Lecture 7

October 18, 2018

Galaxies and Data Analysis for Lab 4

News

- Lab 2 & 3
  - Handed back next week (I hope).
- Lab 4
  - Imaging the galaxies M31, M32, and M33.
  - Observing done, I will assign data to groups that got clouded out.
  - Due October 25
- Lab 5 (Transiting Exoplanets)
  - Handed out next week and observing will start

Galaxy & Stellar Photometry in Images

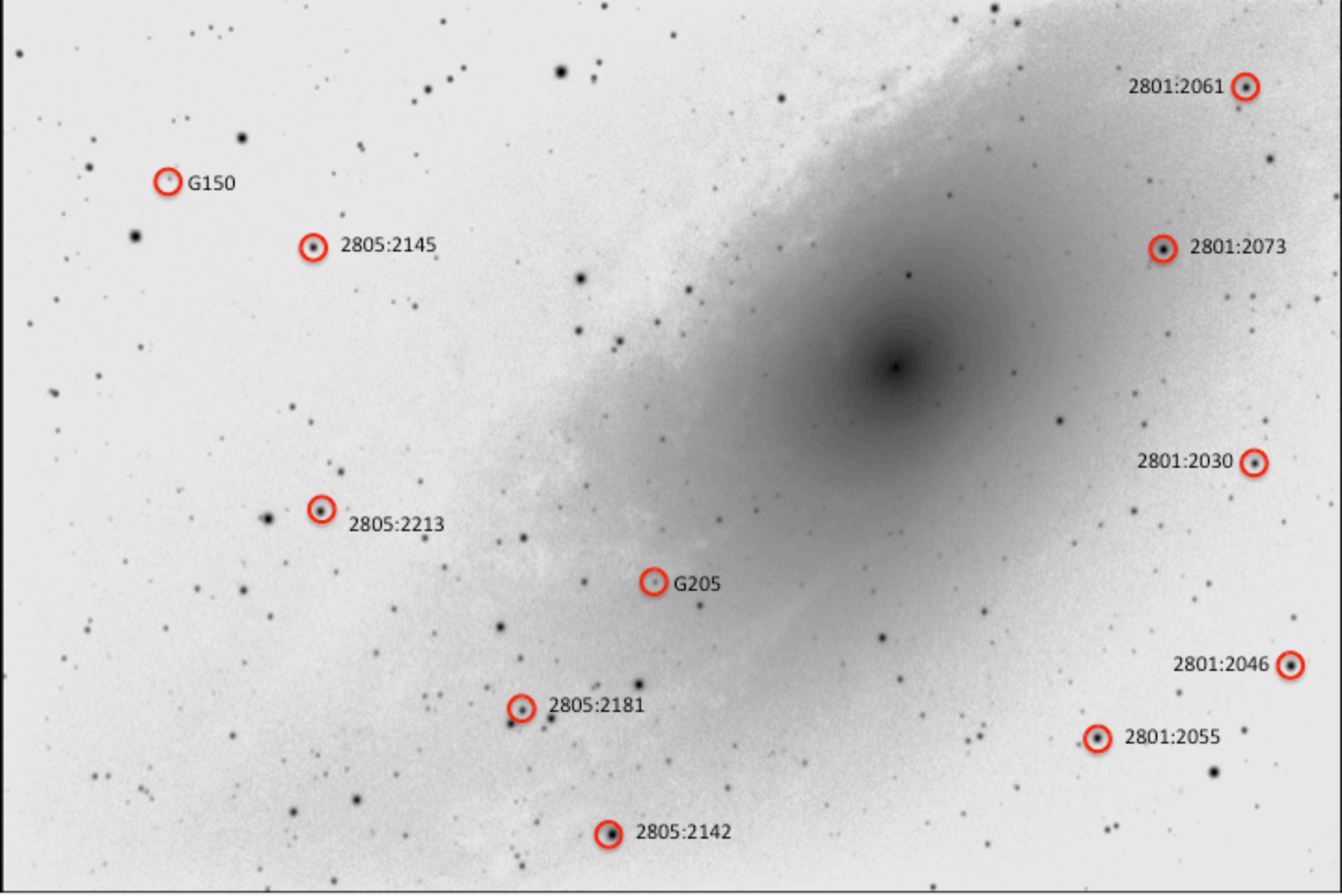
- Galaxy Structure (radial and azimuthal)
- Galaxy colors (light from a stellar population)
- Brightness of individual objects: clusters and stars

M31 V Oct 12 early

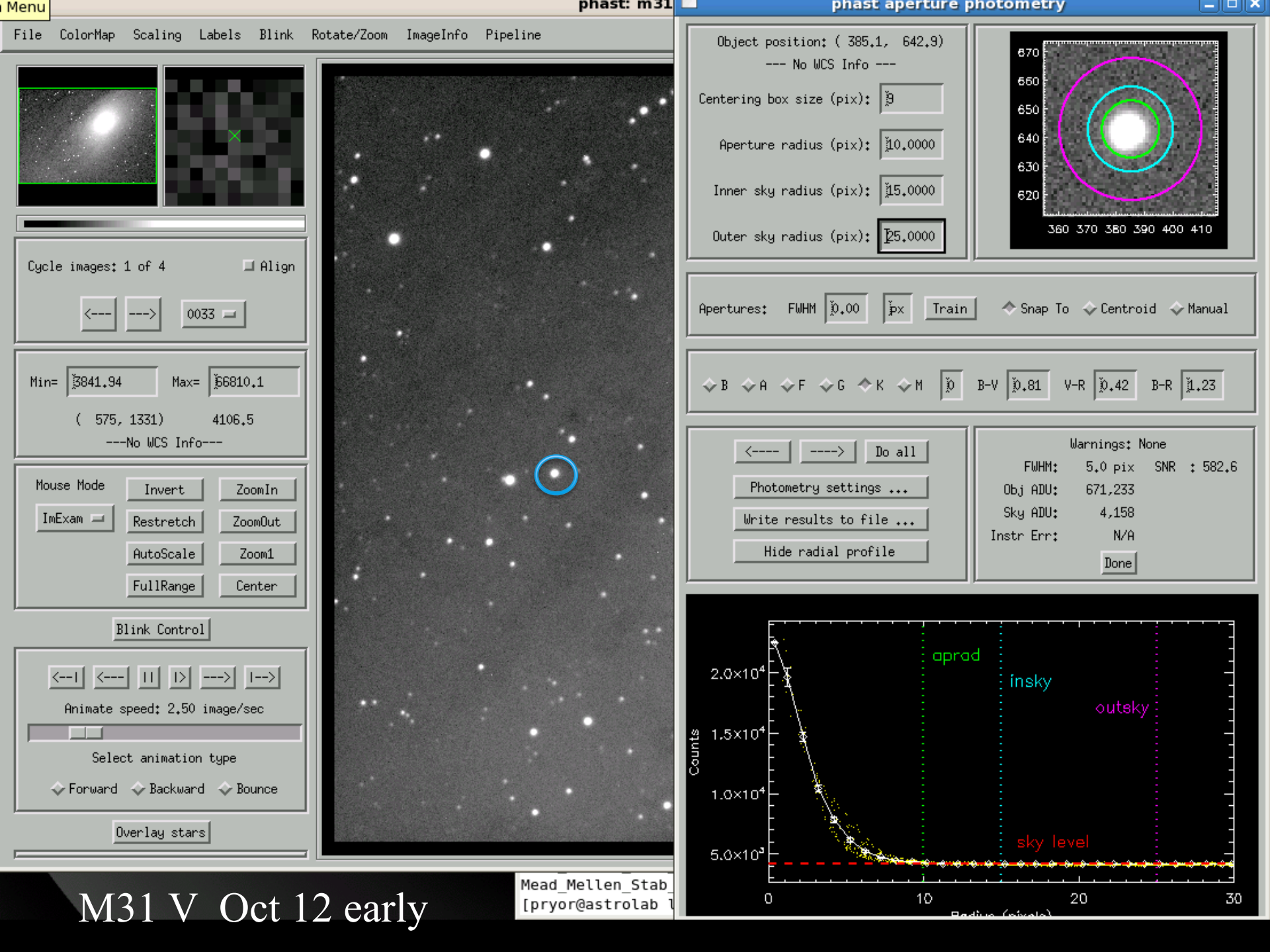
M31 V Oct 13 Prof Pryor (rotated, since taken W of meridian)

