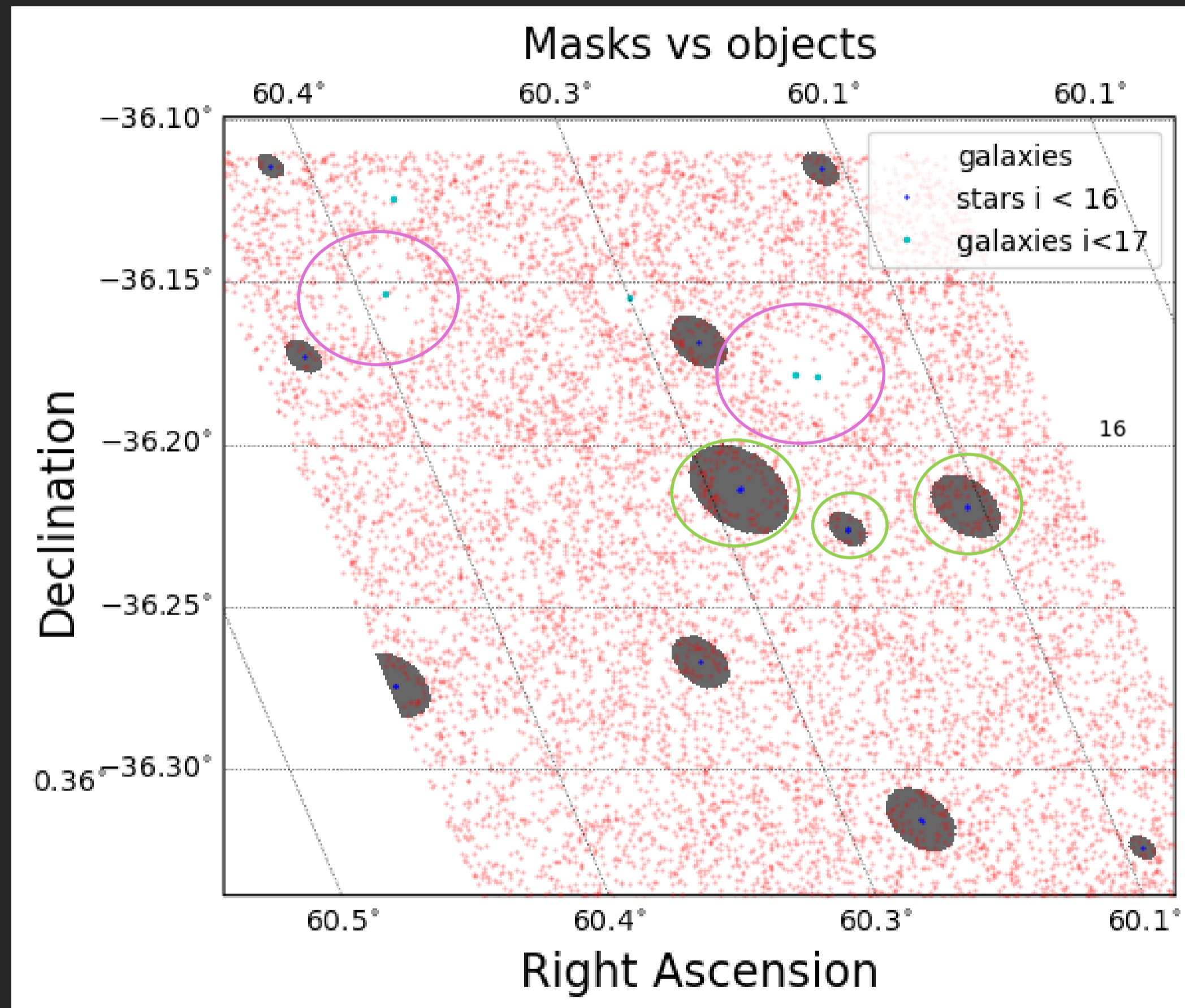
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# Bright objects vs Images

