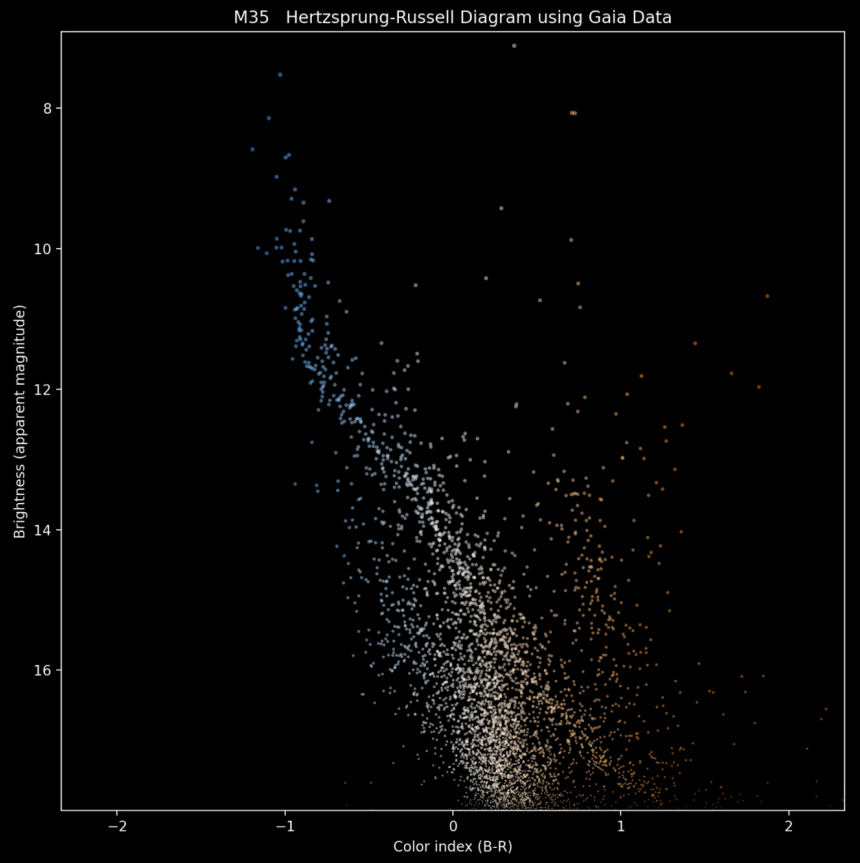
HR-Diagrams of Open Clusters – Side-by-Side

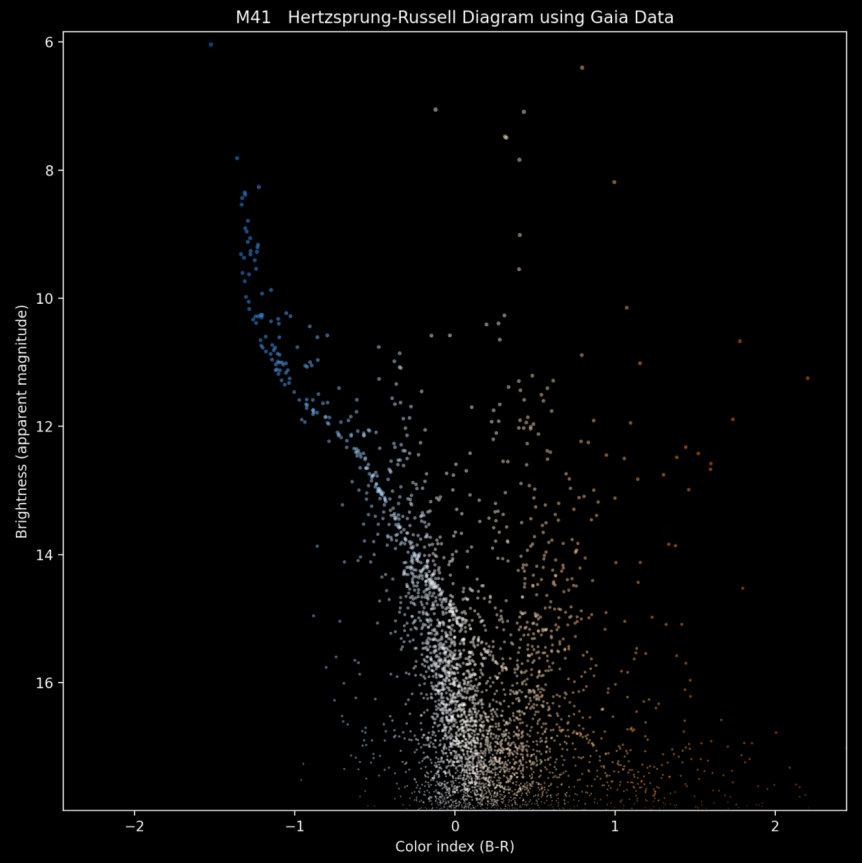
HR-Diagrams of Open Clusters – Side-by-Side

Using Gaia Data

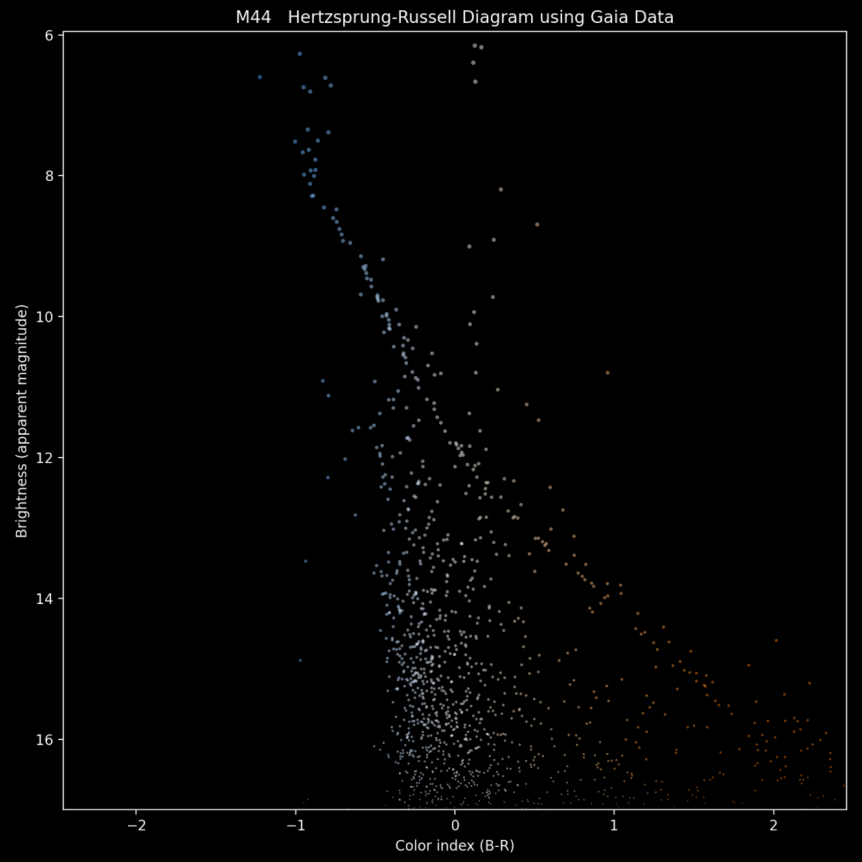
M35


M35 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
8
10
12
14
16
−2
−1
0
1
2
Color index (B-R)

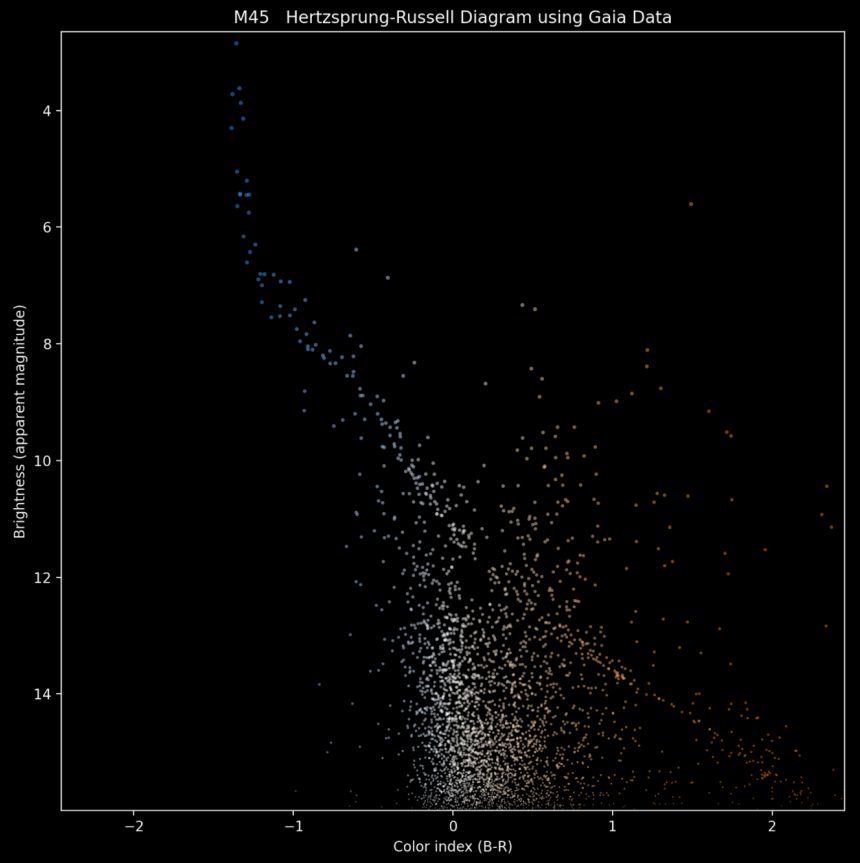
M41


M41 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
6
8
10
12
14
16
−2
−1
0
1
2
Color index (B-R)