M31 V Oct 17 early

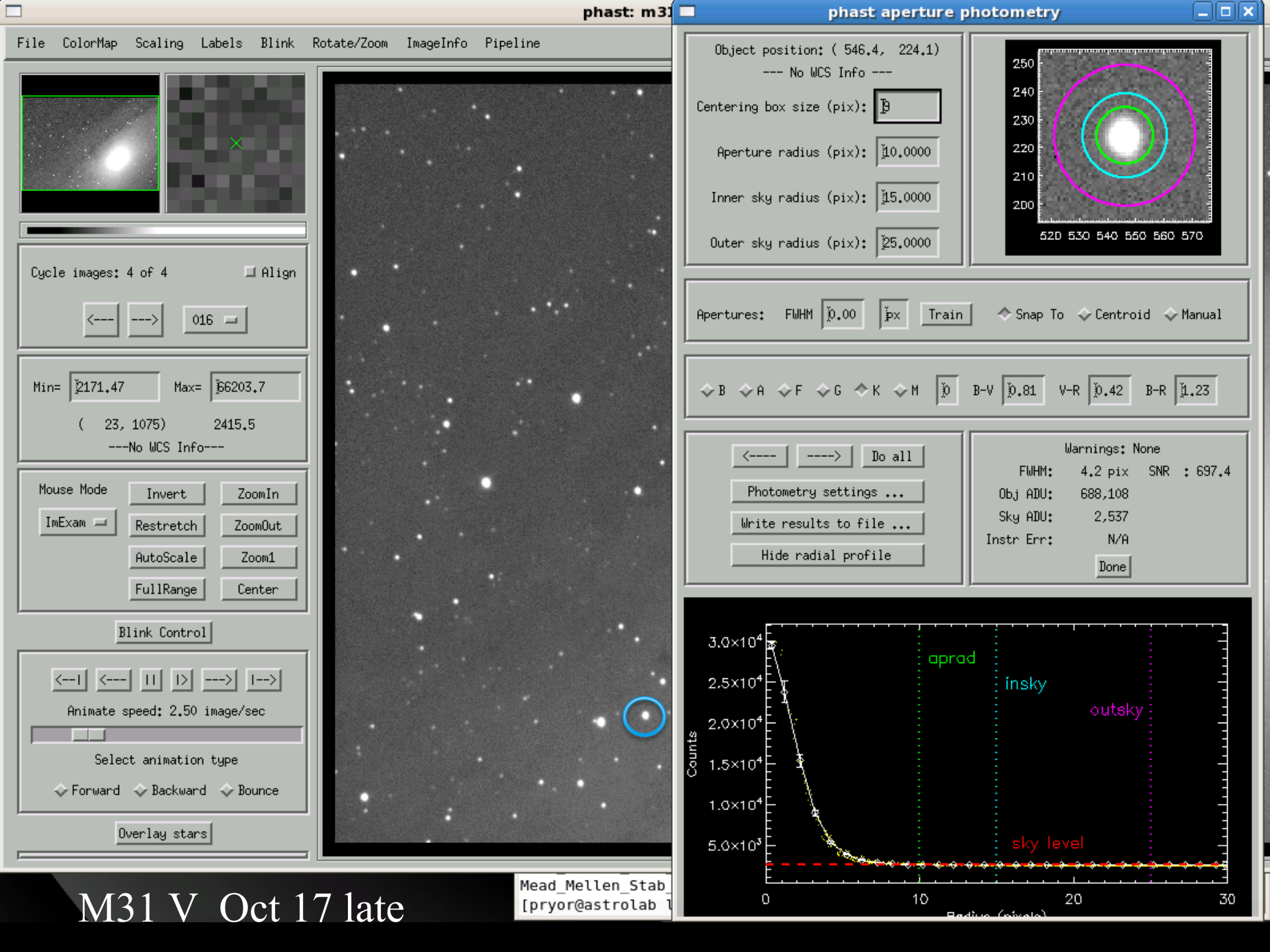
M31 V Oct 17 late



I performed photometry of GSC 2805:2213…



M31 V Oct 12 early


phast: m31
File ColorMap Scaling Labels Blink Rotate/Zoom ImageInfo Pipeline
Cycle images: 4 of 4
Align
<---
--->
016
Min= 2171.47
Max= 66203.7
(23, 1075) 2415.5
---No WCS Info---
Mouse Mode
ImExam
Invert
ZoomIn
Restretch
ZoomOut
AutoScale
Zoom1
FullRange
Center
Blink Control
<--I
<---
II
I>
--->
I-->
Animate speed: 2.50 image/sec
Select animation type
Forward
Backward
Bounce
Overlay stars
phast aperture photometry
Object position: (546.4, 224.1)
--- No WCS Info ---
Centering box size (pix): 9
Aperture radius (pix): 10.0000
Inner sky radius (pix): 15.0000
Outer sky radius (pix): 25.0000
250
240
230
220
210
200
520 530 540 550 560 570
Apertures: FWHM 0.00 px Train
Snap To
Centroid
Manual
B A F G K M 0 B-V 0.81 V-R 0.42 B-R 1.23
<----
---->
Do all
Photometry settings ...
Write results to file ...
Hide radial profile
Warnings: None
FWHM: 4.2 pix SNR : 697.4
Obj ADU: 688,108
Sky ADU: 2,537
Instr Err: N/A
Done
3.0x10^4
2.5x10^4
2.0x10^4
1.5x10^4
1.0x10^4
5.0x10^3
Counts
aprad
insky
outsky
sky level
0
10
20
30
Mead_Mellen_Stab
[pryor@astrolab
M31 V Oct 17 late

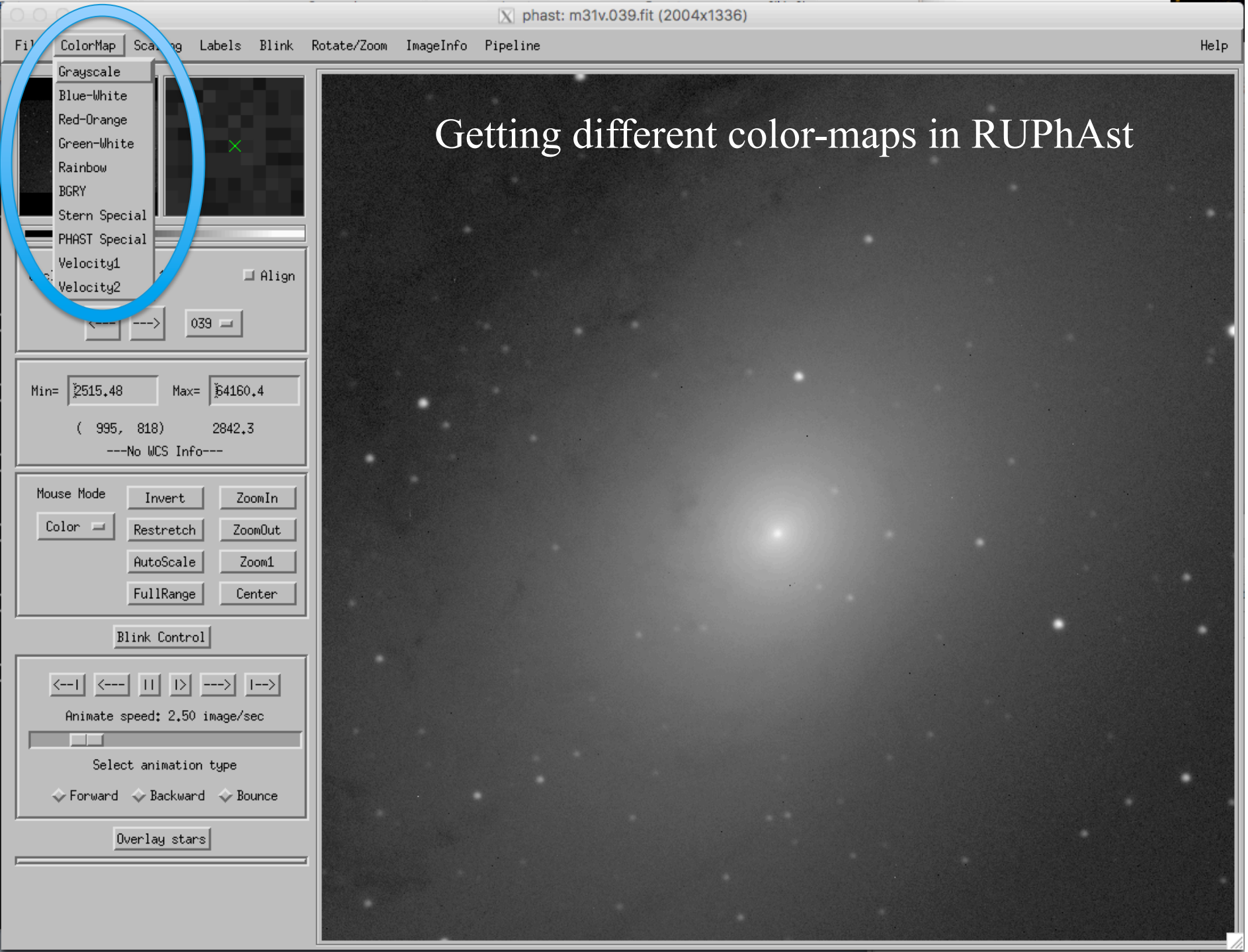
Photometry of GSC 2805:2213

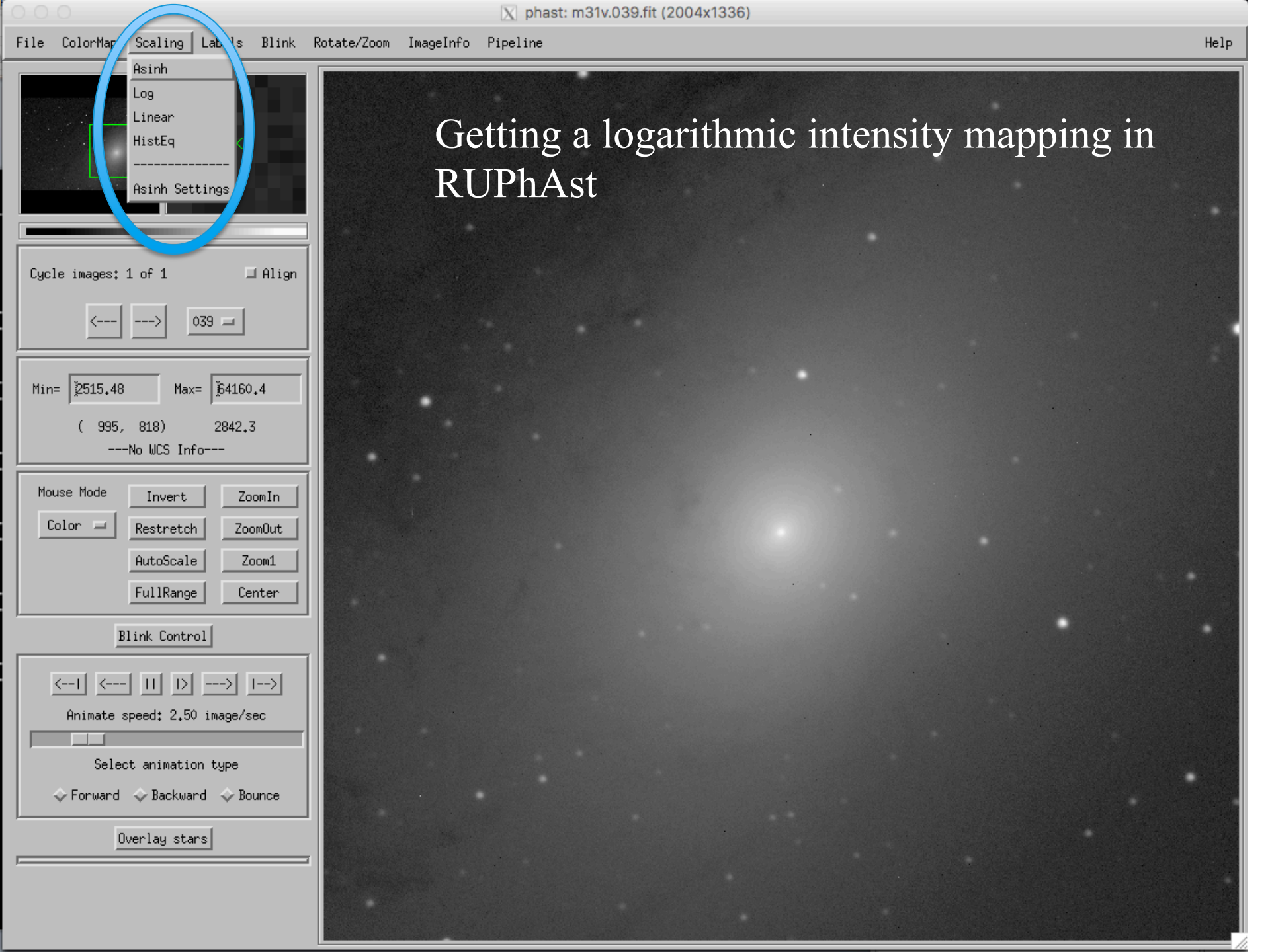
- Used the aperture photometry tool in the four images with an aperture radius of 10 pixels and a sky annulus with radii of 15 and 25 pixels.
- I did not convert to instrumental magnitudes
-

