Topics in Astrostatistics - 8 September 2015

The Art & Science of Image Processing

Joseph DePasquale
Visualization Scientist
Chandra X-ray Center
Office of Communication and Public Engagement

Communication and Public Engagement

The Astronomical Journal, 133:598–611, 2007 February

arXiv:astro-ph/0412138

IMAGE-PROCESSING TECHNIQUES FOR THE CREATION OF PRESENTATION-QUALITY ASTRONOMICAL IMAGES

Travis A. Rector
Department of Physics and Astronomy, University of Alaska Anchorage, AK, USA; rector@uaa.alaska.edu

Zoltan G. Levay and Lisa M. Frattare
Space Telescope Science Institute, Baltimore, MD, USA

Jayanne English
Department of Physics and Astronomy, University of Manitoba, Winnipeg, MB, Canada

and

Kirk Pu'uohau-Pummill
Gemini Observatory, Hilo, HI, USA
Received 2004 December 6; accepted 2006 September 29

ABSTRACT

The quality of modern astronomical data and the agility of current image-processing software enable the visualization of data in a way that exceeds the traditional definition of an astronomical image. Two developments in particular have led to a fundamental change in how astronomical images can be assembled. First, the availability of high-quality multiwavelength and narrowband data allow for images that do not correspond to the wavelength sensitivity of the human eye, thereby introducing ambiguity in the usage and interpretation of color. Second, many image-processing software packages now use a layering metaphor that allows for any number of astronomical data sets to be combined into a color image. With this technique, images with as many as eight data sets have been produced. Each data set is intensity-scaled and colorized independently, creating an immense parameter space that can be used to assemble the image. Since such images are intended for data visualization, scaling and color schemes must be chosen that best illustrate the science. A practical guide is presented on how to use the layering metaphor to generate publication-ready astronomical images from as many data sets as desired. A methodology is also given on how to use intensity scaling, color, and composition to create contrasts in an image that highlight the scientific detail. Examples of image creation are discussed.

Key words: techniques: image processing

Online material: color figures

Research & Applications

What Determines the Aesthetic Appeal of Astronomical Images?

Lars Lindberg Christensen
European Southern Observatory
lars@eso.org

Olivier Hainaut
European Southern Observatory
ohainaut@eso.org

Douglas Pierce-Price
European Southern Observatory
dpiercep@eso.org

Keywords
Astronomical Images, Astrophotography, Photography, Image Processing

capjournal.org/issues/14/14_20.pdf

Summary

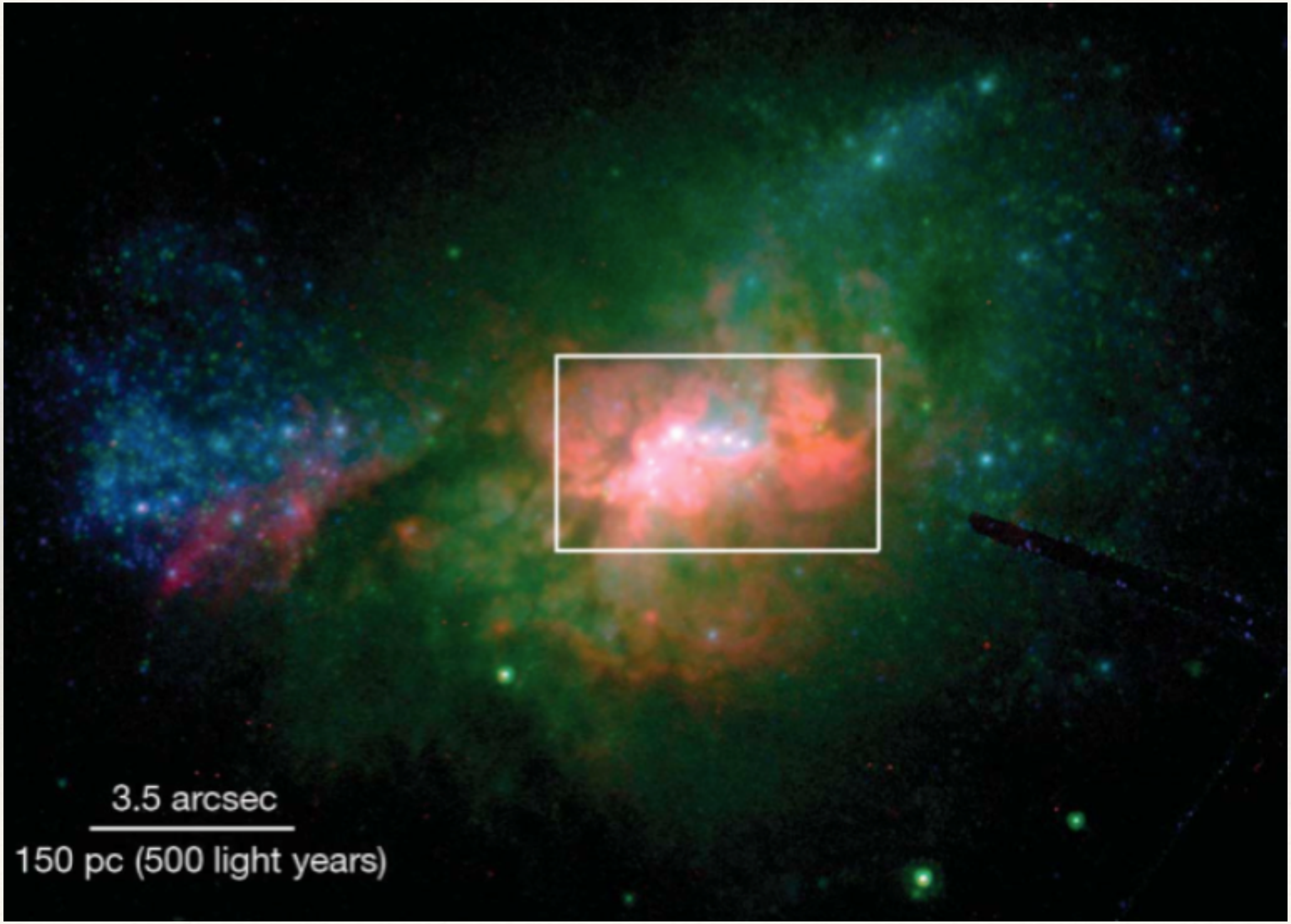
In the context of images used for education and outreach purposes, this paper describes a set of parameters that are key in determining the aesthetic appeal, or beauty, of an astronomical image.