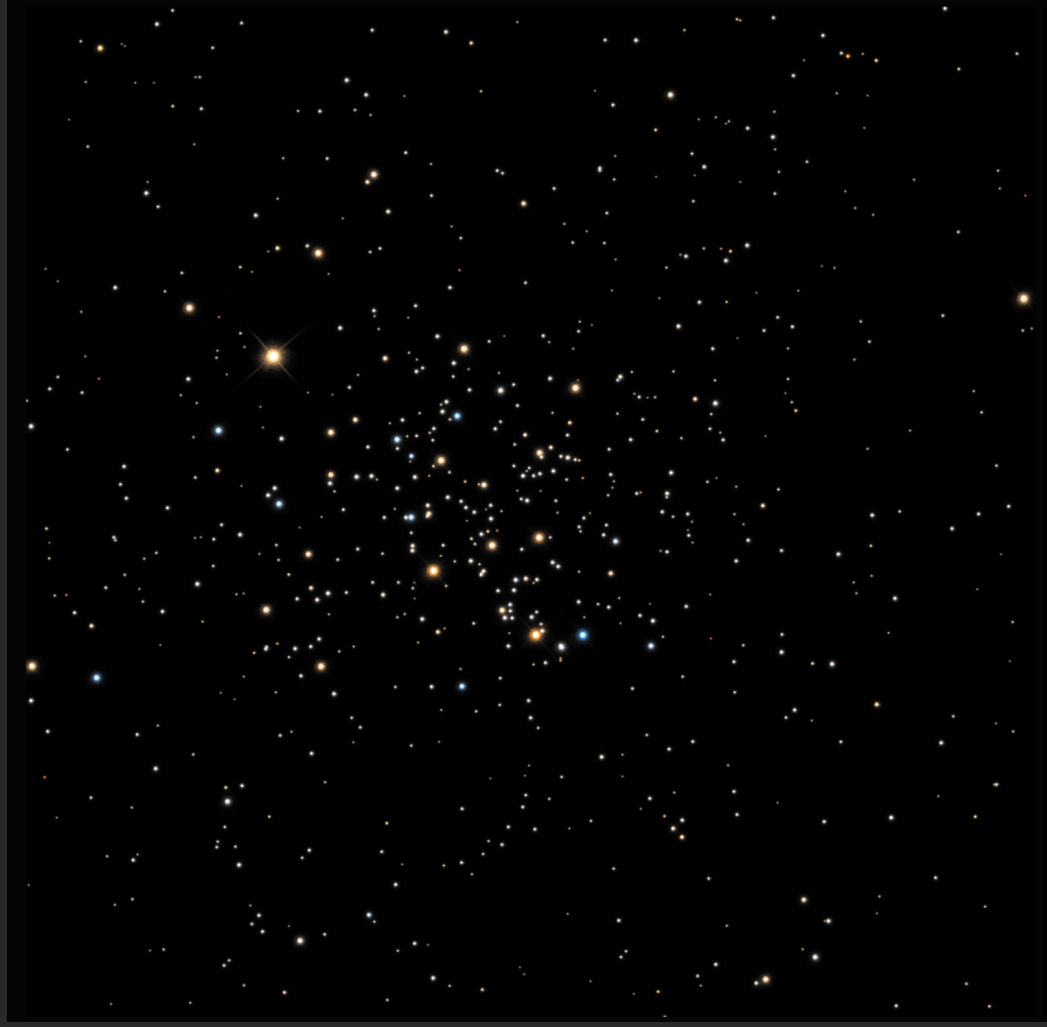
M44

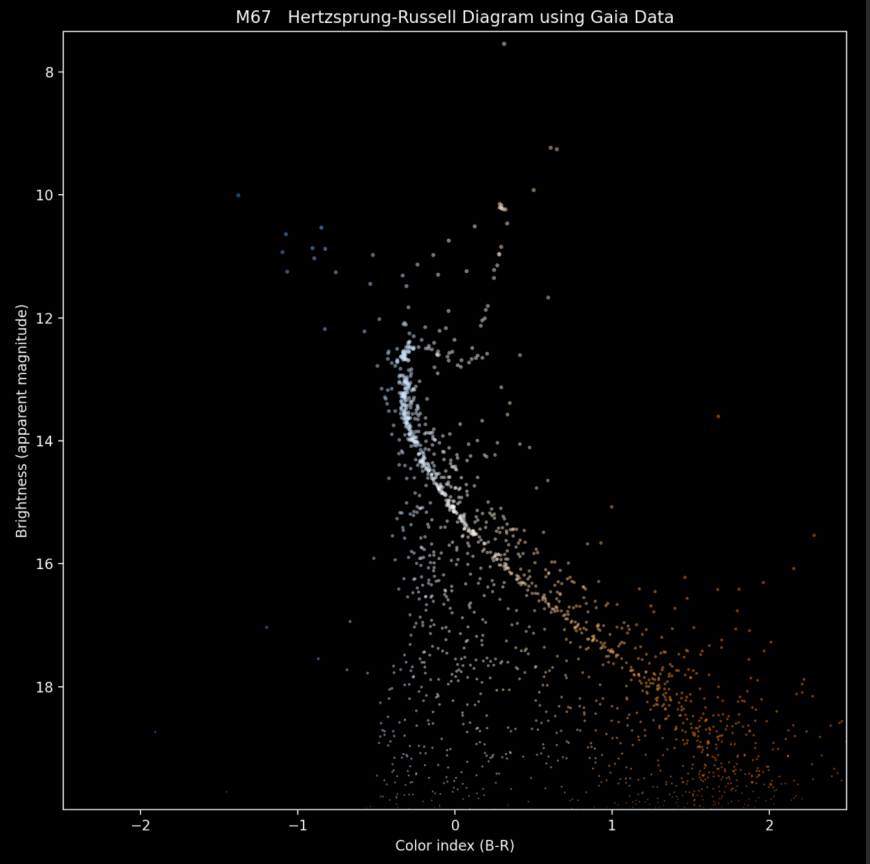

M44 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
6
8
10
12
14
16
−2
−1
0
1
2
Color index (B-R)

M45

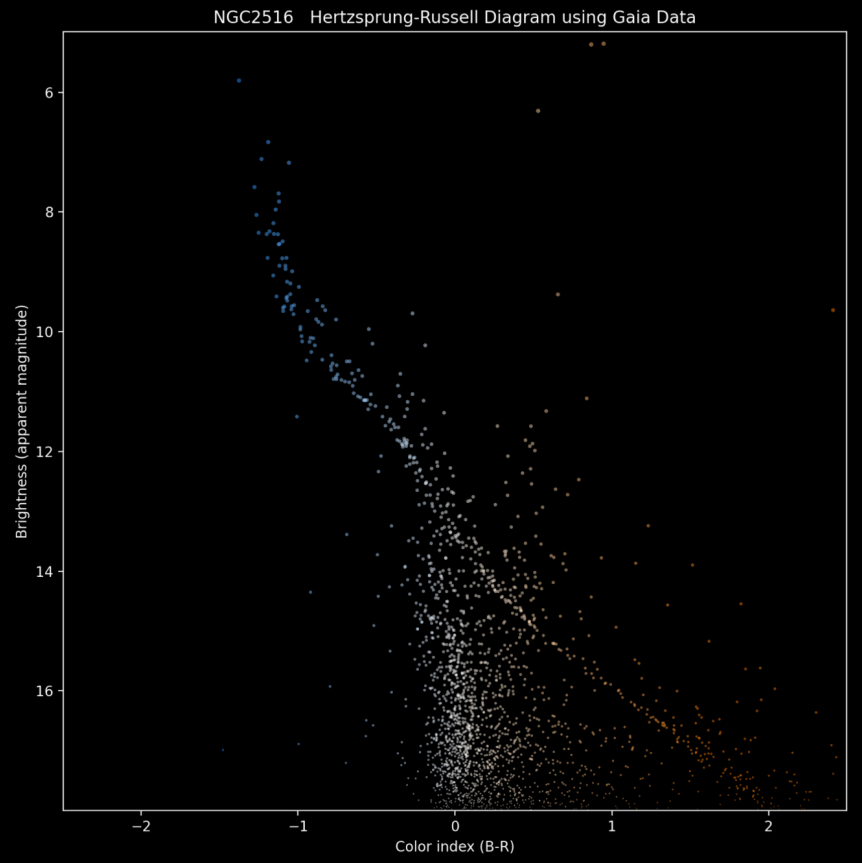

M45 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
4
6
8
10
12
14
−2
−1
0
1
2
Color index (B-R)

M67

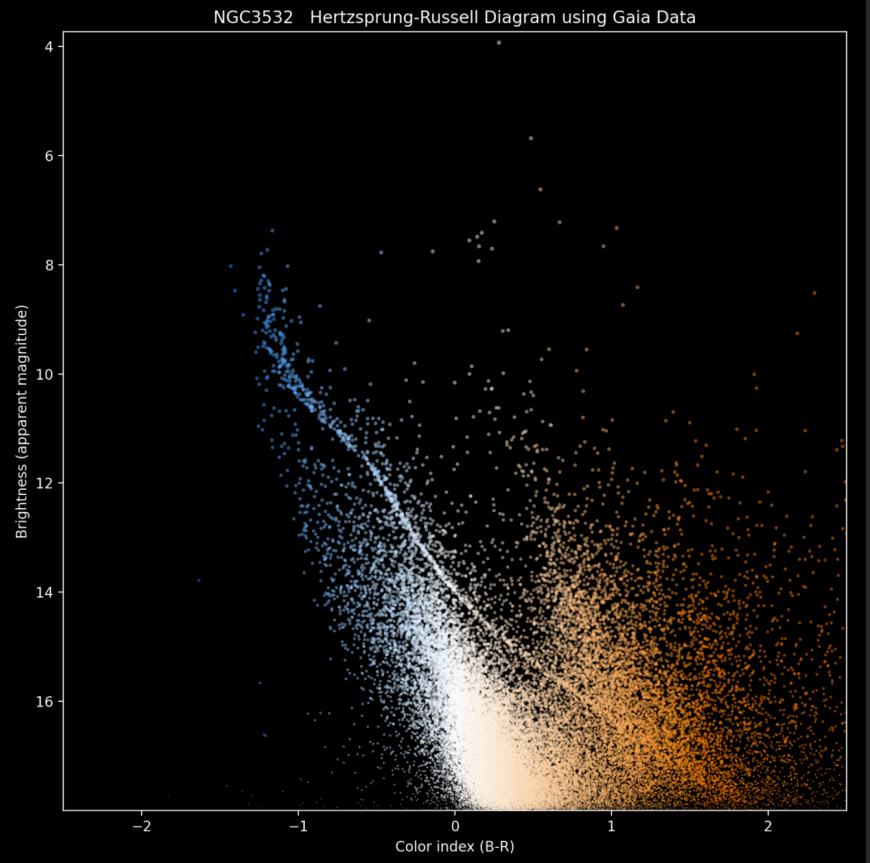



M67 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
8
10
12
14
16
18
−2
−1
0
1
2
Color index (B-R)

NGC2516

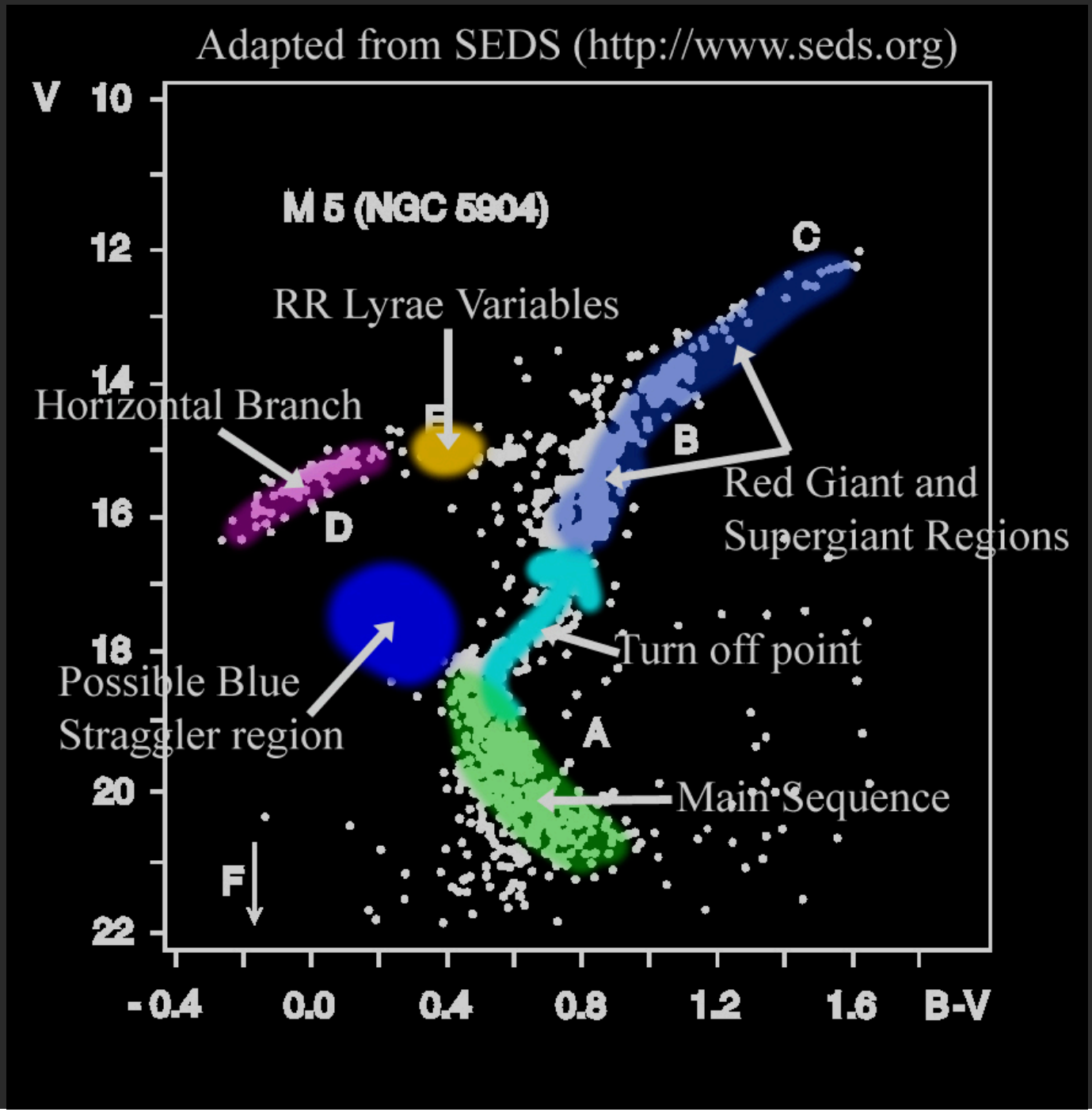

NGC2516 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
6
8
10
12
14
16
−2
−1
0
1
2
Color index (B-R)