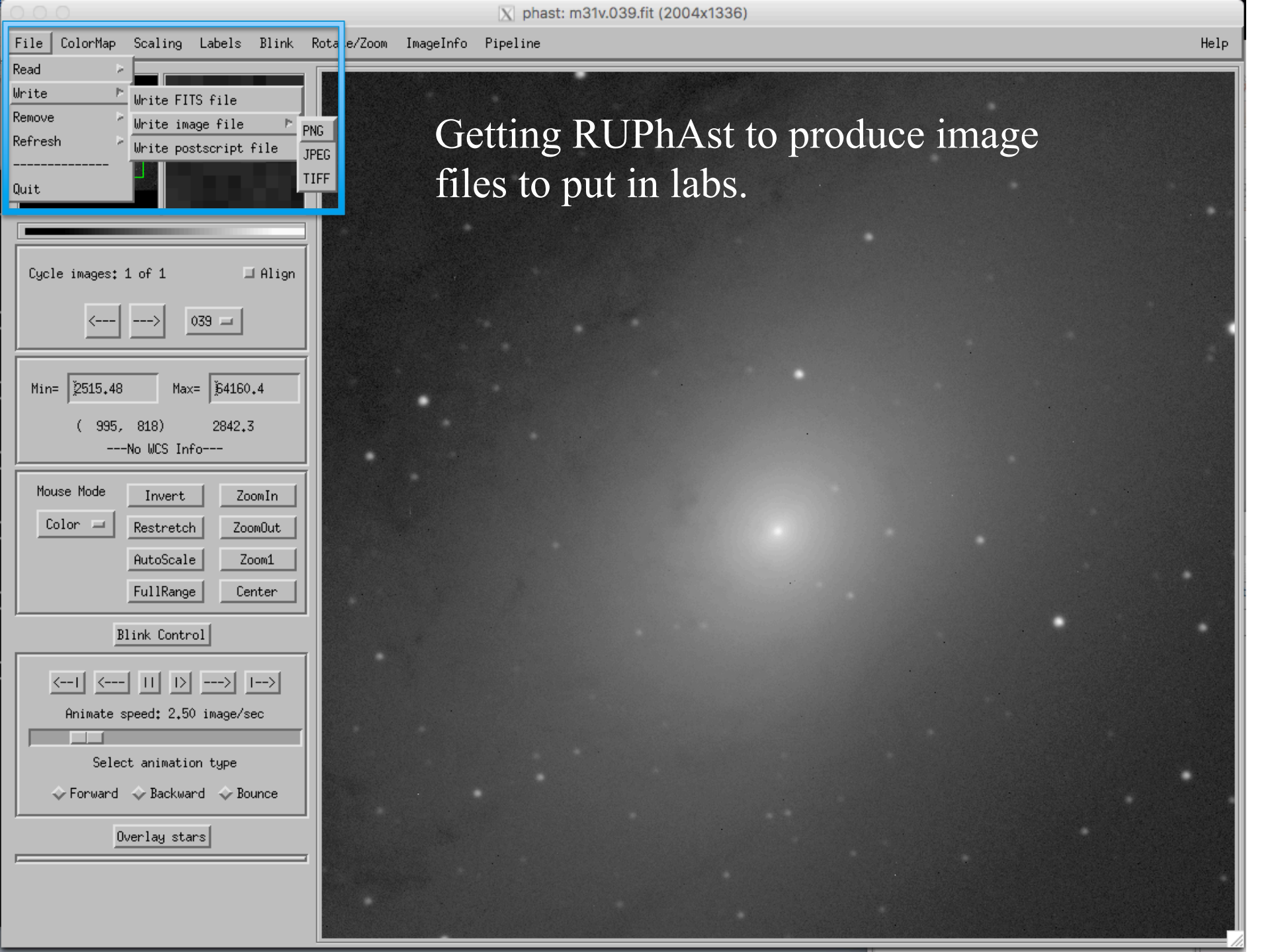
Image	object (ADU)	sky (ADU)
Oct 12 early	671,233	4158
Oct 13 TP	667,159	2025
Oct 17 early	667,122	3911
Oct 17 late	688,103	2537

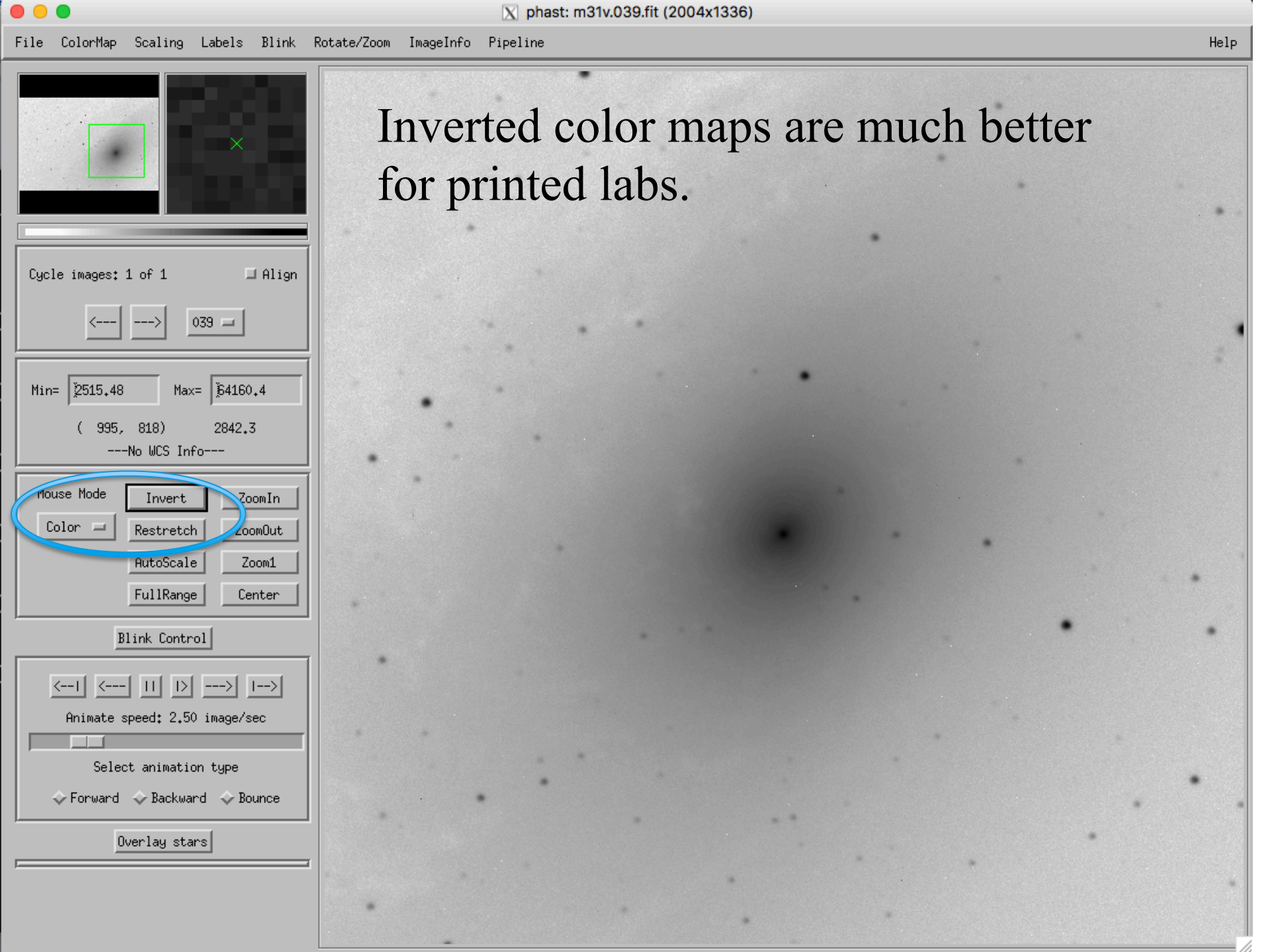
Galaxy & Stellar Photometry in Images

- Galaxy Structure (radial and azimuthal)
- Galaxy colors (light from a stellar population)
- Brightness of individual objects: clusters and stars


phast: m31v.039.fit (2004x1336)
ColorMap
Labels
Blink
Rotate/Zoom
ImageInfo
Pipeline
Help
Grayscale
Blue-White
Red-Orange
Green-White
Rainbow
BGRY
Stern Special
PHAST Special
Velocity1
Velocity2
Align
039
Min= 2515.48
Max= 64160.4
(995, 818) 2842.3
---No WCS Info---
Mouse Mode
Color
Invert
ZoomIn
Restretch
ZoomOut
AutoScale
Zoom1
FullRange
Center
Blink Control
Animate speed: 2.50 image/sec
Select animation type
Forward
Backward
Bounce
Overlay stars
Getting different color-maps in RUPhAst


phast: m31v.039.fit (2004x1336)
File
ColorMap
Scaling
Labels
Blink
Rotate/Zoom
ImageInfo
Pipeline
Help
Asinh
Log
Linear
HistEq
Asinh Settings
Cycle images: 1 of 1
Align
<---
--->
039
Min= 2515.48
Max= 64160.4
(995, 818) 2842.3
---No WCS Info---
Mouse Mode
Color
Invert
ZoomIn
Restretch
ZoomOut
AutoScale
Zoom1
FullRange
Center
Blink Control
<--|
<---
||
|>
--->
|-->
Animate speed: 2.50 image/sec
Select animation type
Forward
Backward
Bounce
Overlay stars
Getting a logarithmic intensity mapping in RUPhAst


phast: m31v.039.fit (2004x1336)
File
ColorMap
Scaling
Labels
Blink
Rotate/Zoom
ImageInfo
Pipeline
Help
Read
Write
Remove
Refresh
Quit
Write FITS file
Write image file
Write postscript file
PNG
JPEG
TIFF
Getting RUPhAst to produce image files to put in labs.
Cycle images: 1 of 1
Align
<---
--->
039
Min= 2515.48
Max= 64160.4
(995, 818) 2842.3
---No WCS Info---
Mouse Mode
Color
Invert
ZoomIn
Restretch
ZoomOut
AutoScale
Zoom1
FullRange
Center
Blink Control
Animate speed: 2.50 image/sec
Select animation type
Forward
Backward
Bounce
Overlay stars


phast: m31v.039.fit (2004x1336)
File ColorMap Scaling Labels Blink Rotate/Zoom ImageInfo Pipeline Help
Cycle images: 1 of 1
Align
<--- ---> 039
Min= 2515.48 Max= 64160.4
(995, 818) 2842.3
---No WCS Info---
Mouse Mode
Color
Invert
Restretch
AutoScale
FullRange
ZoomIn
ZoomOut
Zoom1
Center
Blink Control
<--| <--- || |> ---> |-->
Animate speed: 2.50 image/sec
Select animation type
Forward Backward Bounce
Overlay stars
Inverted color maps are much better for printed labs.