What do I do?

Create the best possible representations of telescope data for public consumption

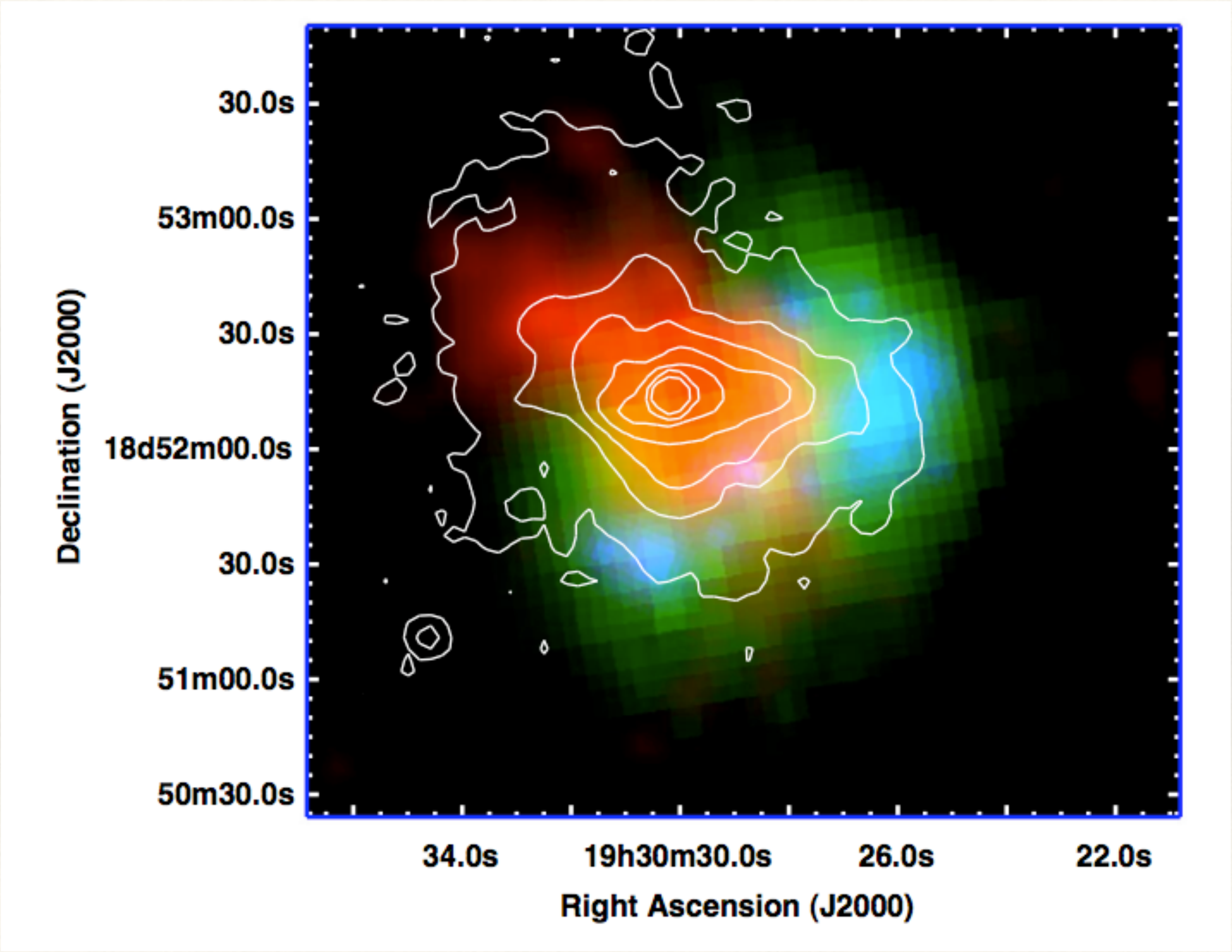
The images must tell the story of the science behind the data in the most aesthetically pleasing way possible while preserving data integrity