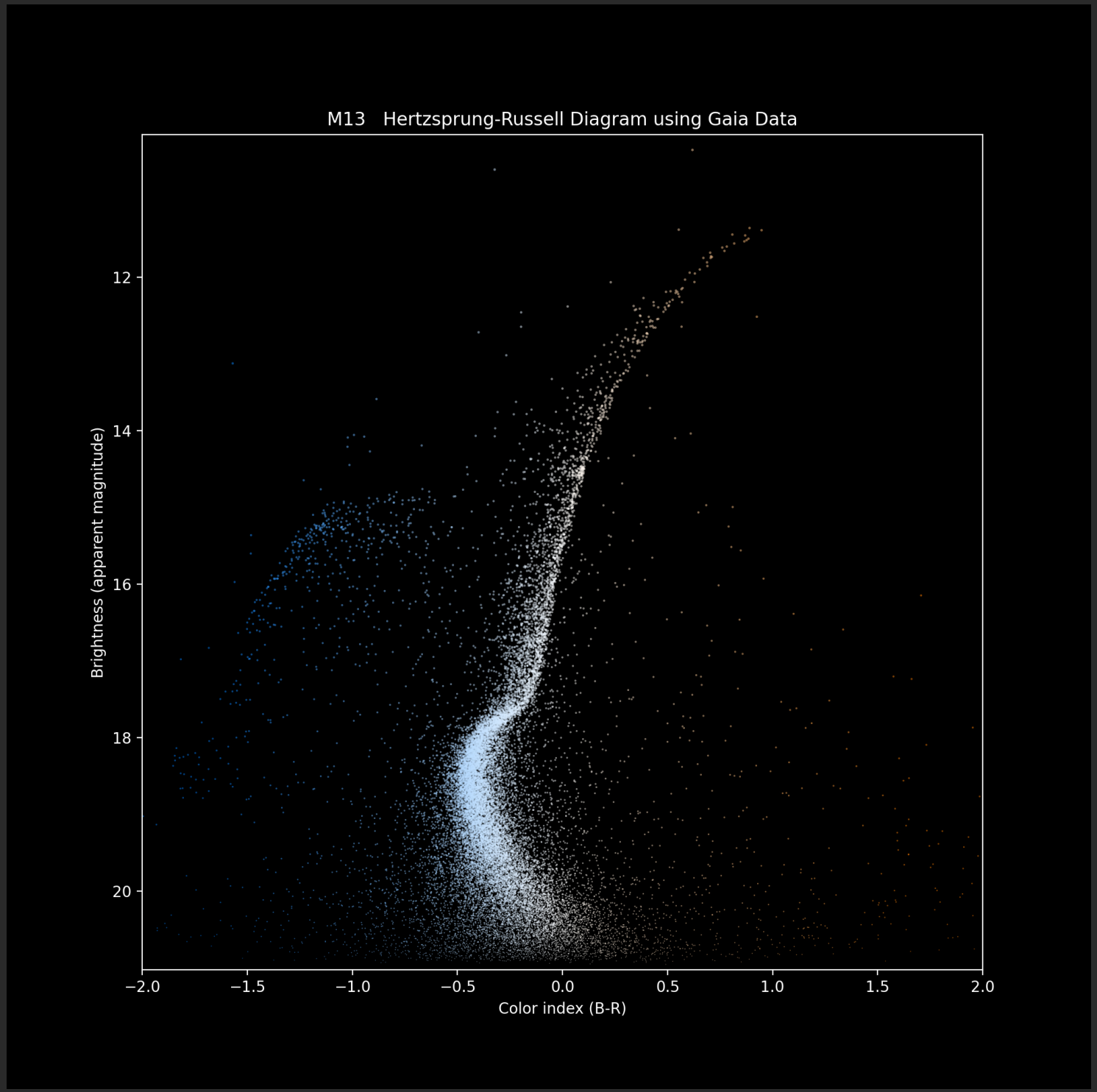
NGC3532

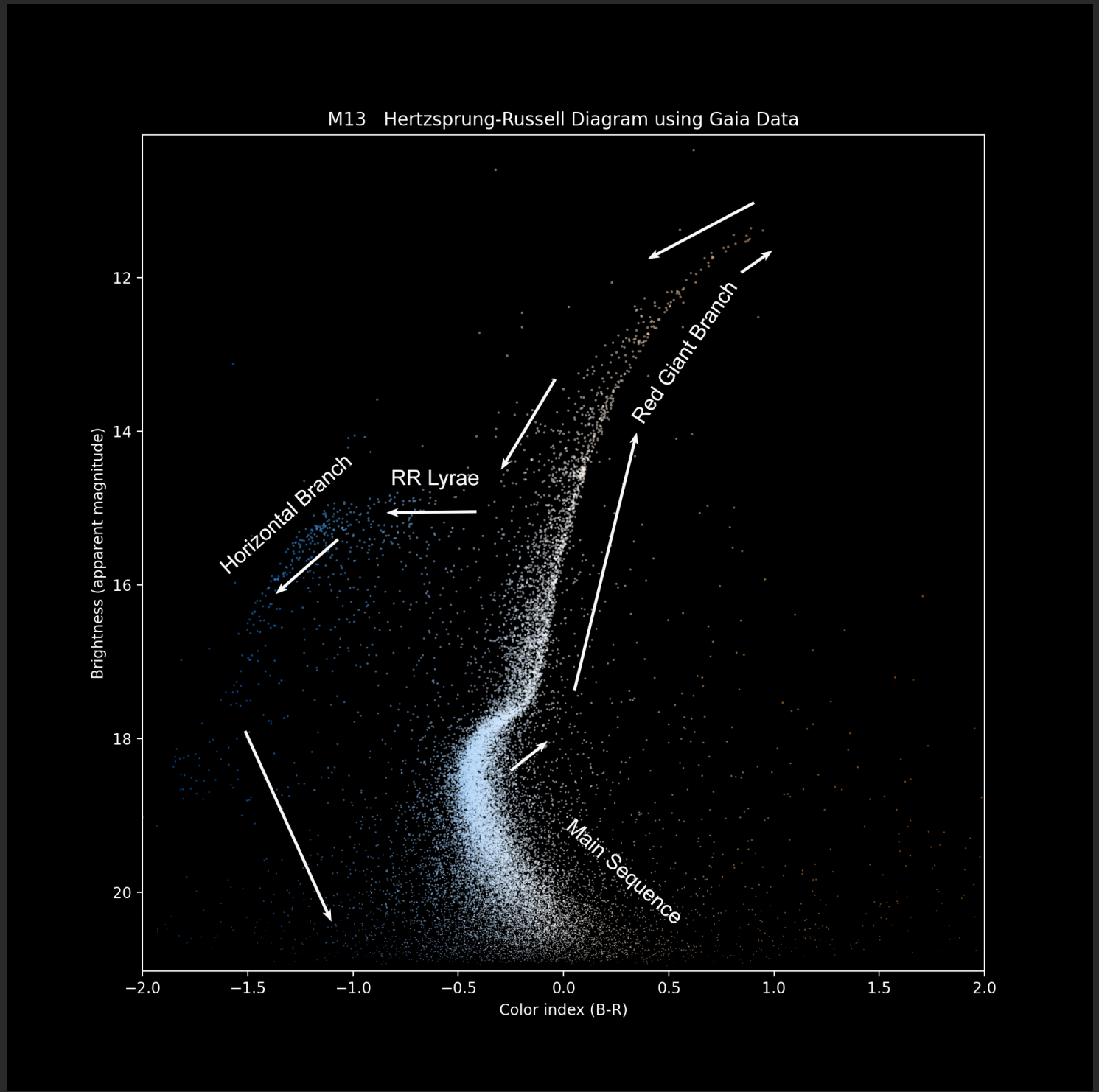

NGC3532 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
4
6
8
10
12
14
16
−2
−1
0
1
2
Color index (B-R)

Any Questions?

Variable Stars

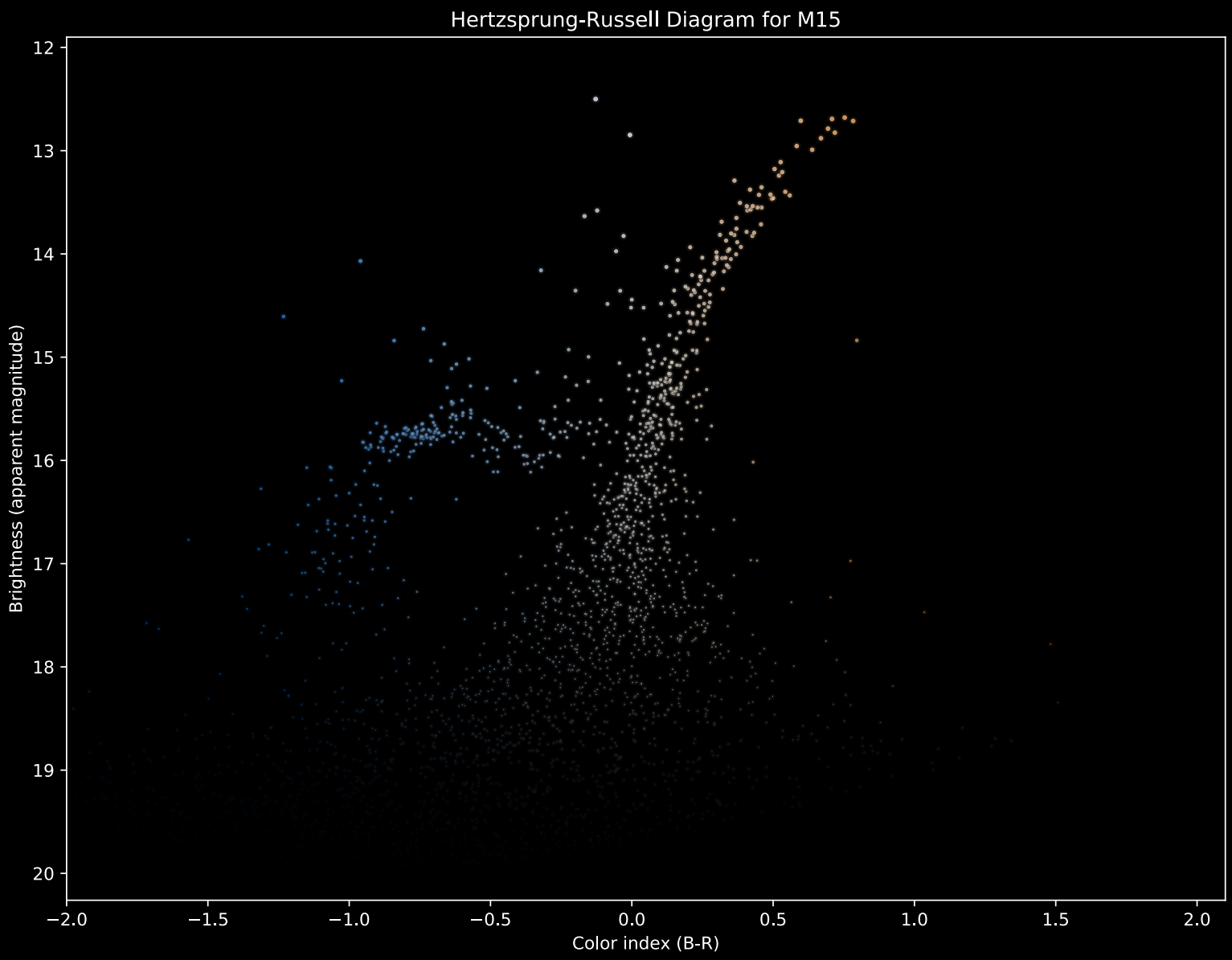



M13 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
12
14
16
18
20
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
Color index (B-R)