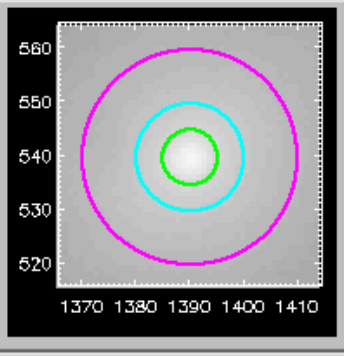
Galaxy & Stellar Photometry in Images

- Galaxy Structure (radial and azimuthal)
  - Nucleus
  - Spheroid ("bulge" in disk galaxies; elliptical galaxies are all spheroid)
  - Disk (may have central bar, outer warps)
- Galaxy colors (light from a stellar population)
  - Primary influence: age (young = blue, old = red)
  - Secondary: metallicity (decreasing metallicity makes the light from a stellar population bluer)
- Brightness of individual objects: clusters and stars

phast aperture photometry

Object position: (1390.2, 539.7)
--- No WCS Info ---

Centering box size (pix): 9
Aperture radius (pix): 5.00000
Inner sky radius (pix): 10.0000
Outer sky radius (pix): 20.0000

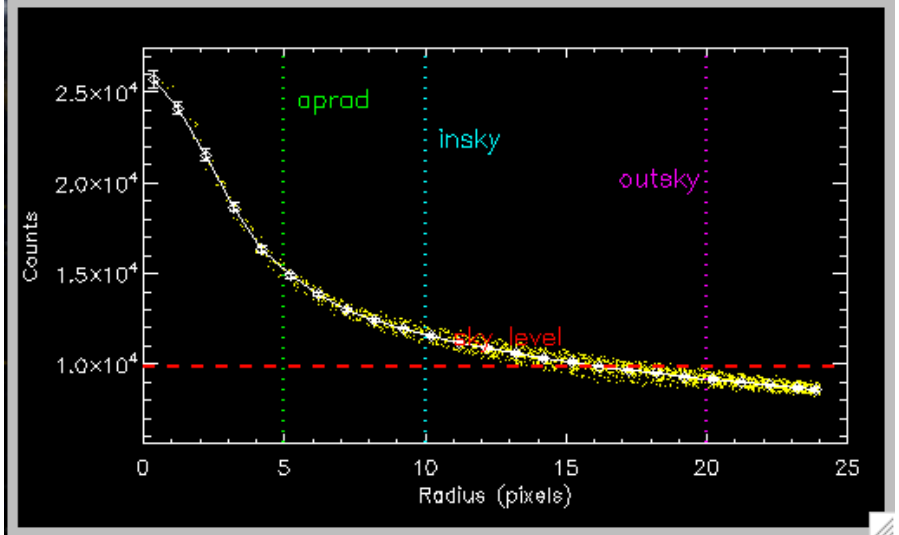


Apertures: FWHM 0.00 px Train Snap To Centroid Manual

B A F G K M 0 B-V 0.81 V-R 0.42 B-R 1.23

<---- ----> Do all
Photometry settings ...
Write results to file ...
Hide radial profile

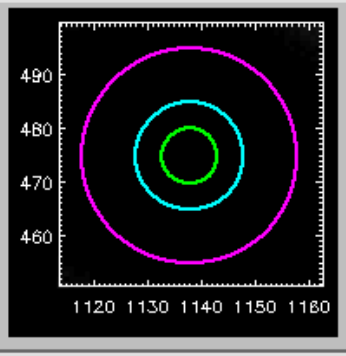
Warnings: None
FWHM: 8.4 pix SNR : 102.6
Obj ADU: 695,802
Sky ADU: 9,811
Instr Err: N/A
Done



phast aperture photometry

Object position: (1138.0, 474.7)
--- No WCS Info ---

Centering box size (pix): 9
Aperture radius (pix): 5.00000
Inner sky radius (pix): 10.0000
Outer sky radius (pix): 20.0000

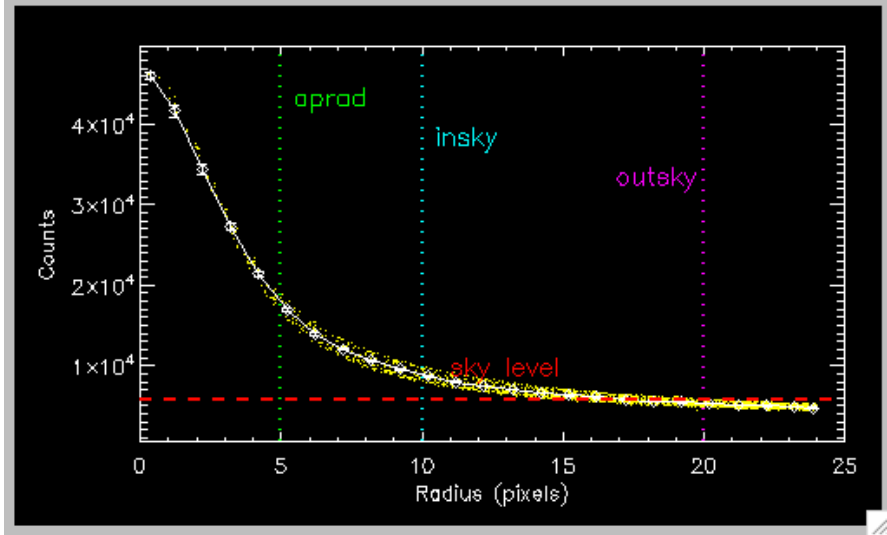


Apertures: FWHM 0.00 px Train Snap To Centroid Manual

B A F G K M 0 B-V 0.81 V-R 0.42 B-R 1.23

<---- ----> Do all
Photometry settings ...
Write results to file ...
Hide radial profile

Warnings: None
FWHM: 7.2 pix SNR : 180.7
Obj ADU: 1,694,476
Sky ADU: 5,737
Instr Err: N/A
Done

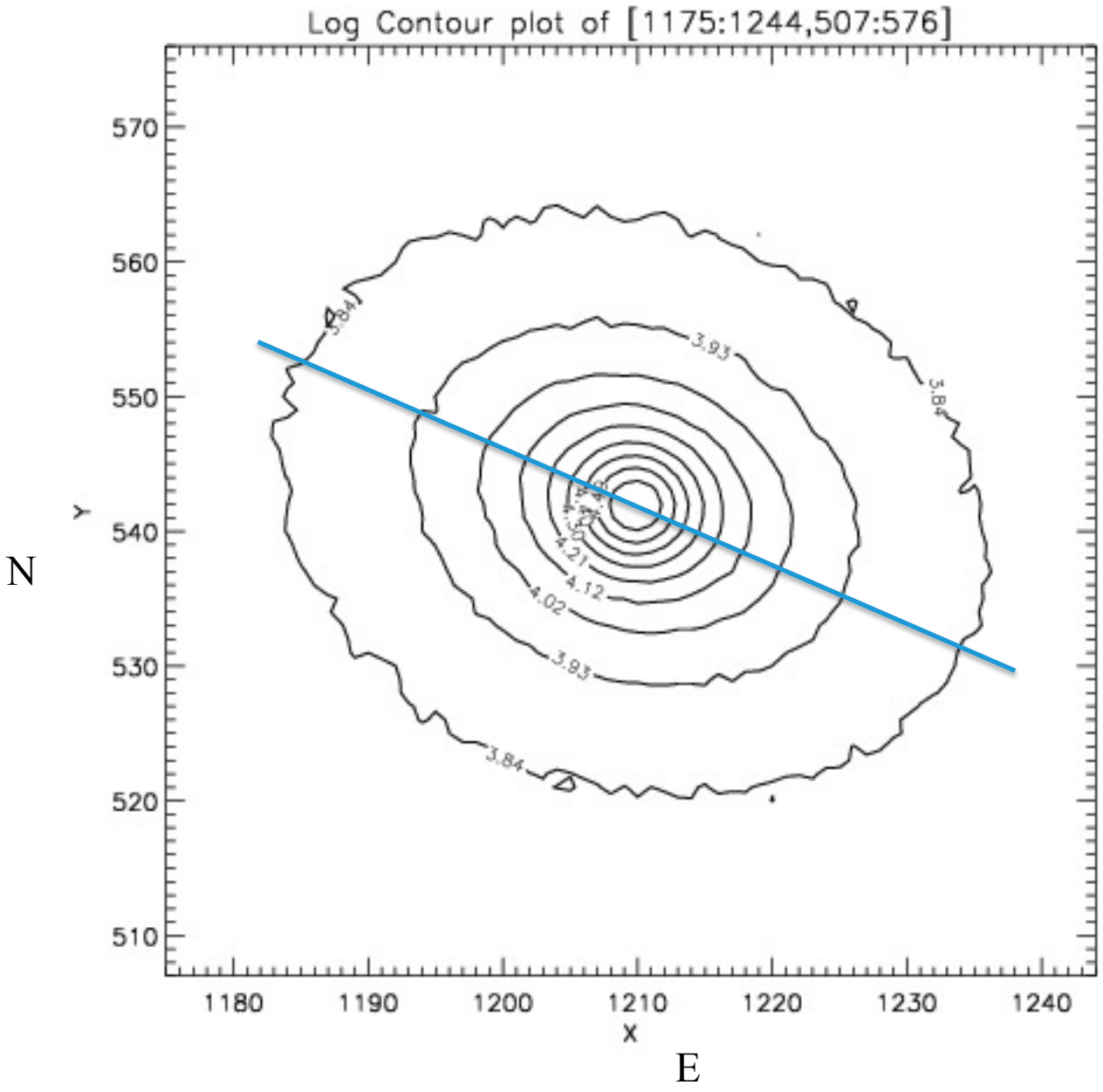


Lab 4: Galaxy Surface Photometry

- Galaxies are not resolved into stars (certainly not in our telescope!)
  - So measure amount of light per area (mag/sq arcmin)
- Measure projected shape of light distribution.
  - Shape is elliptical to first order.
    - "Disky" and "boxy" departures from ellipses are seen.
  - Ellipticity and position angle of major axis can vary with radius.
    - Ellipticity: $\varepsilon = 1 - b/a$; b=minor axis, a=major axis
    - Position angle: angle from North to major axis (measured positive through east).