What do I do?



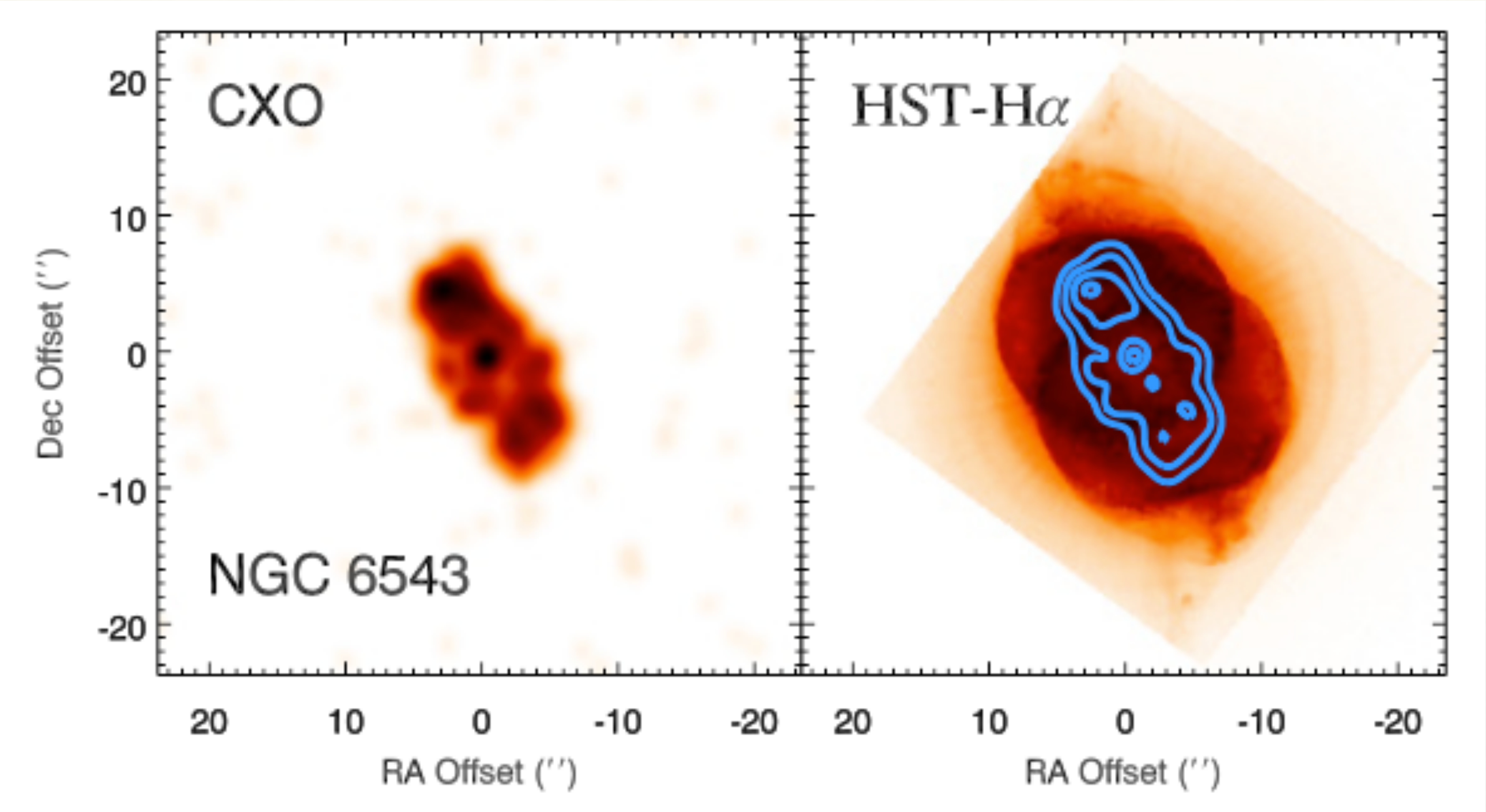
What do I do?