M13 Hertzsprung-Russell Diagram using Gaia Data
Brightness (apparent magnitude)
12
14
16
18
20
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
Color index (B-R)
Red Giant Branch
RR Lyrae
Horizontal Branch
Main Sequence

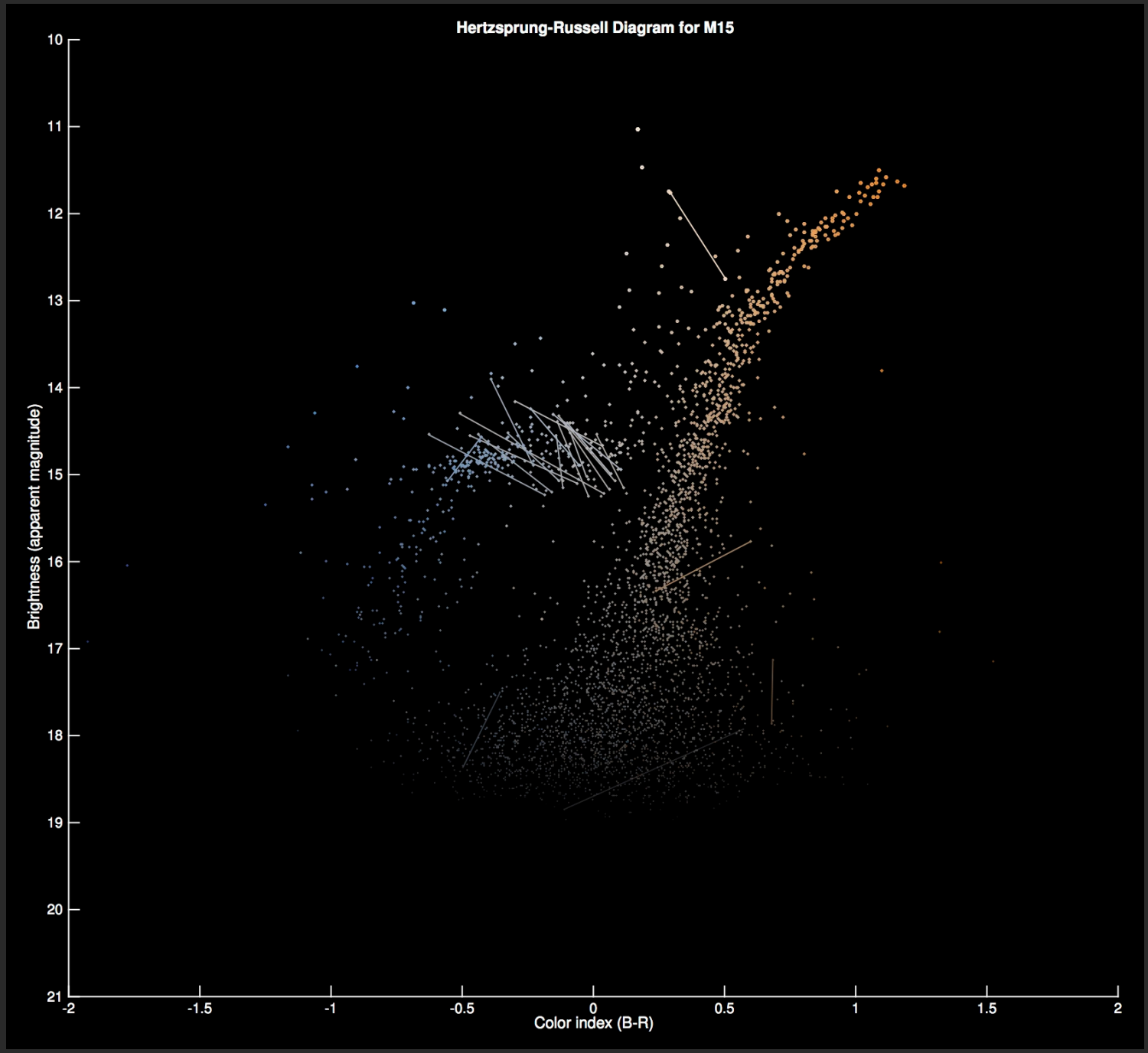
Globular Cluster M15

Click to see it

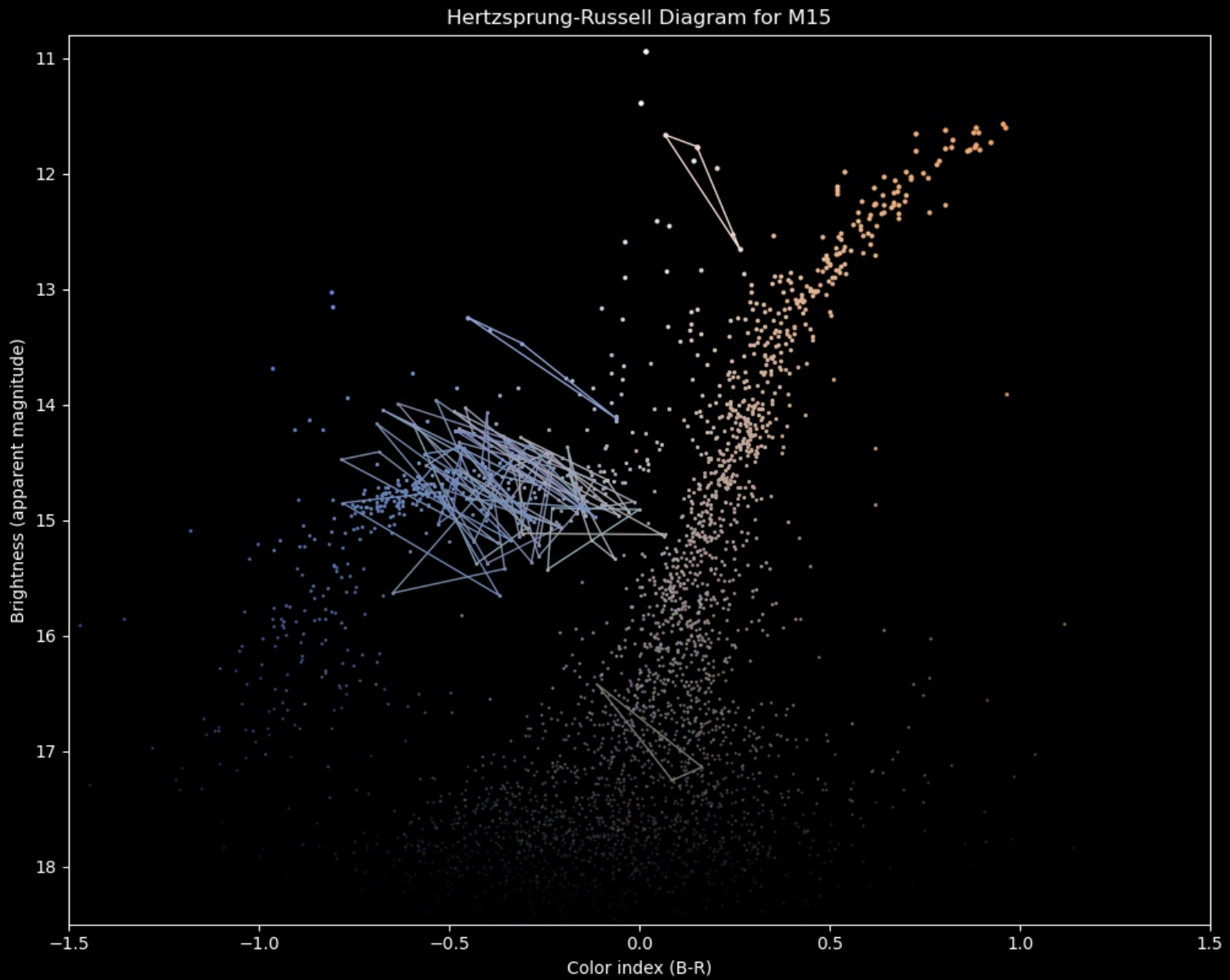

Hertzsprung-Russell Diagram for M15
Brightness (apparent magnitude)
12
13
14
15
16
17
18
19
20
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
Color index (B-R)