Log Scaling

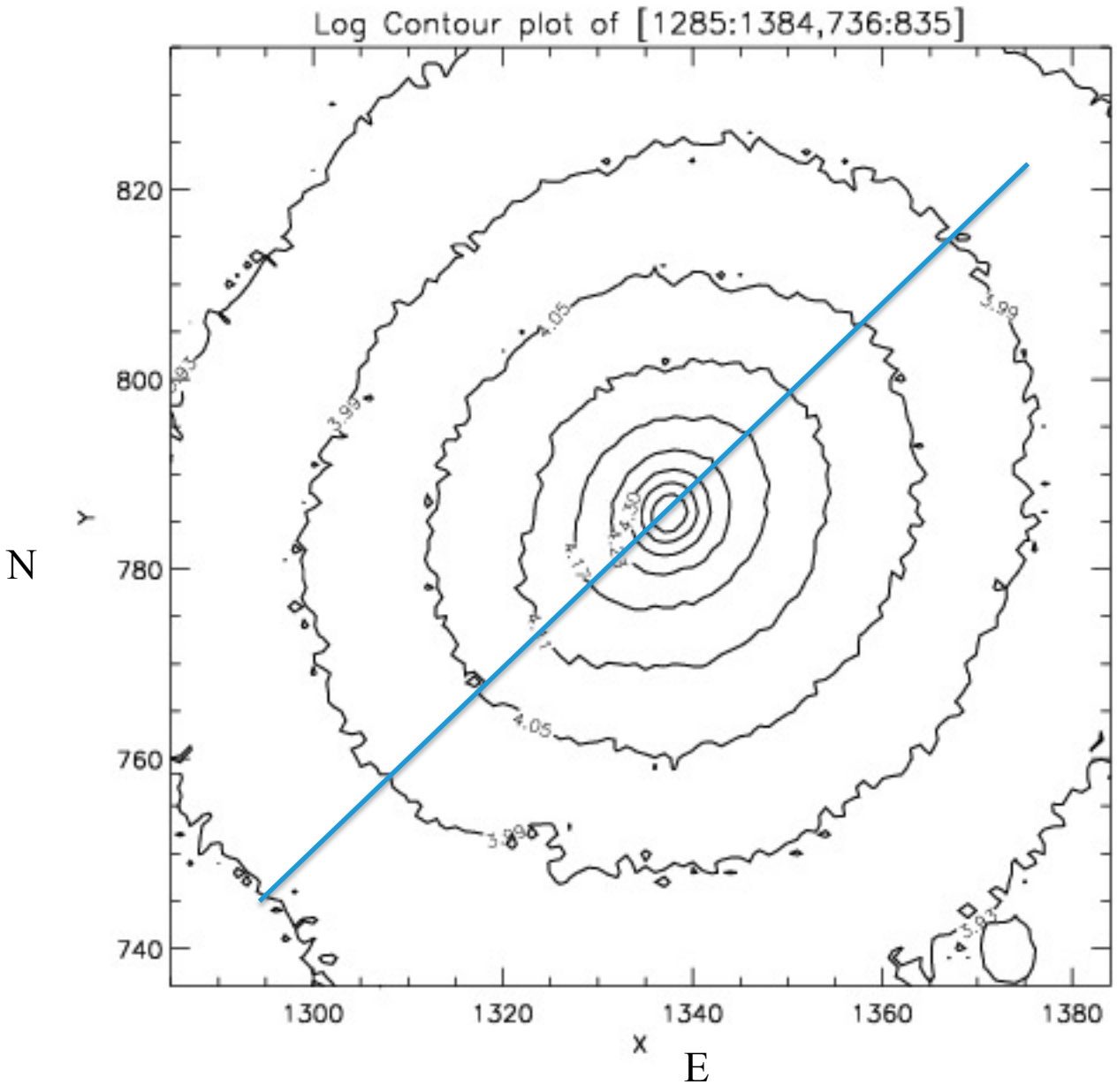
M32 V



Logarithmically spaced contours (select log scaling in RUPhAst)

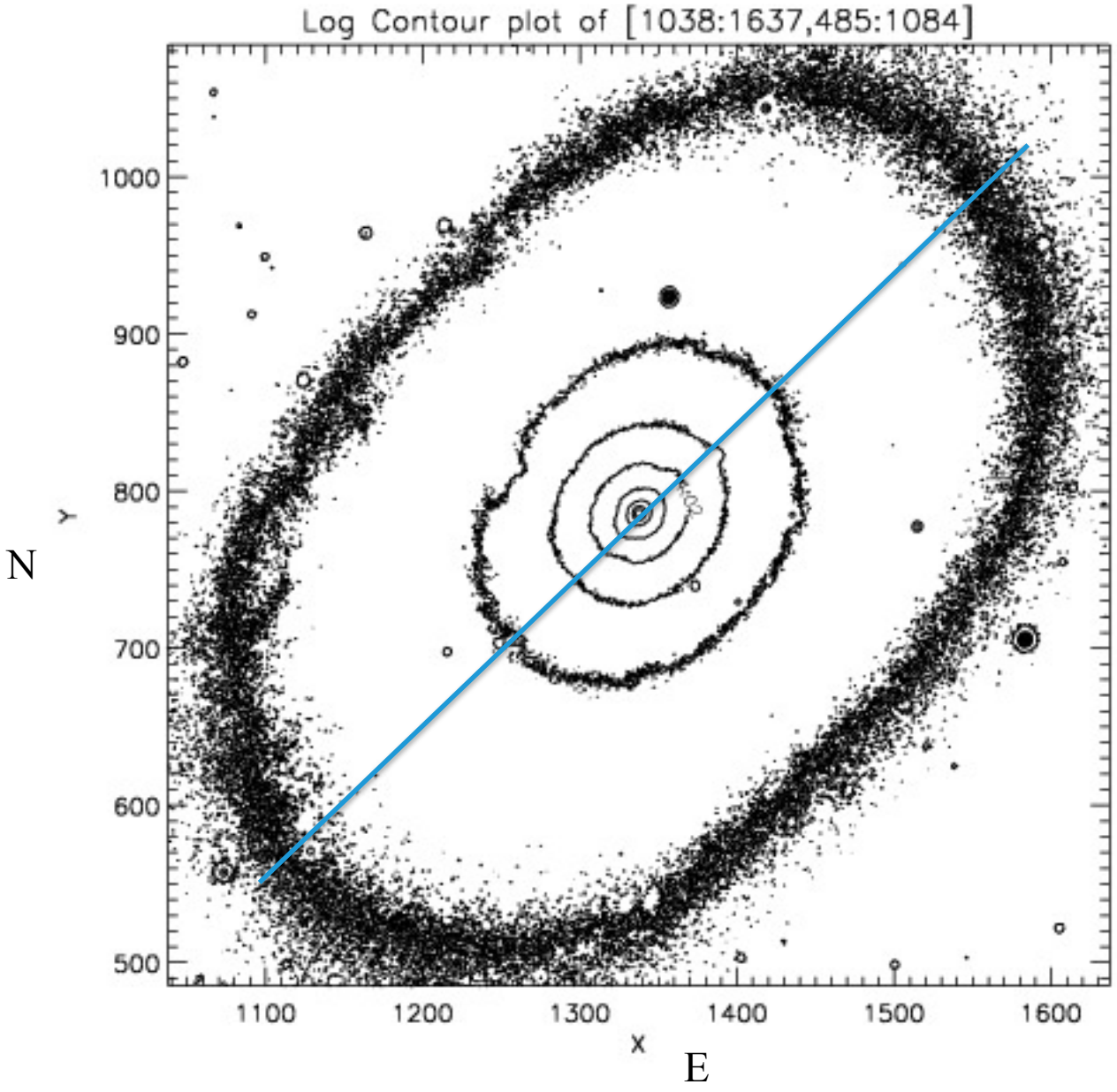
Log Scaling

M31 V



Logarithmically spaced contours (select log scaling in RUPhAst)