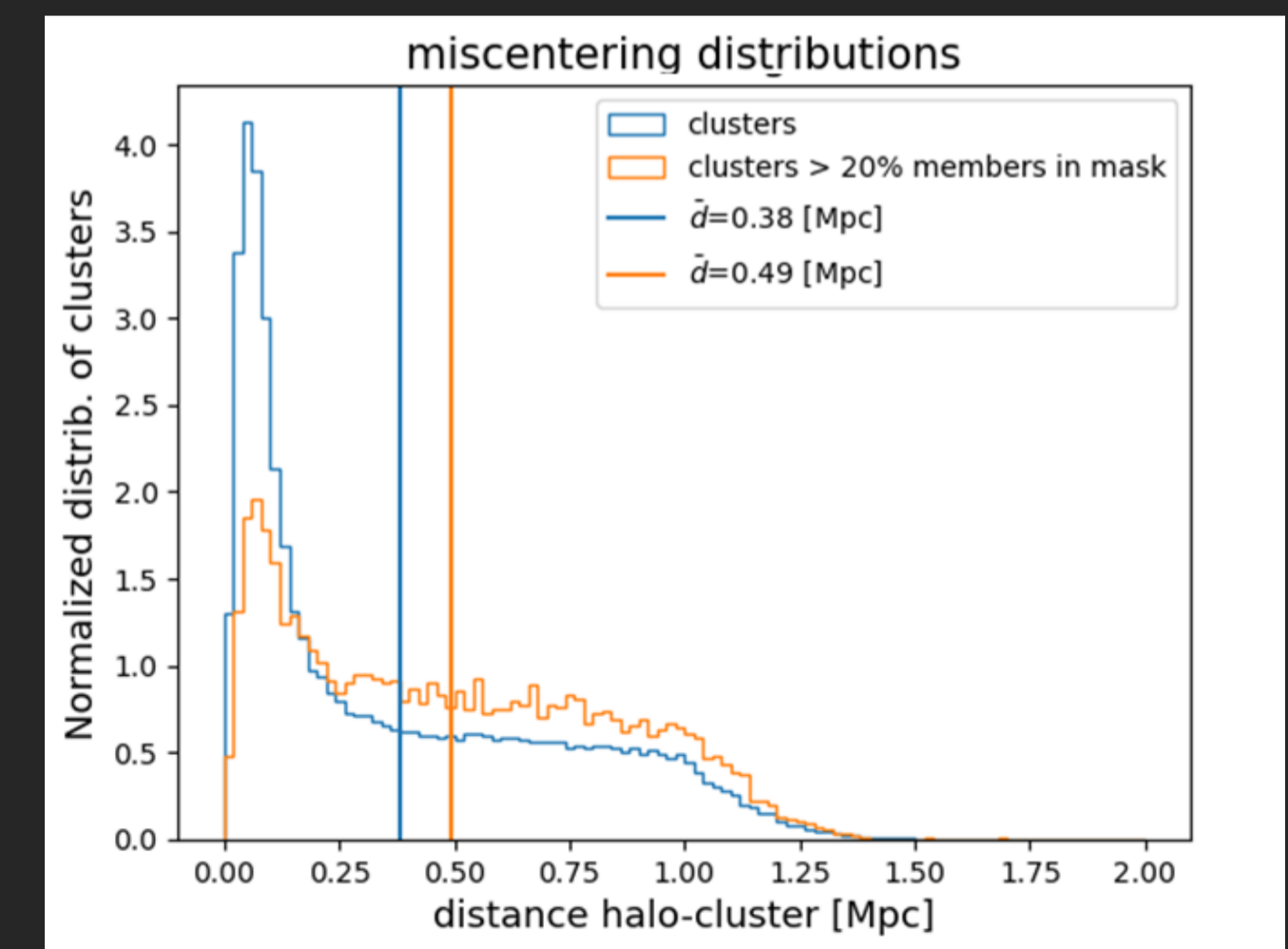
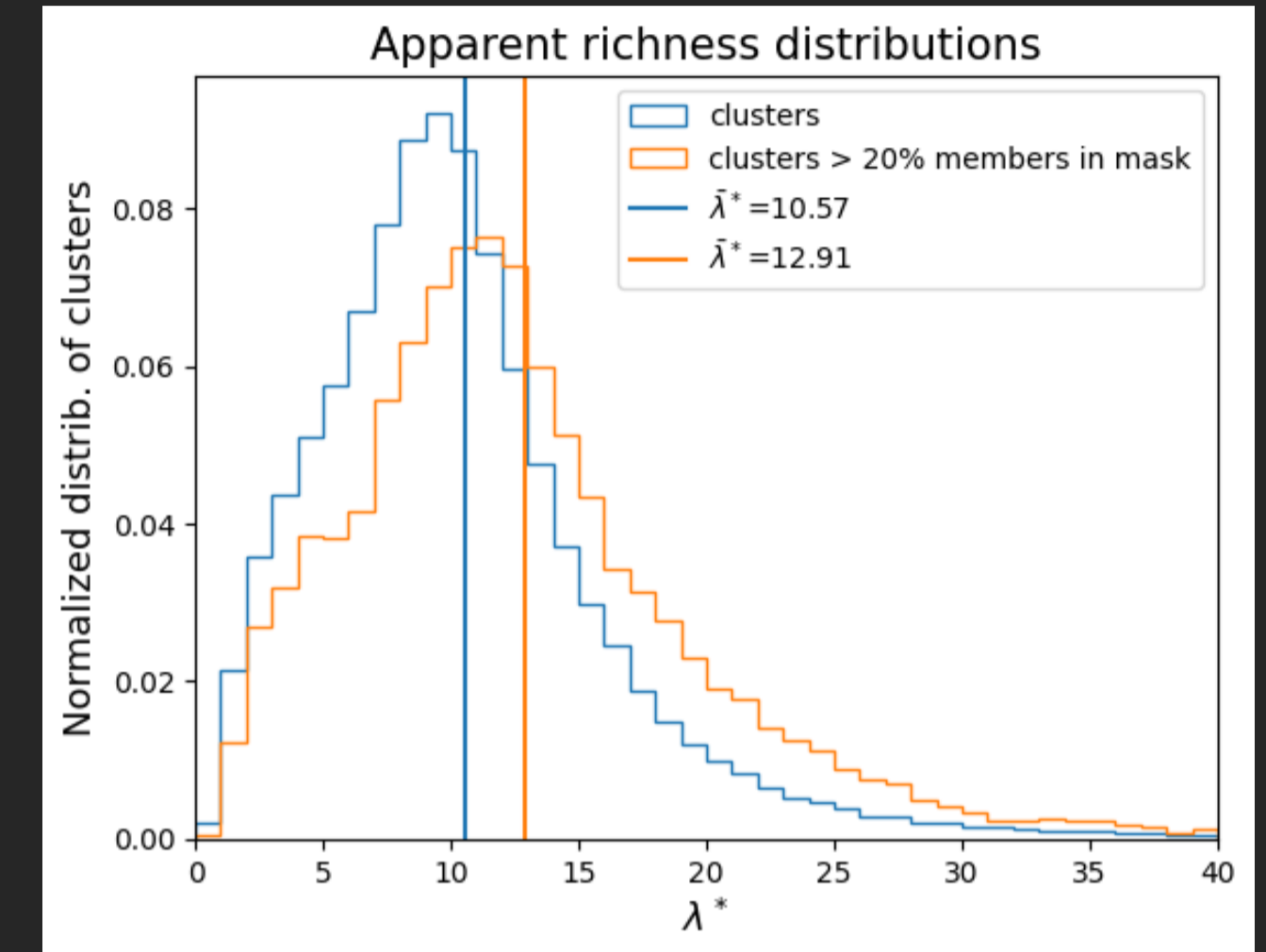
patch of tract = 3830



Not the best comparison but you can still see stars

# Impact of masks on cluster finder AMICO

- Masks are downgraded : masked pixels have weights
  - AMICO corrects richness for masked fraction
- Clusters near masks :
  - Higher apparent richness
  - Higher miscentering
- Impact on completeness and purity ?





# Conclusion and perspectives

- Bright object masks will be crucial for various WGs
- First stable release of the package is now available [here](#) (mask production is now very and « easily » customizable)
- Brightest stars were selected to produce the masks
- First masks being studied in AMICO validation project

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  - First stable release of the package is now available [here](#) (mask production is now very and « easily » customizable)
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  - First masks being studied in AMICO validation project
- 
- Bright galaxies sample to study for masks
  - Study the impact of Nside (pixel resolution)
  - Validation of masks in different WGs

**Thanks for your attention**