HR-Diagram Showing RR-Lyrae Stars

Click to see it



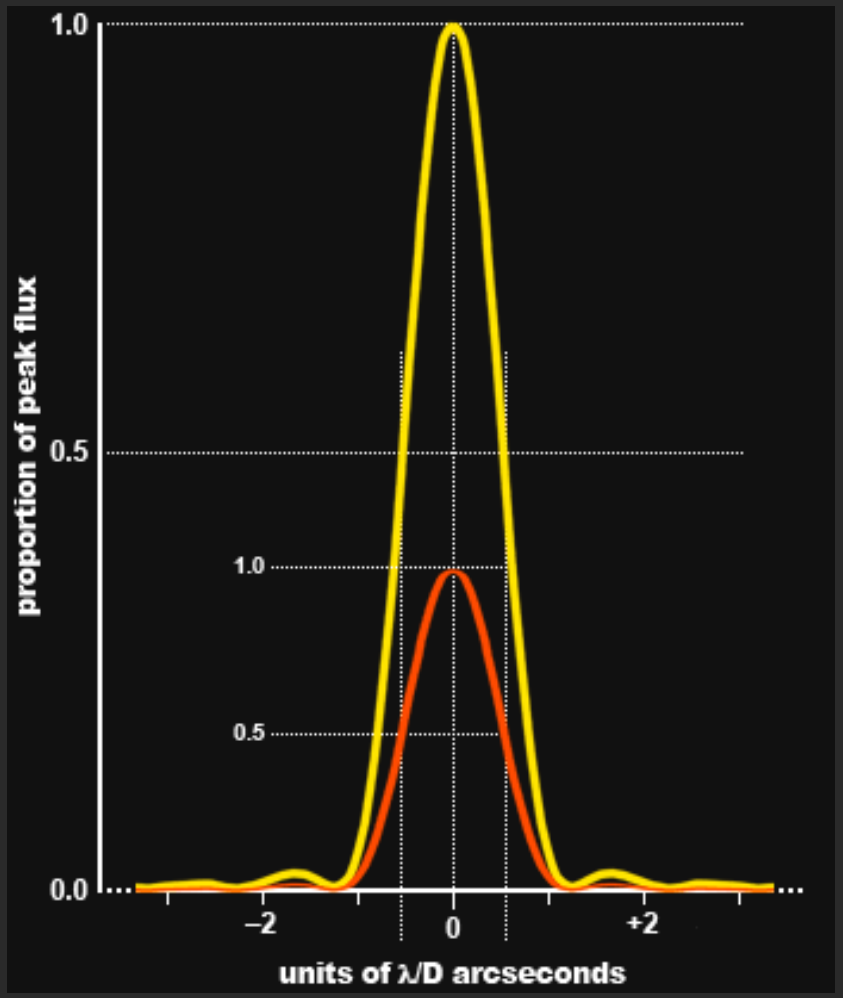
HR-Diagram Showing RR-Lyrae Stars

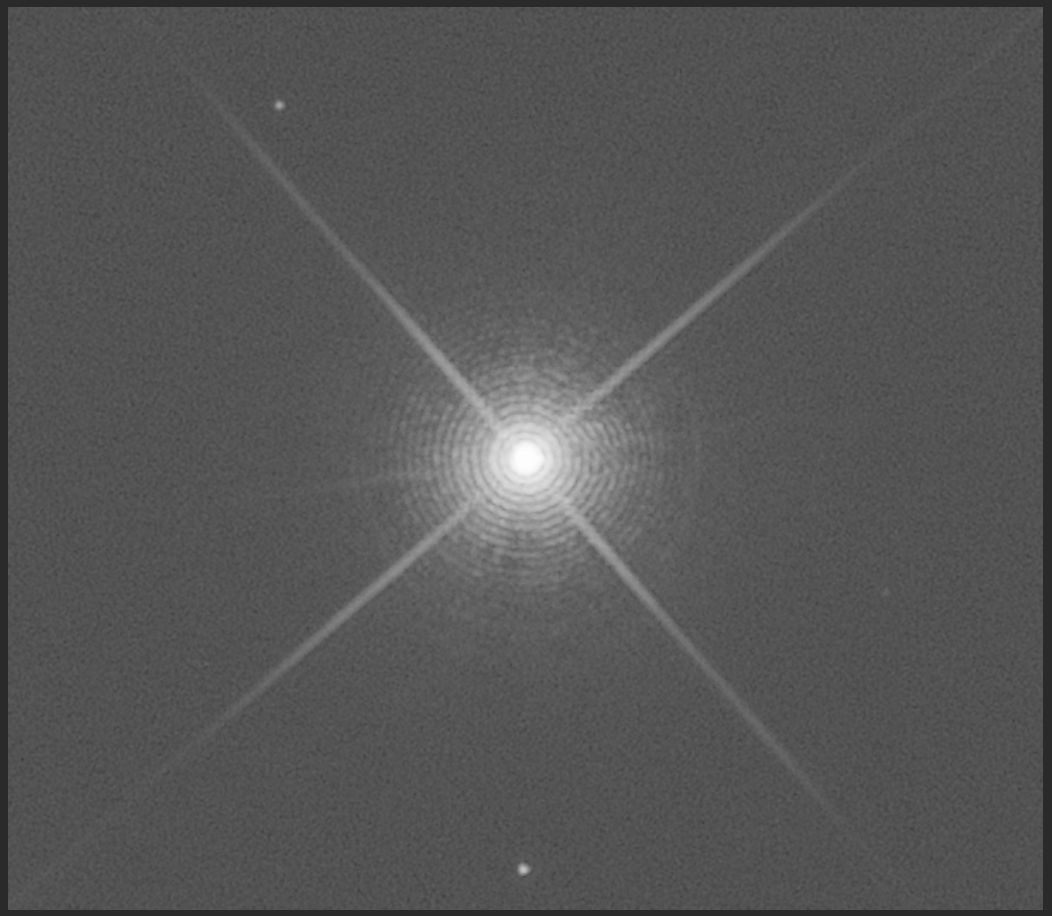


RR-Lyrae distance: 258 parsecs

RR-Lyrae distance: 258 parsecs

Resolution





$$\text{Full-width half-max (FWHM)} = 1.22\,\frac{\lambda}{D}\ \text{radians}$$

$\lambda =$ wavelength, $D =$ aperture diameter

Camera/Telescope Details

Aperture: $D = 10$ inches $= 254$ mm

Wavelength: $\lambda \approx 5080$ Angstroms $= 508$ nm $= 0.508$ microns $= 0.000508$ mm

FWHM $= 1.22\frac{\lambda}{D} = 1.22\frac{0.000508}{254} = 0.00000244$ radians $= 0.503$ arcseconds

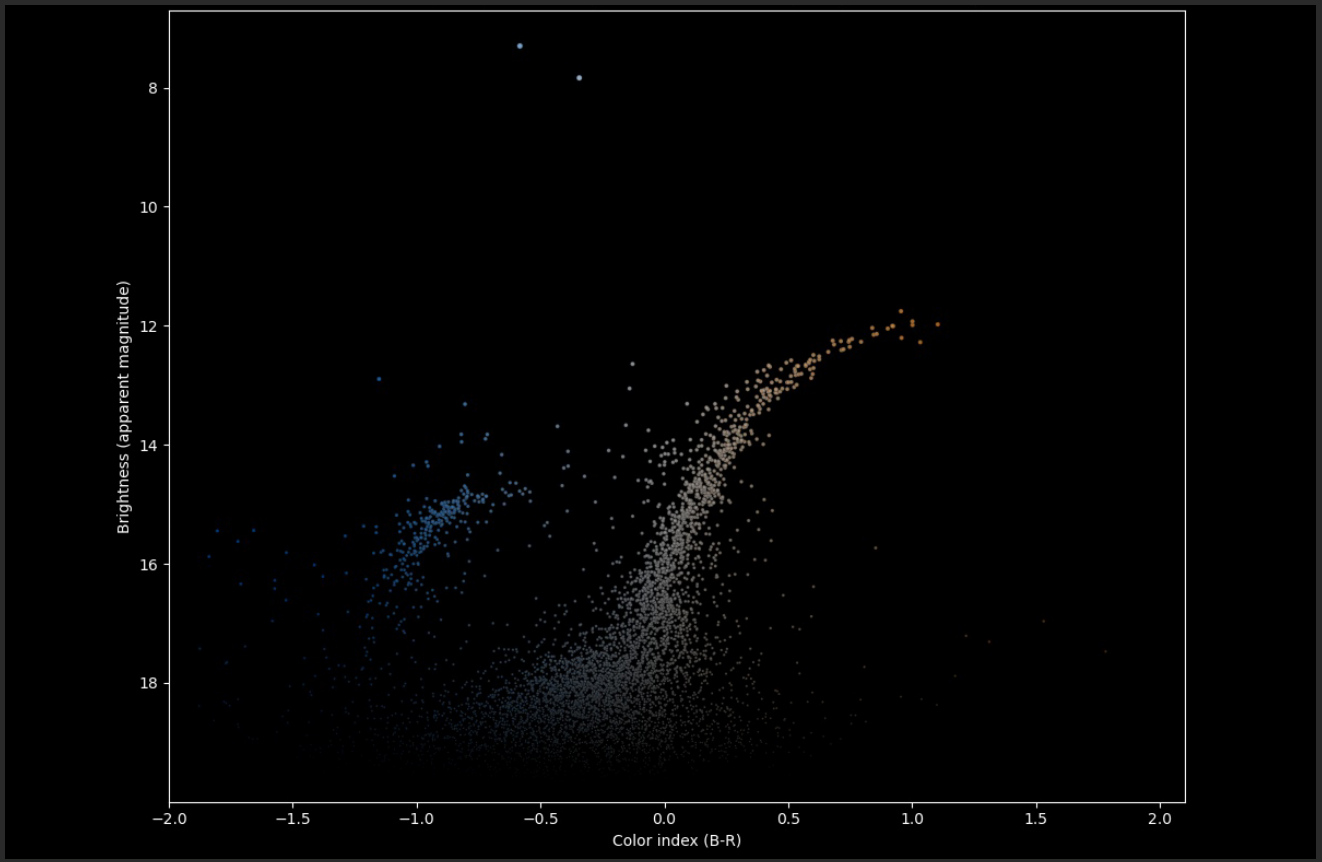
Focal Length: $f = 90$ inches $= 2286$ mm

FWHM in microns $= 0.00000244$ radians $\times$ 2286 mm $\times$ 1000microns/mm $=$ 5.58 microns

Pixel Size: 6.4 microns/pixel

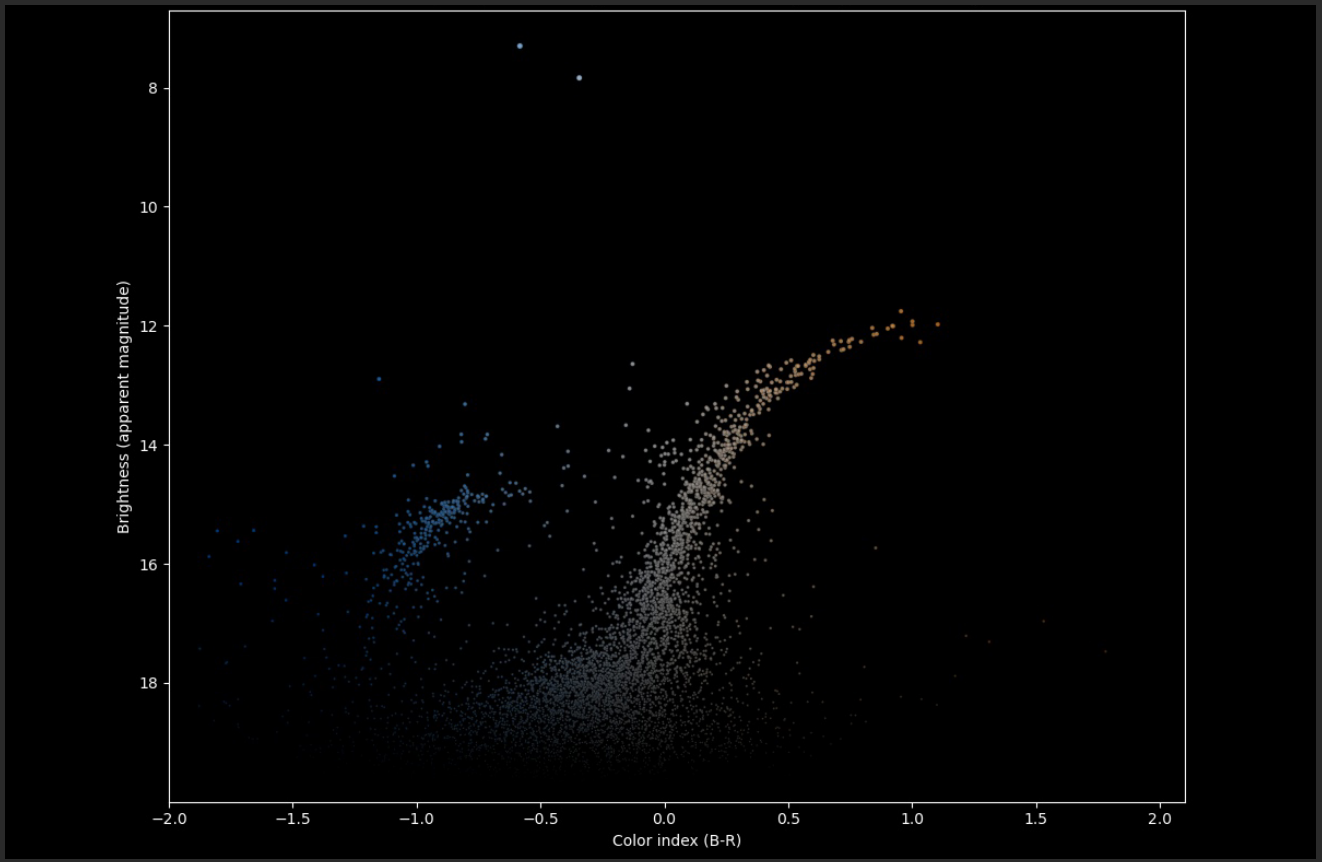
FWHM in pixels: $5.58/6.4 = 0.87$ pixels