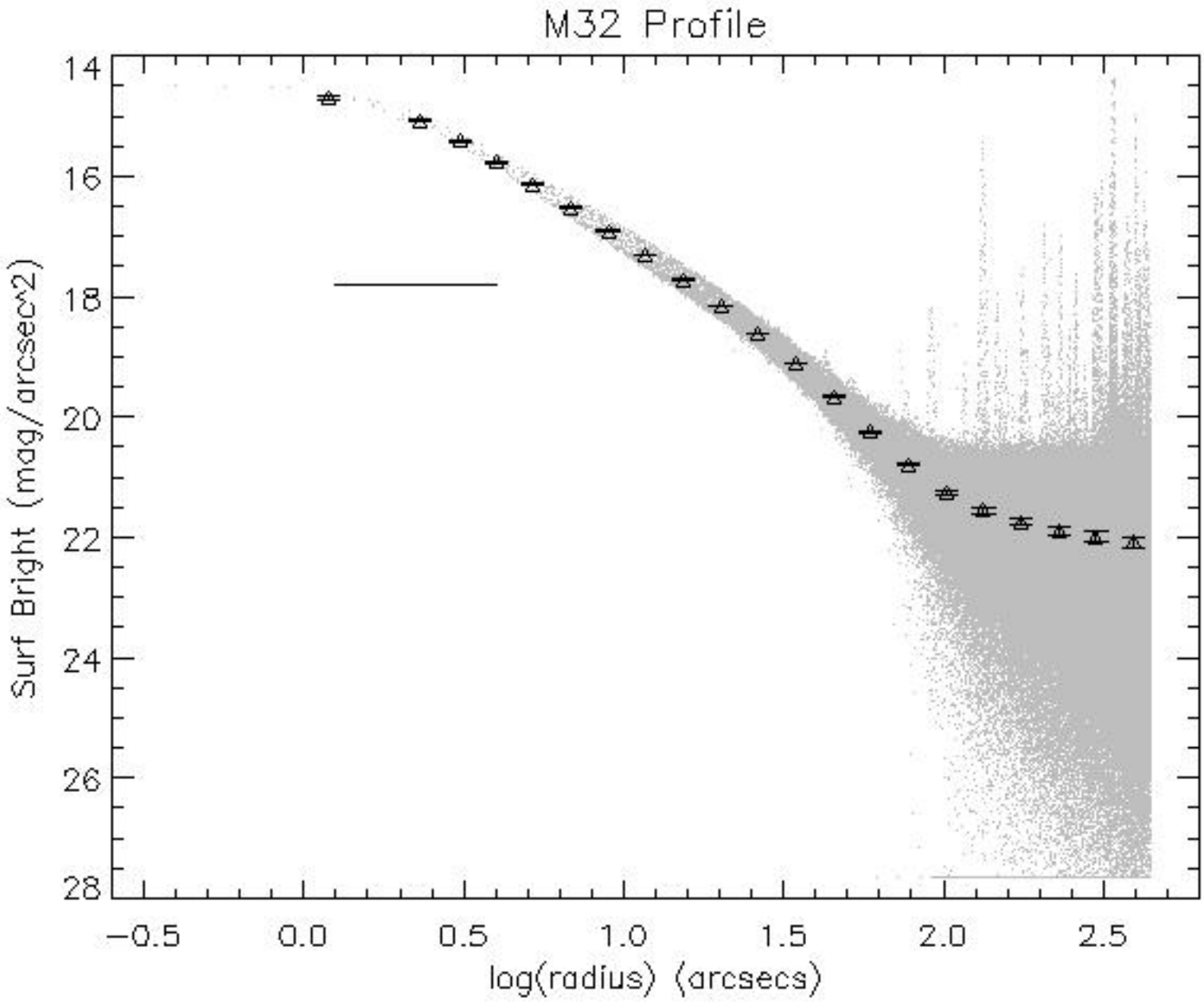
M31 V

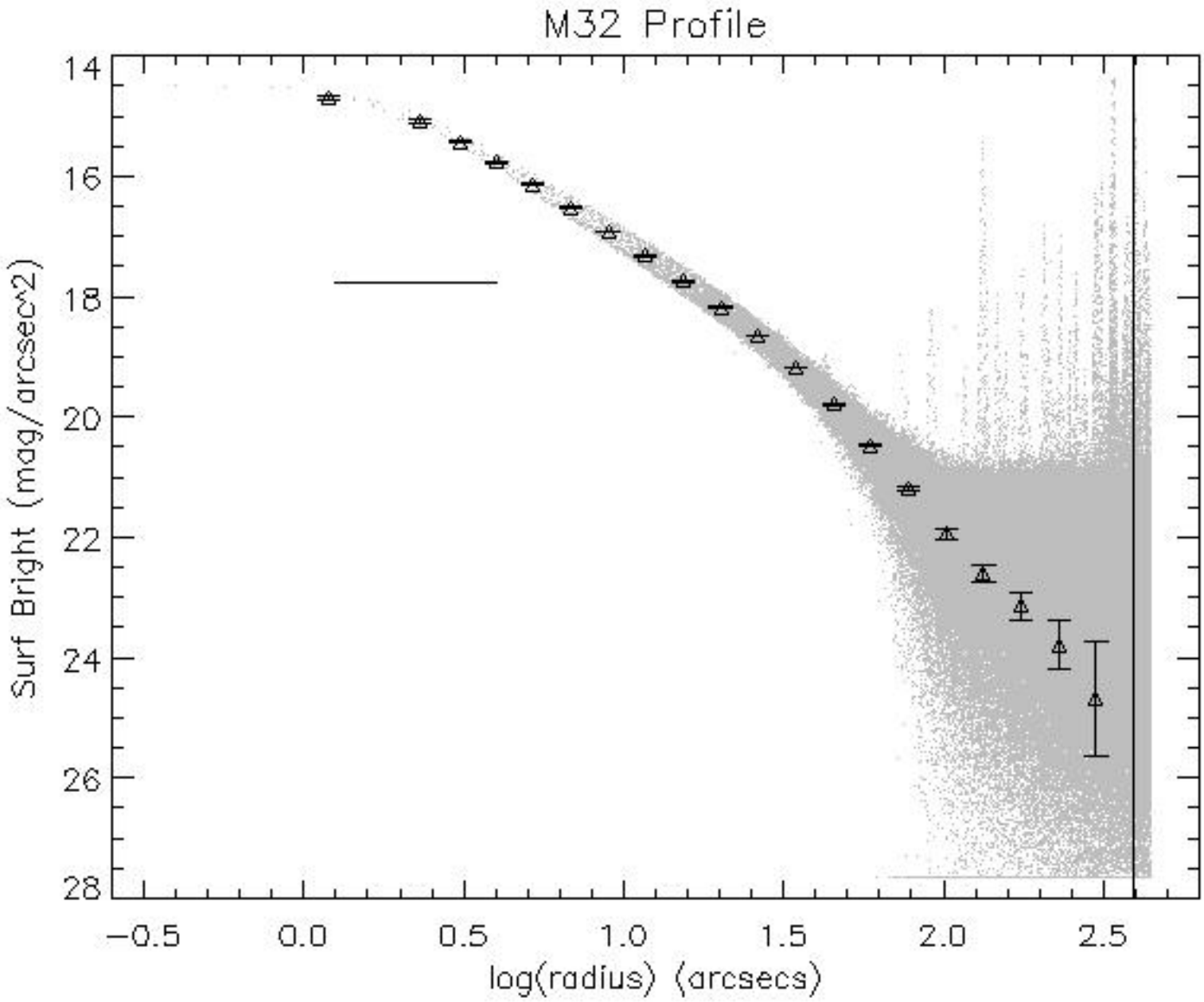


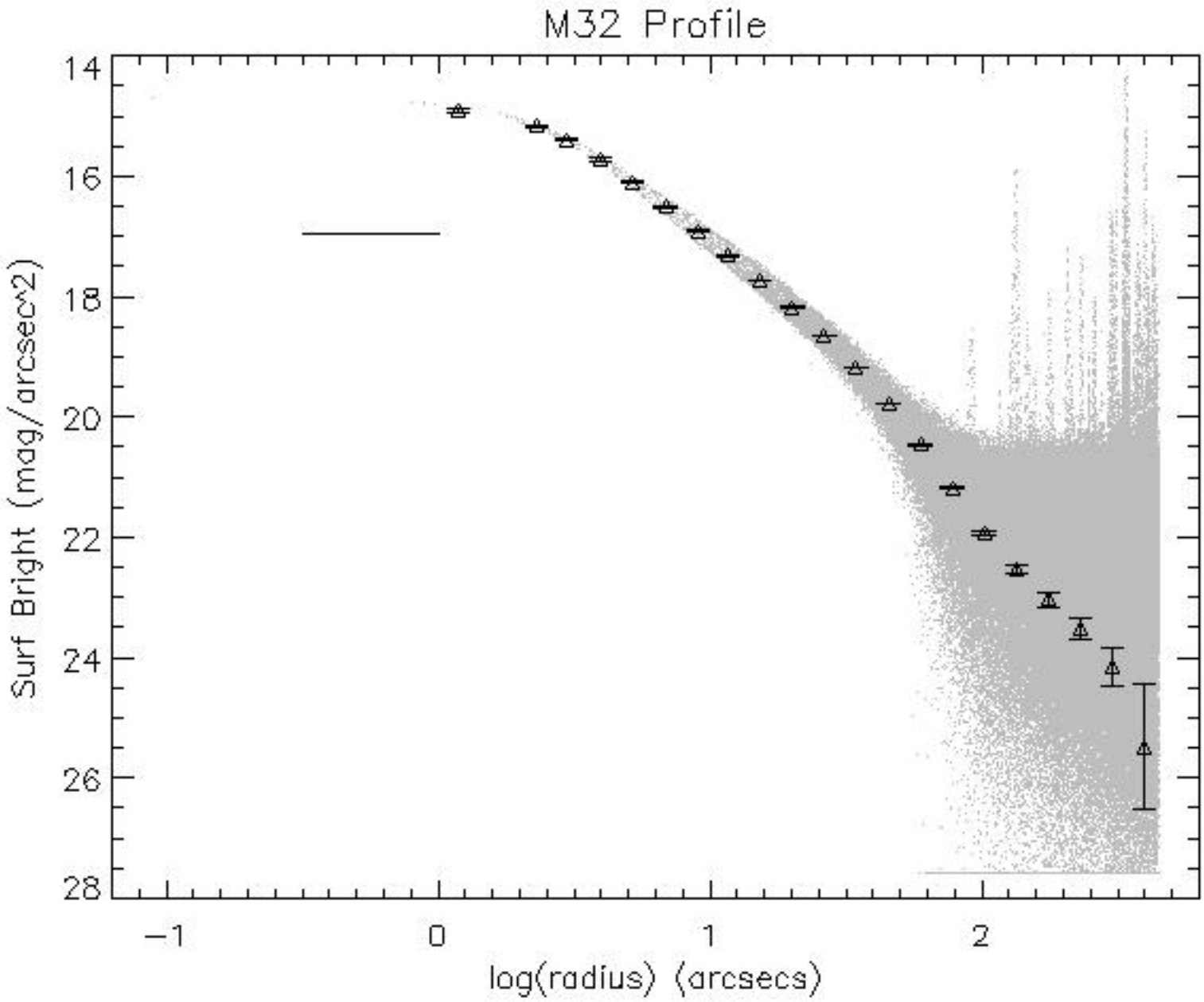
Logarithmically spaced contours (select log scaling in RUPhAst)

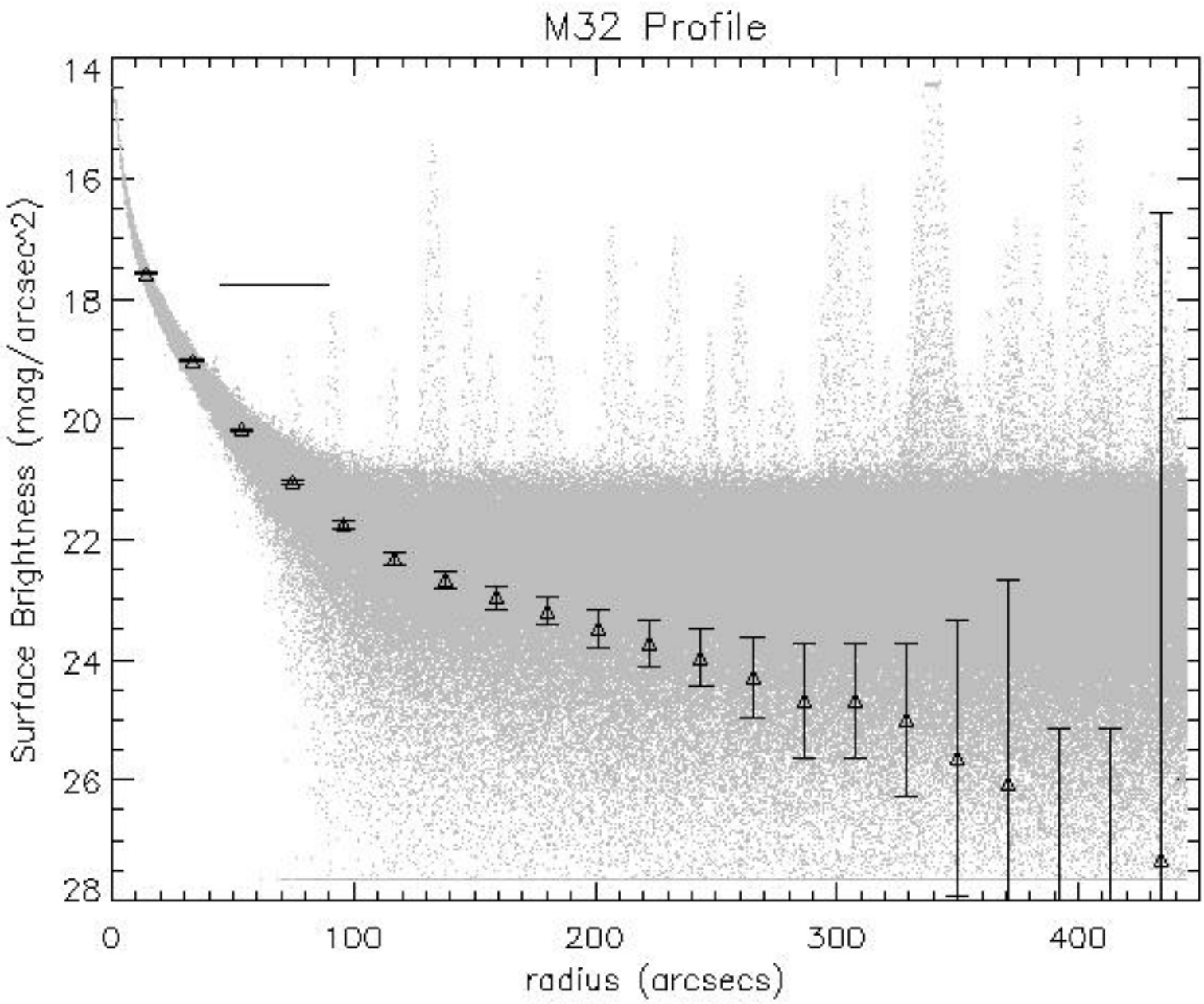
Lab 4: Galaxy Surface Photometry

- Galaxies are not resolved into stars (certainly not in our telescope!)
  - So measure amount of light per area (mag/sq arcmin)
- Measure radial profile of light distribution.
  - Ideally on ellipsoidal contours
    - Galsbmag_ru uses circular apertures.
  - Choosing a local "sky" level is critical since galaxy profiles quickly become fainter than it.
    - galsbmag_ru, img, xcen, ycen, rmax, sky, skyunc, img_scale, m_1,title