Measuring Distances: RR-Lyrae and M13



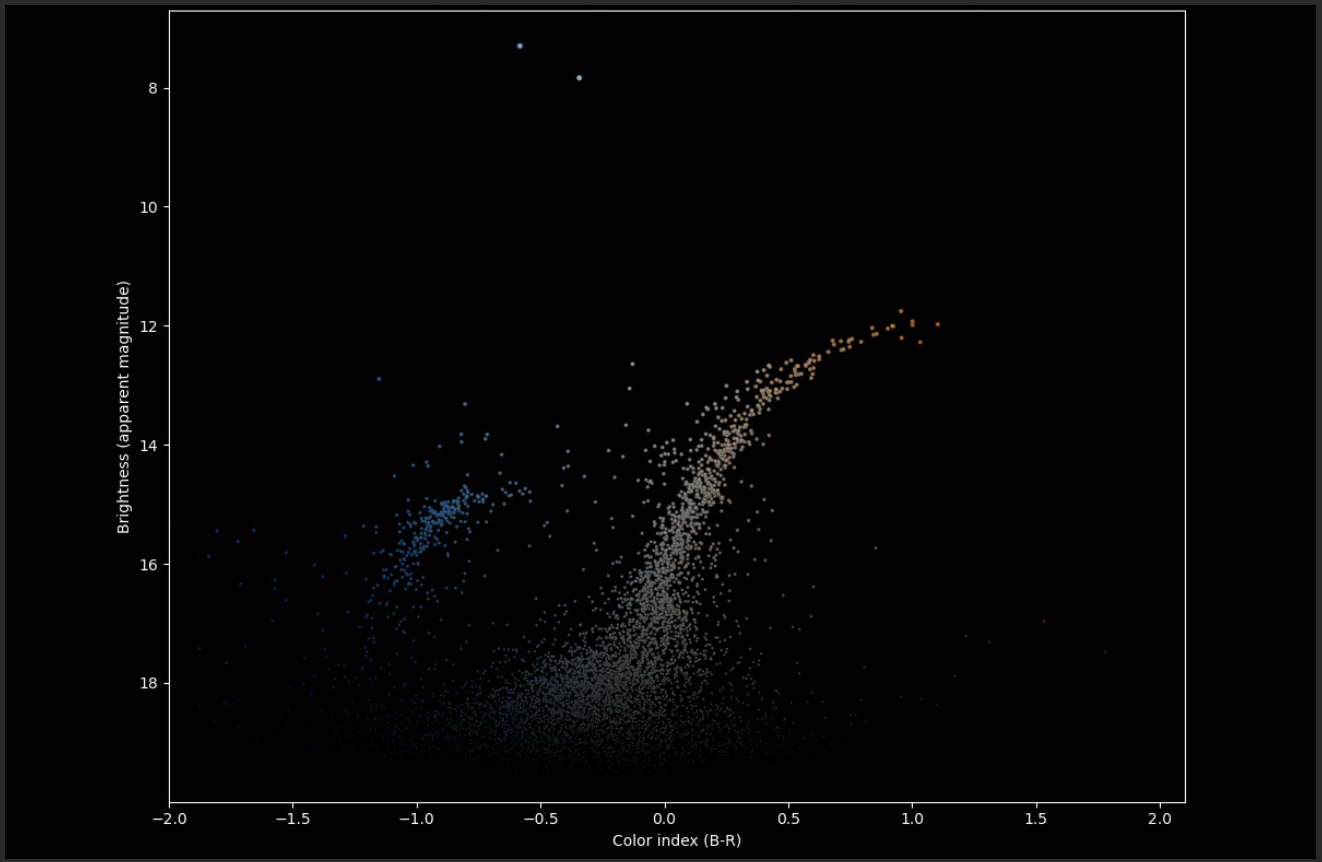
Assuming that the distance to RR-Lyrae is known, we can overlay an image of RR-Lyrae on an image of M13 to estimate the distance to the cluster.

Measuring Distances: RR-Lyrae and M13



Assuming that the distance to RR-Lyrae is known, we can overlay an image of RR-Lyrae on an image of M13 to estimate the distance to the cluster. The two data points brighter than magnitude 8 are the two instances of RR-Lyrae.

Measuring Distances: RR-Lyrae and M13



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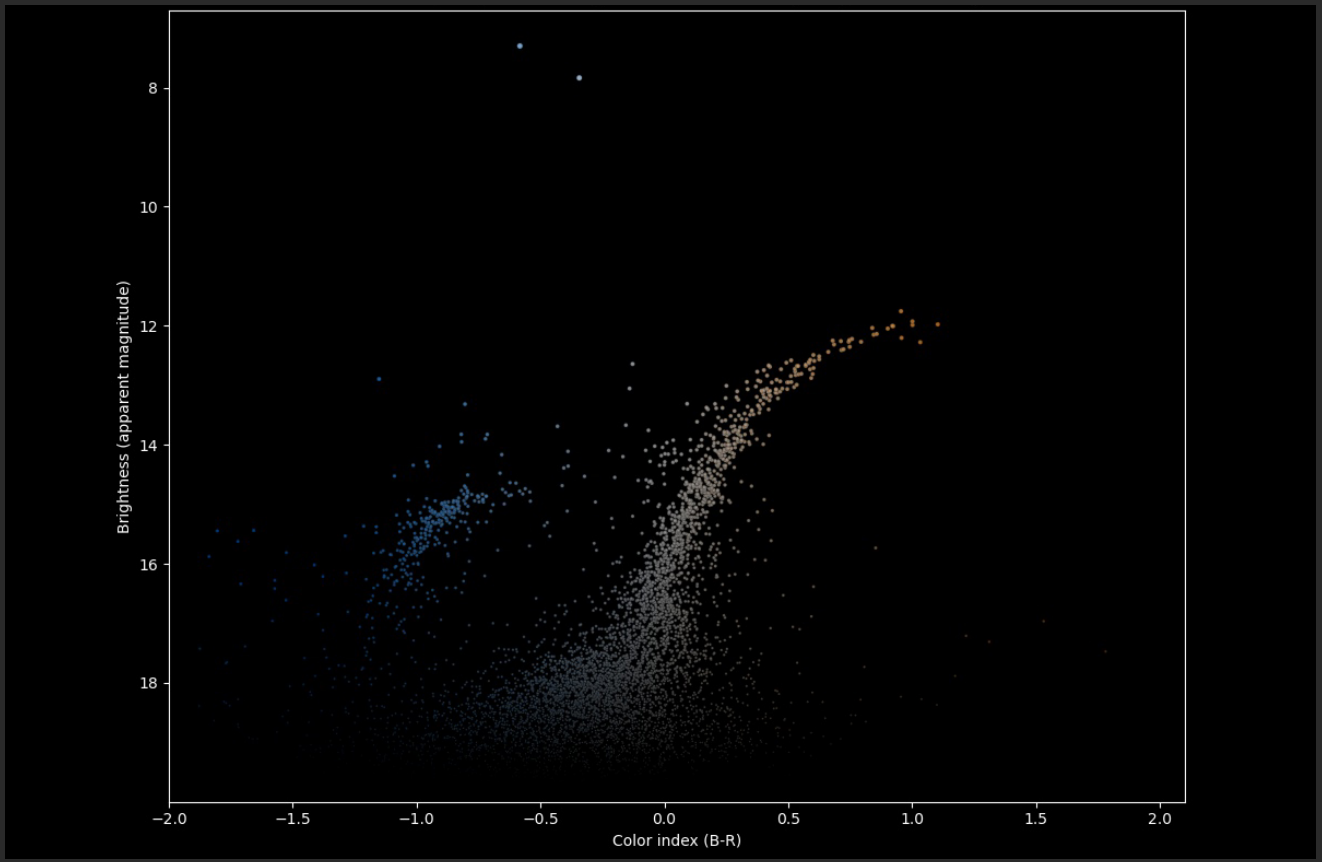
Measuring Distances: RR-Lyrae and M13



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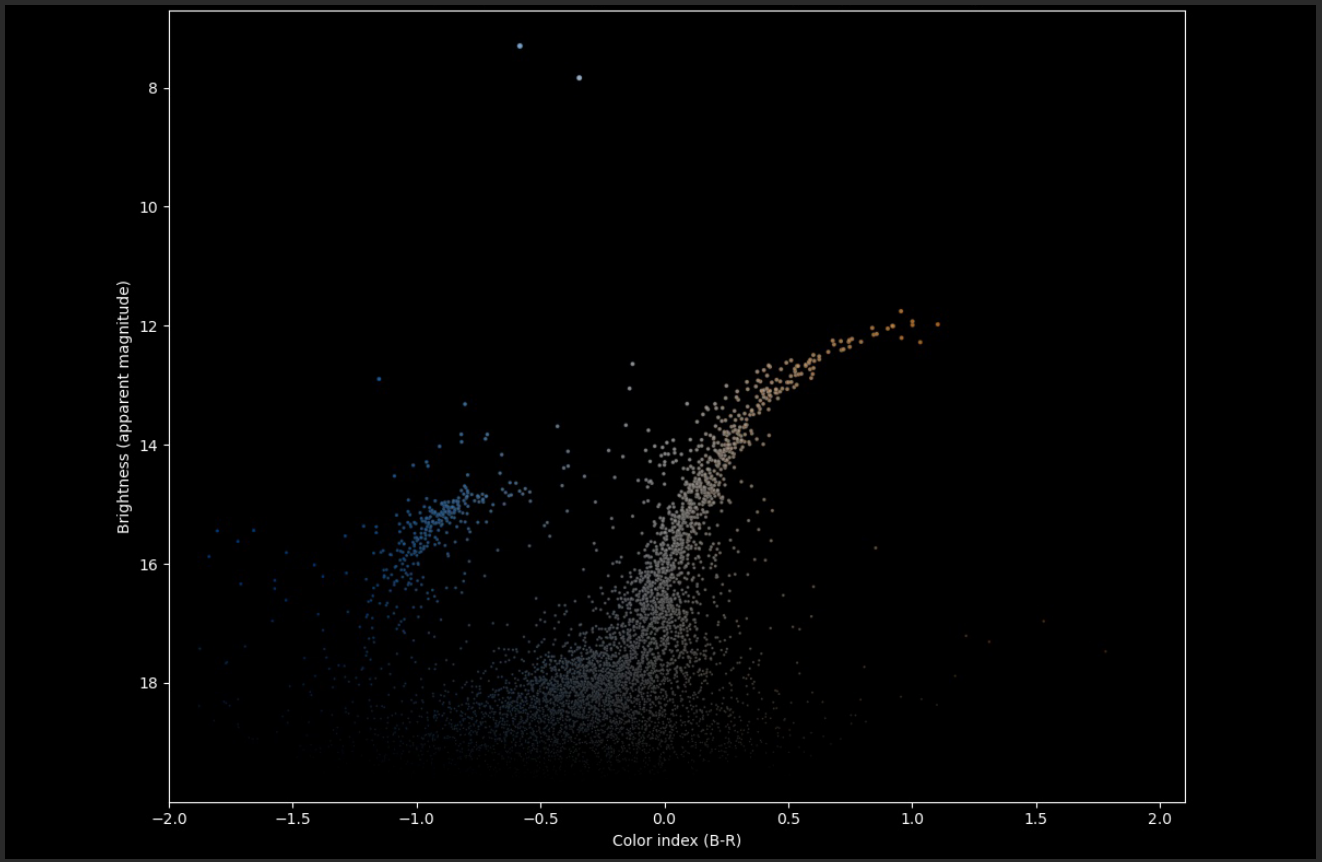
Measuring Distances: RR-Lyrae and M13



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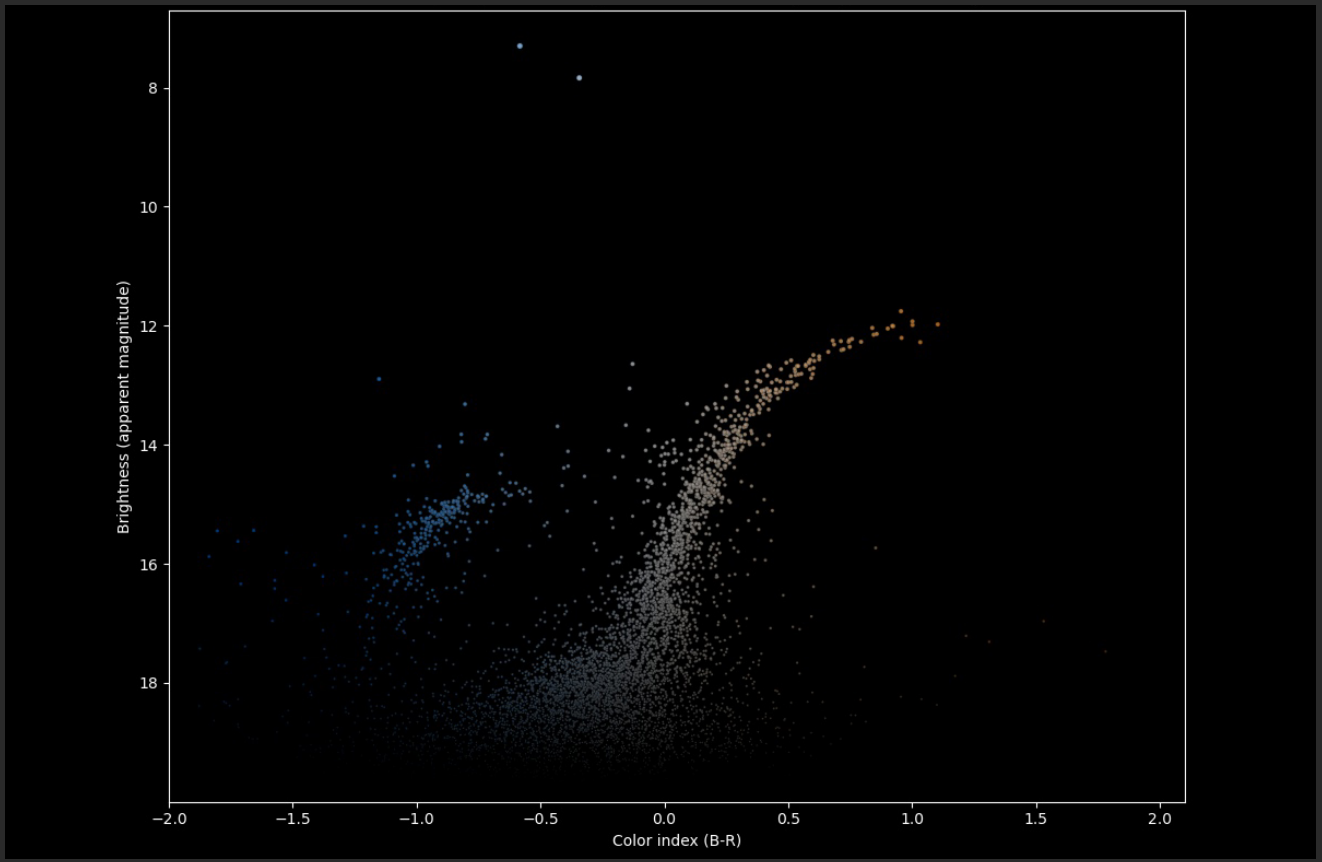
Measuring Distances: RR-Lyrae and M13



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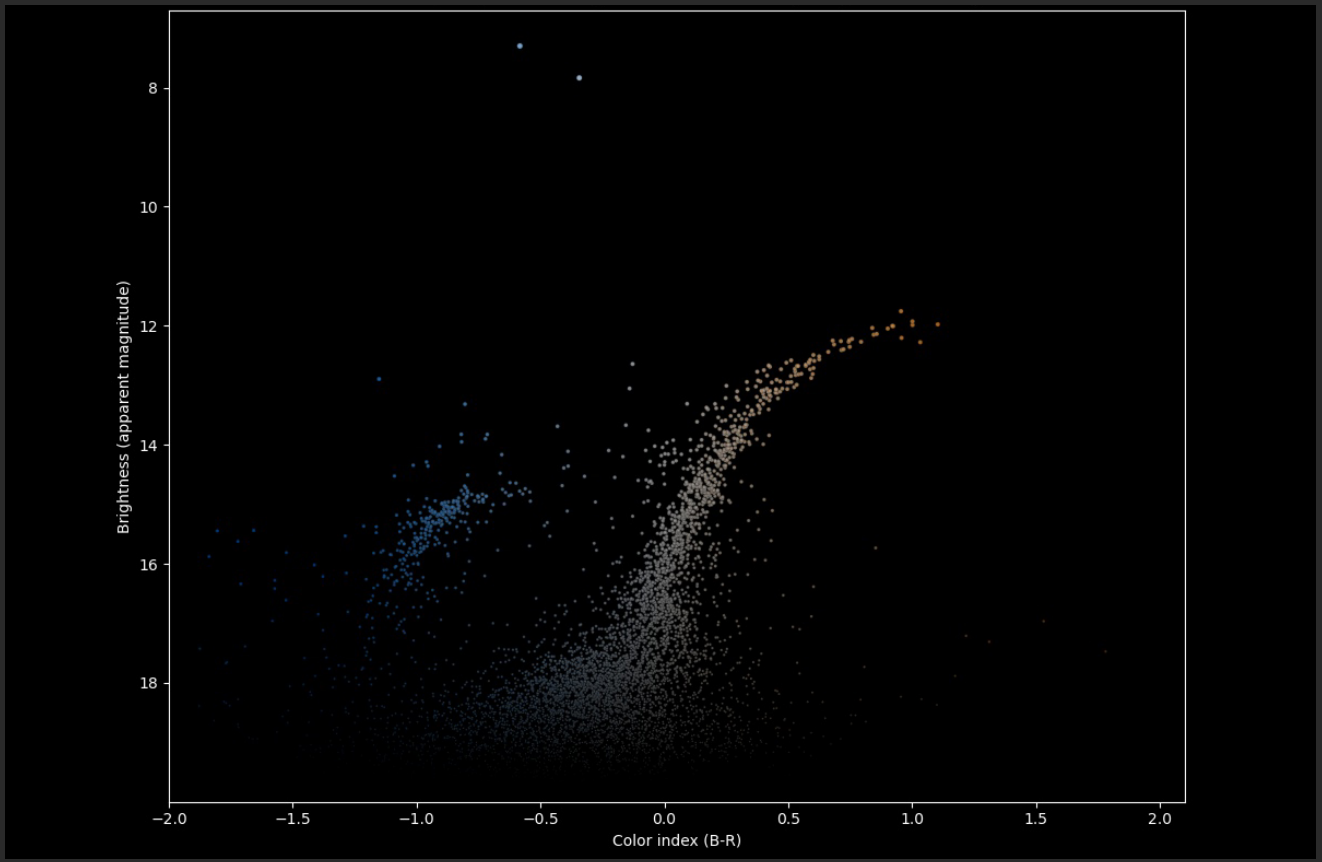
Measuring Distances: RR-Lyrae and M13



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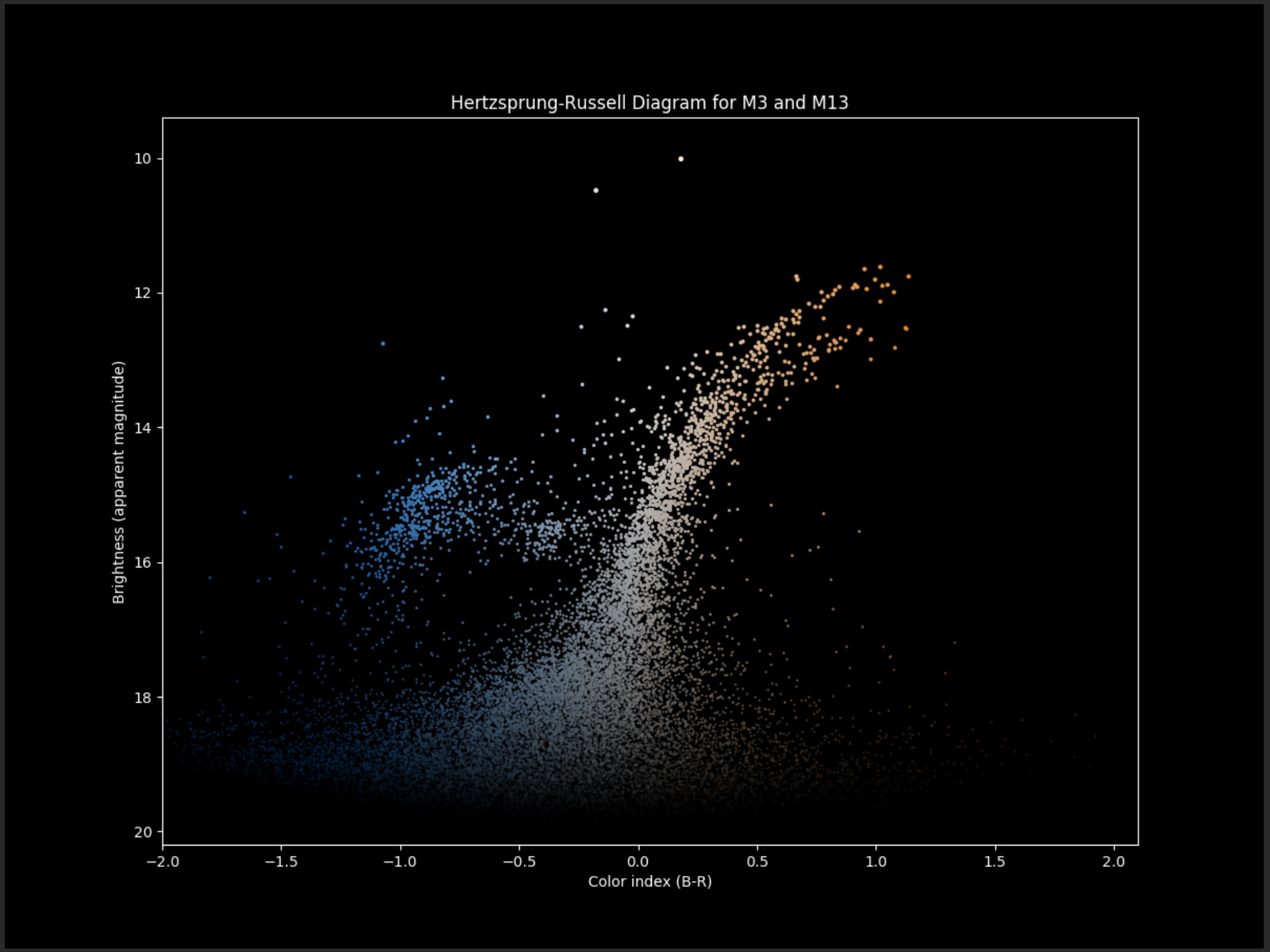
M3/M13 Comparison: Here's M3

M3/M13 Comparison: Here's M13

M3/M13 Comparison



M3/M13 Comparison

Click here to download the Python code.