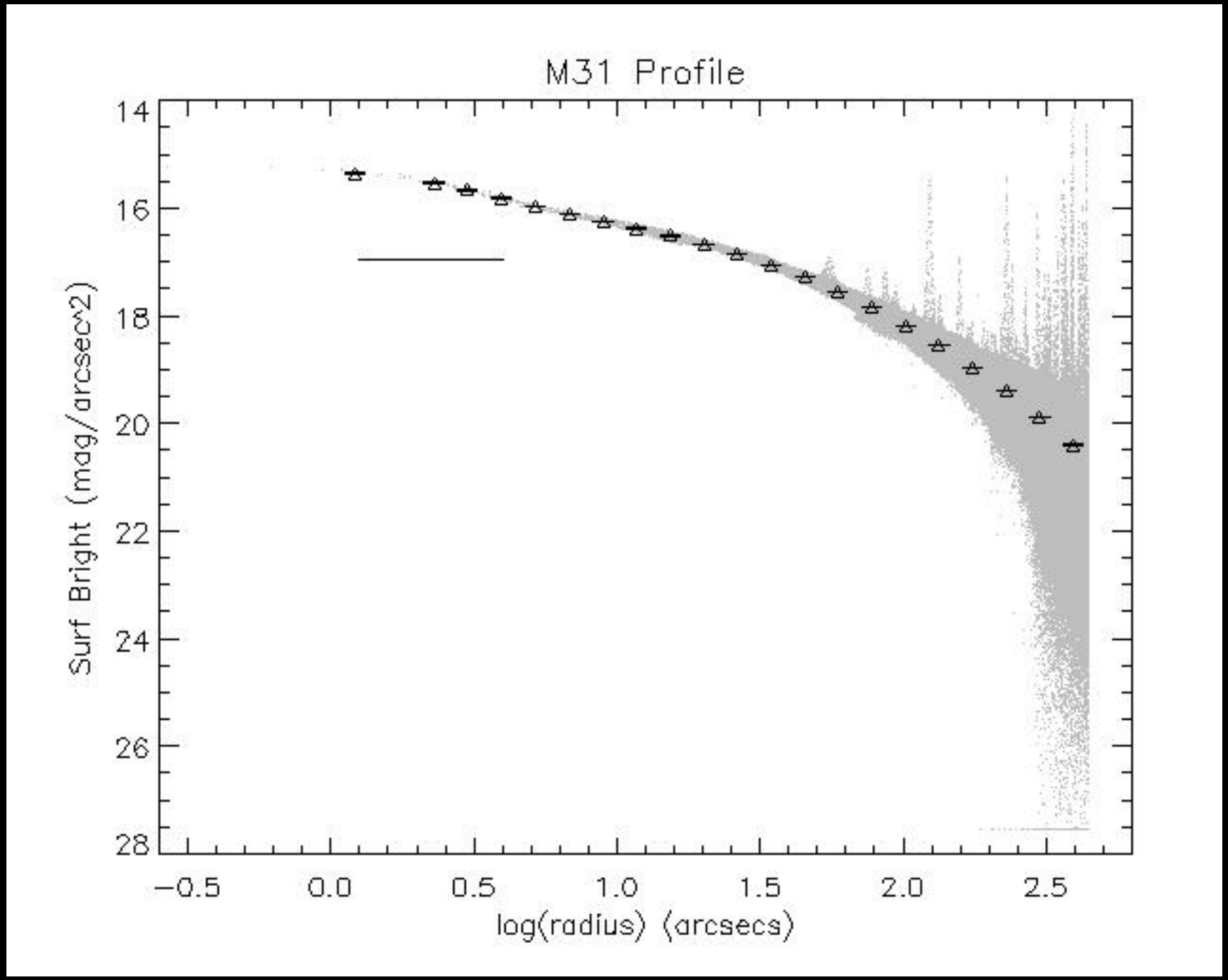

M32 Profile
Surf Bright (mag/arcsec^2)
14
16
18
20
22
24
26
28
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
log(radius) (arcsecs)

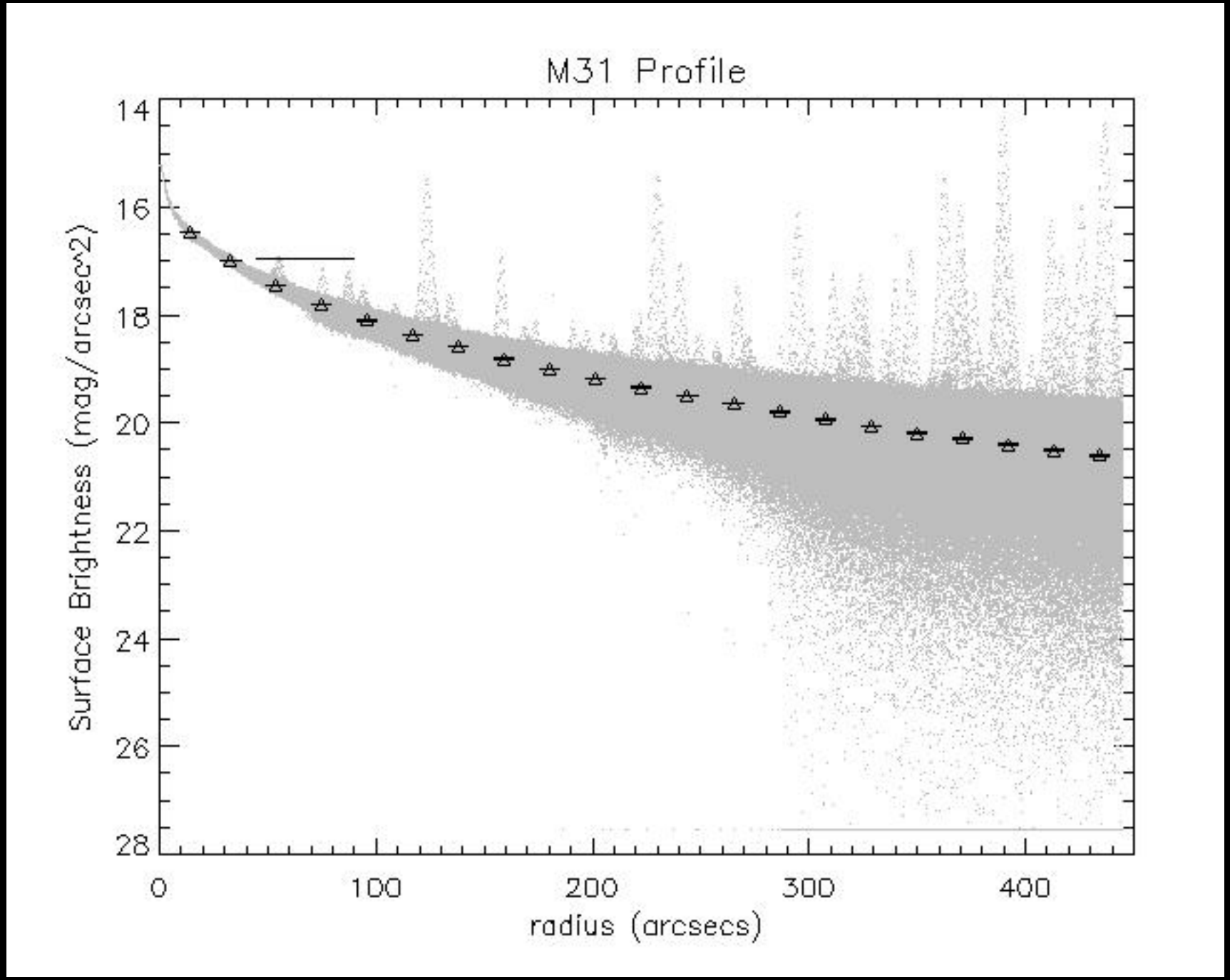

M32 Profile
Surf Bright (mag/arcsec^2)
14
16
18
20
22
24
26
28
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
log(radius) (arcsecs)