The fits files can be accessed here:
https://vanderbei.princeton.edu/FRS_131/python/fits_files/m3-RGB.fit
https://vanderbei.princeton.edu/FRS_131/python/fits_files/m13-RGB.fit

Here's the output from Python:

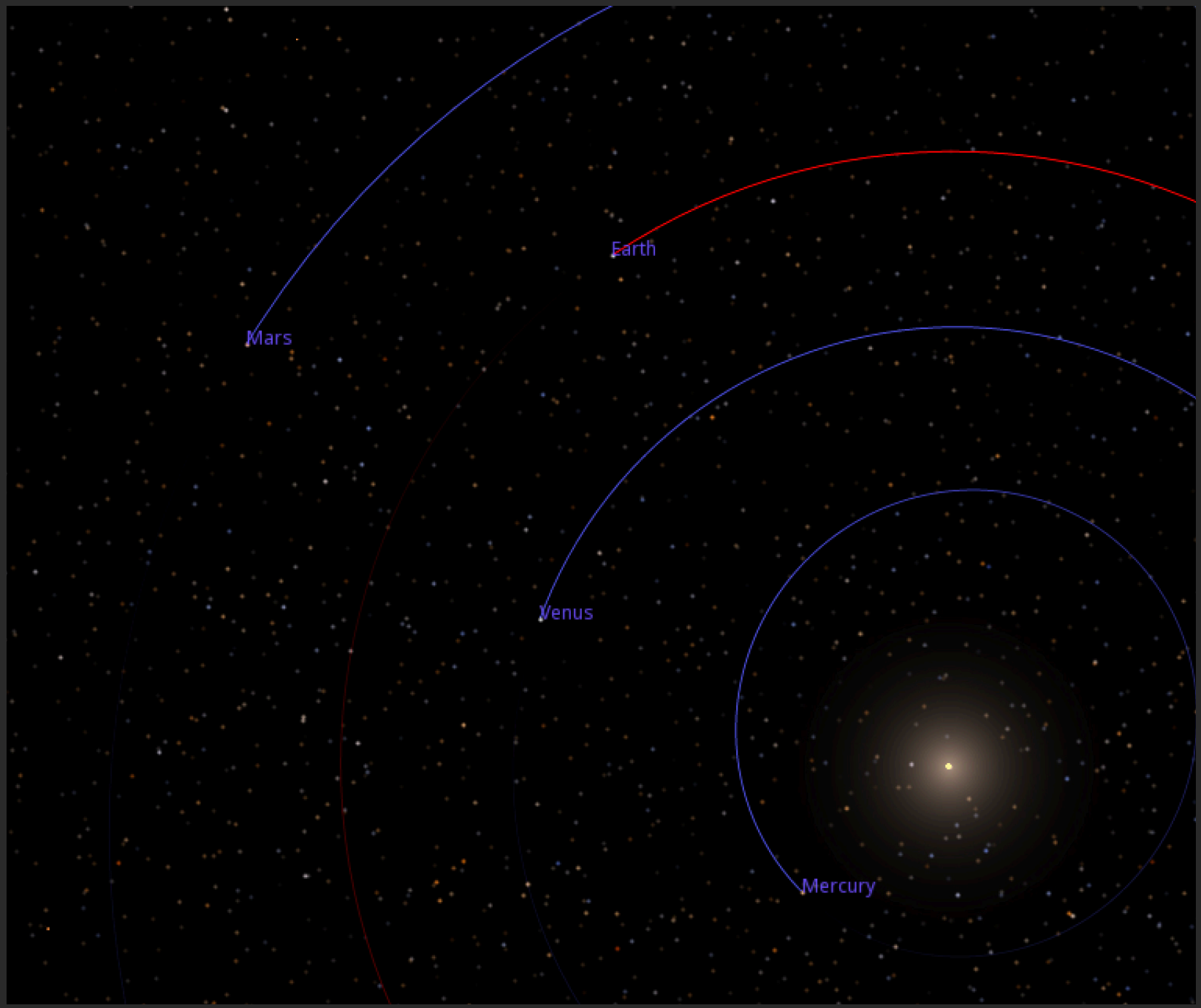
```
difference in brightness is about 0.8 magnitude
difference in flux = 10^(0.8/2.5) =  2.2909
relative distance factor = sqrt(flux) =  1.5136
```

From Wikipedia, we see that the true distances are:

```
M3 = 10.4 kpc and M13 = 6.8 kpc
true distance ratio = 10.4/6.8 =  1.5294
```

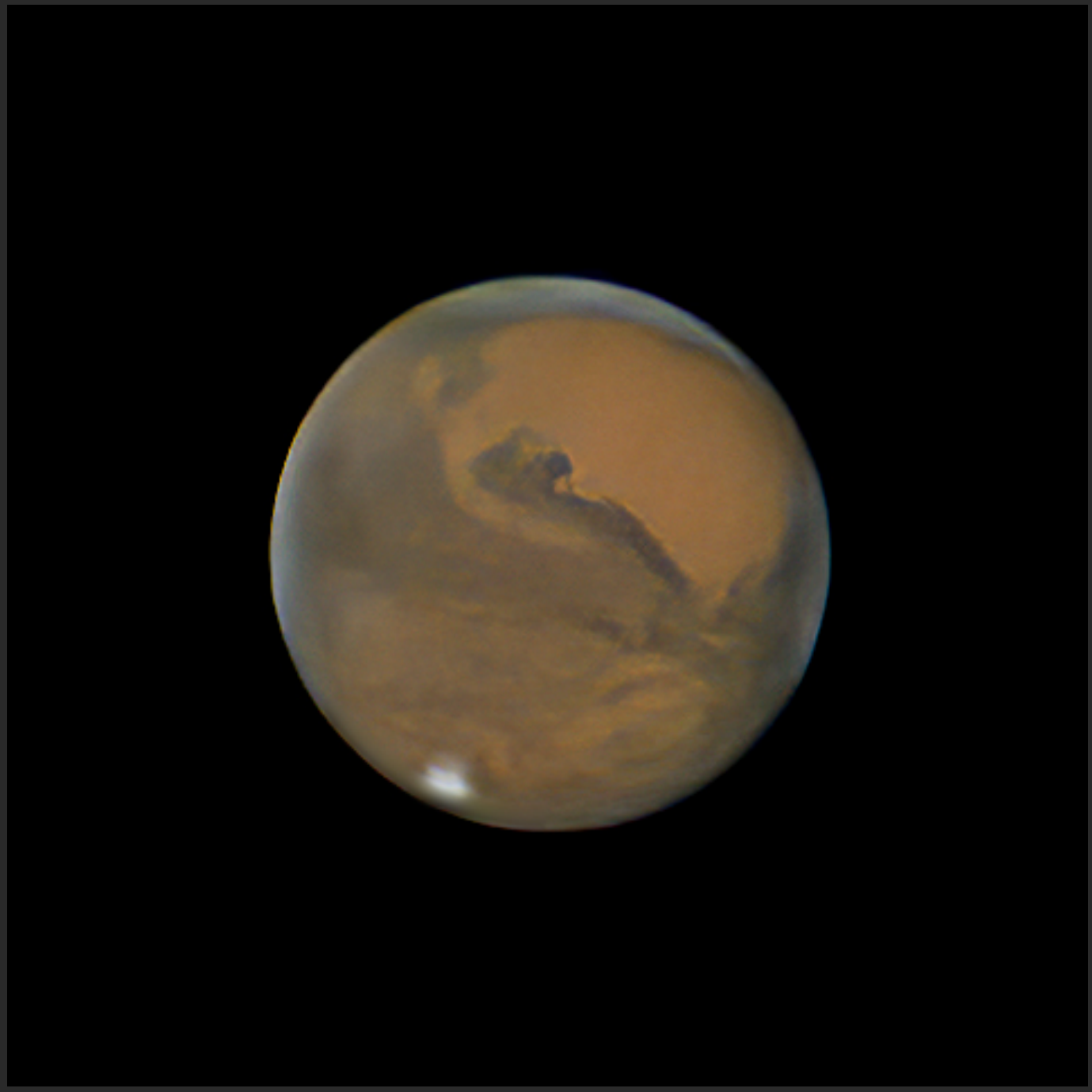
A Brief Step Back Toward Home

Earth "Passed" Mars in Oct. 2020



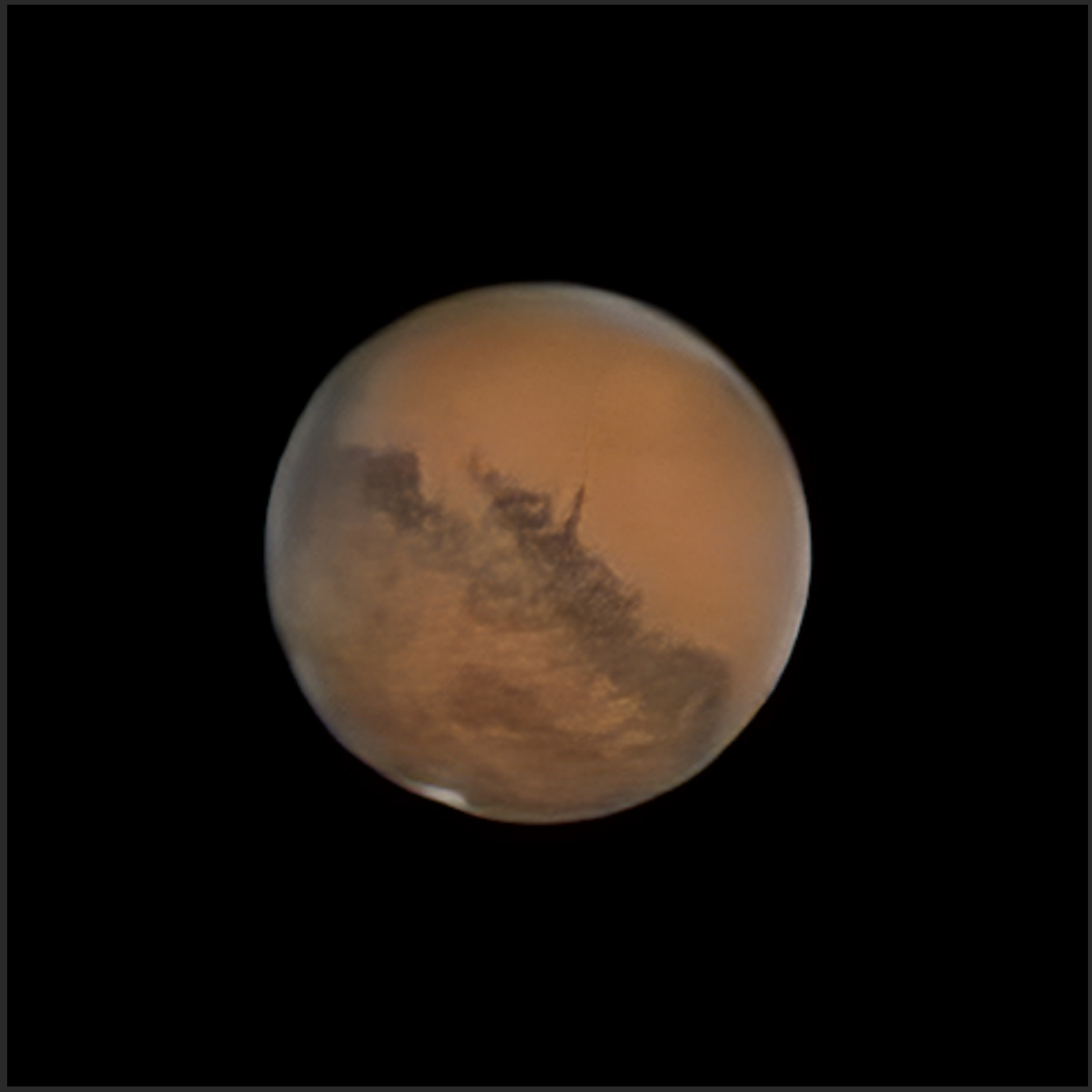
Mars

Oct. 6, 2020



Mars

Oct. 18, 2020



Questions?