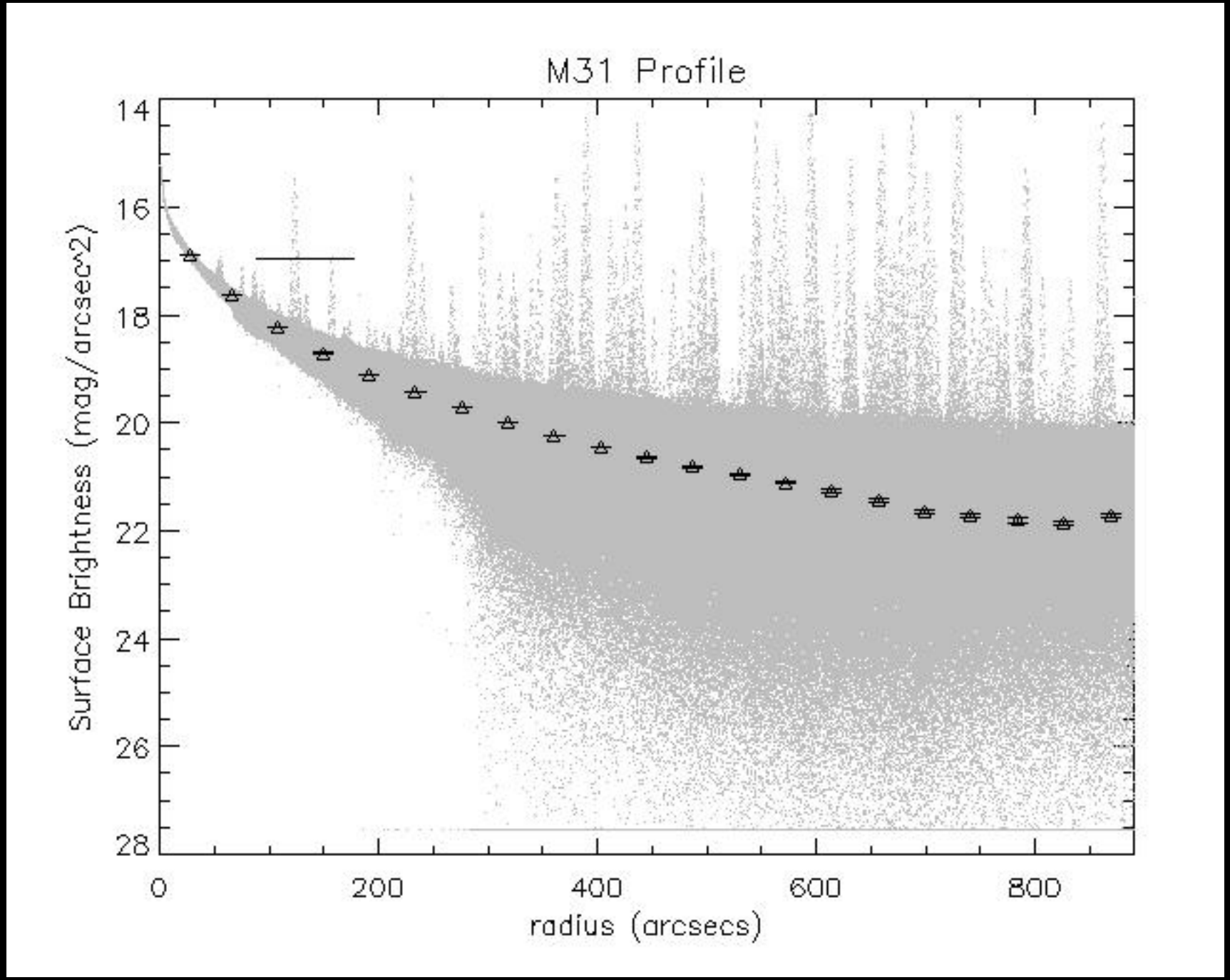

M32 Profile
Surf Bright (mag/arcsec^2)
14
16
18
20
22
24
26
28
−1
0
1
2
log(radius) (arcsecs)


M32 Profile
Surface Brightness (mag/arcsec^2)
14
16
18
20
22
24
26
28
0
100
200
300
400
radius (arcsecs)

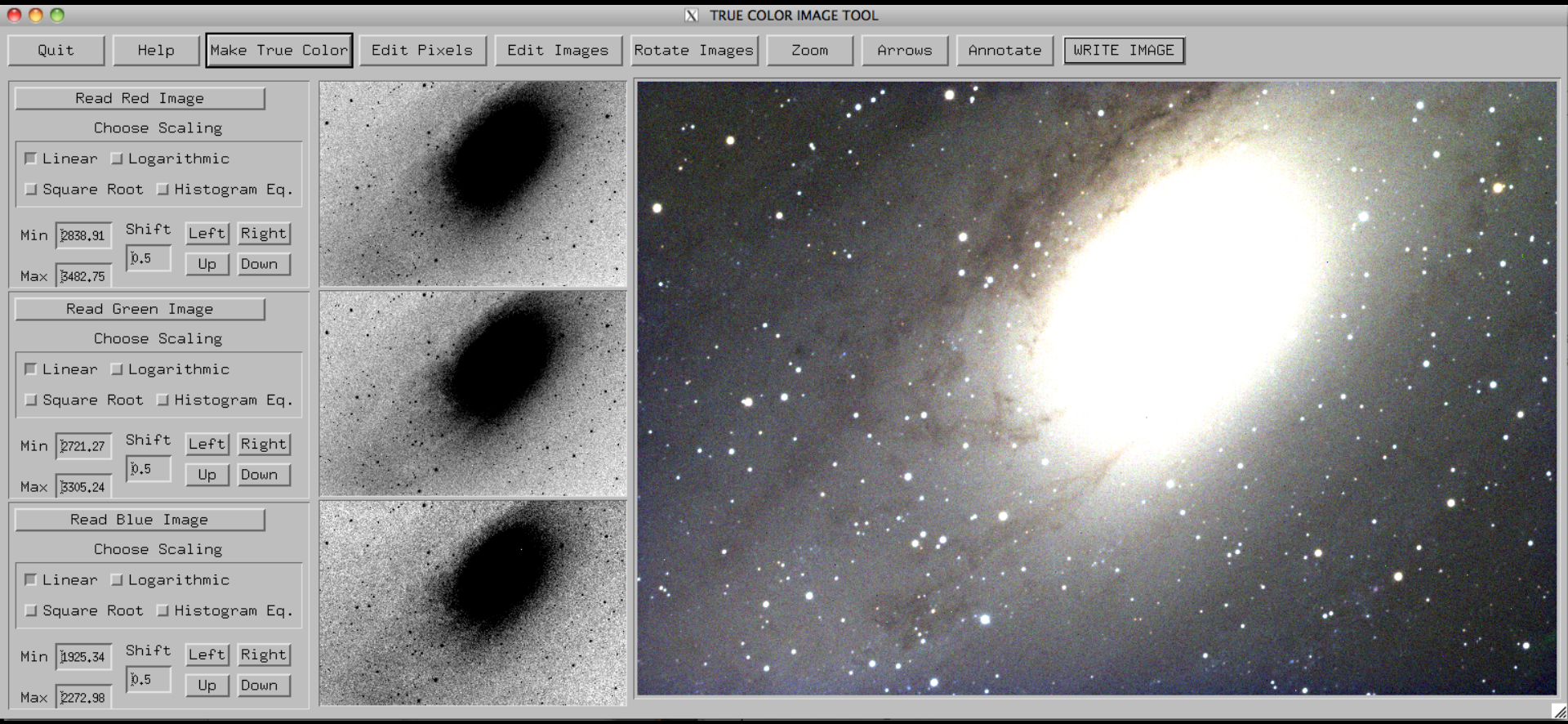
Log Scaling


M31 Profile
Surf Bright (mag/arcsec^2)
14
16
18
20
22
24
26
28
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
log(radius) (arcsecs)

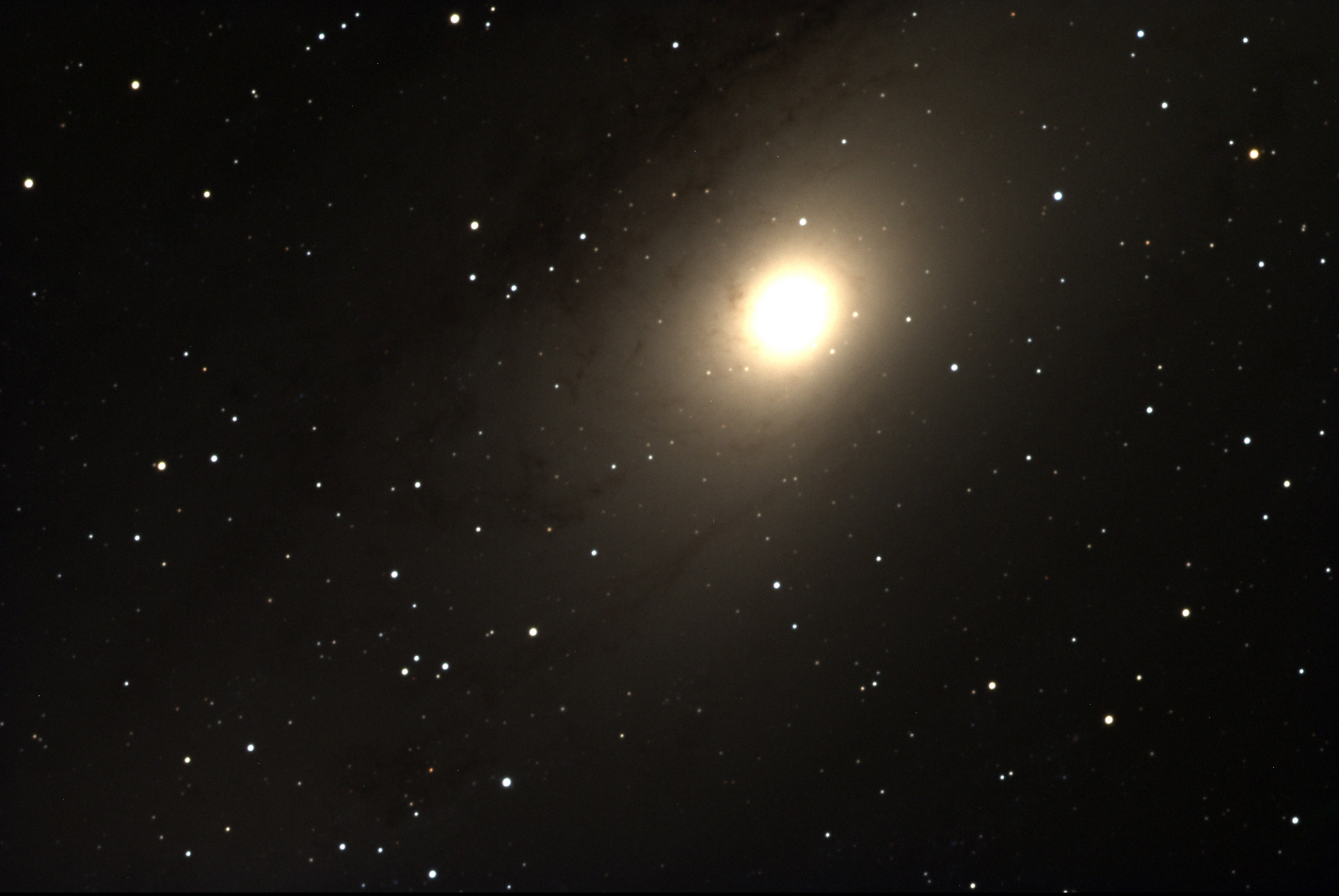

M31 Profile
Surface Brightness (mag/arcsec^2)
14
16
18
20
22
24
26
28
0
100
200
300
400
radius (arcsecs)


M31 Profile
Surface Brightness (mag/arcsec^2)
14
16
18
20
22
24
26
28
0
200
400
600
800
radius (arcsecs)

tctoolru – IDL program to produce color pictures from images taken through three filters.



M31: tctoolru - linear scaling



M31: tctoolru - linear Scaling with higher Max values

M31: tctoolru – log scaling of intensity values

M33: tctoolru - linear scaling

M33: tctoolru – linear scaling displaying fainter pixels