What do I do?

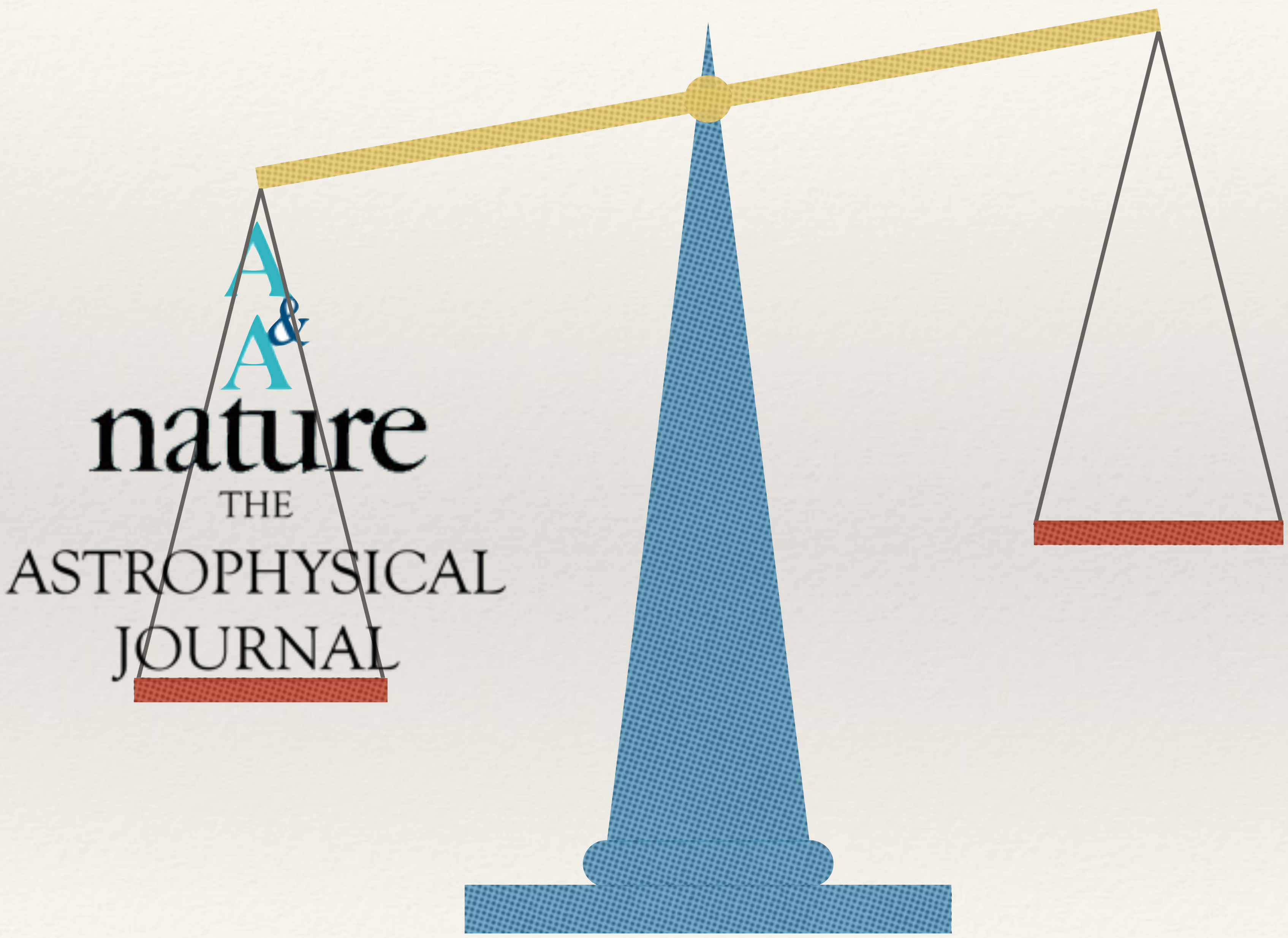


30.0s
53m00.0s
30.0s
18d52m00.0s
30.0s
51m00.0s
50m30.0s
Declination (J2000)
34.0s
19h30m30.0s
26.0s
22.0s
Right Ascension (J2000)

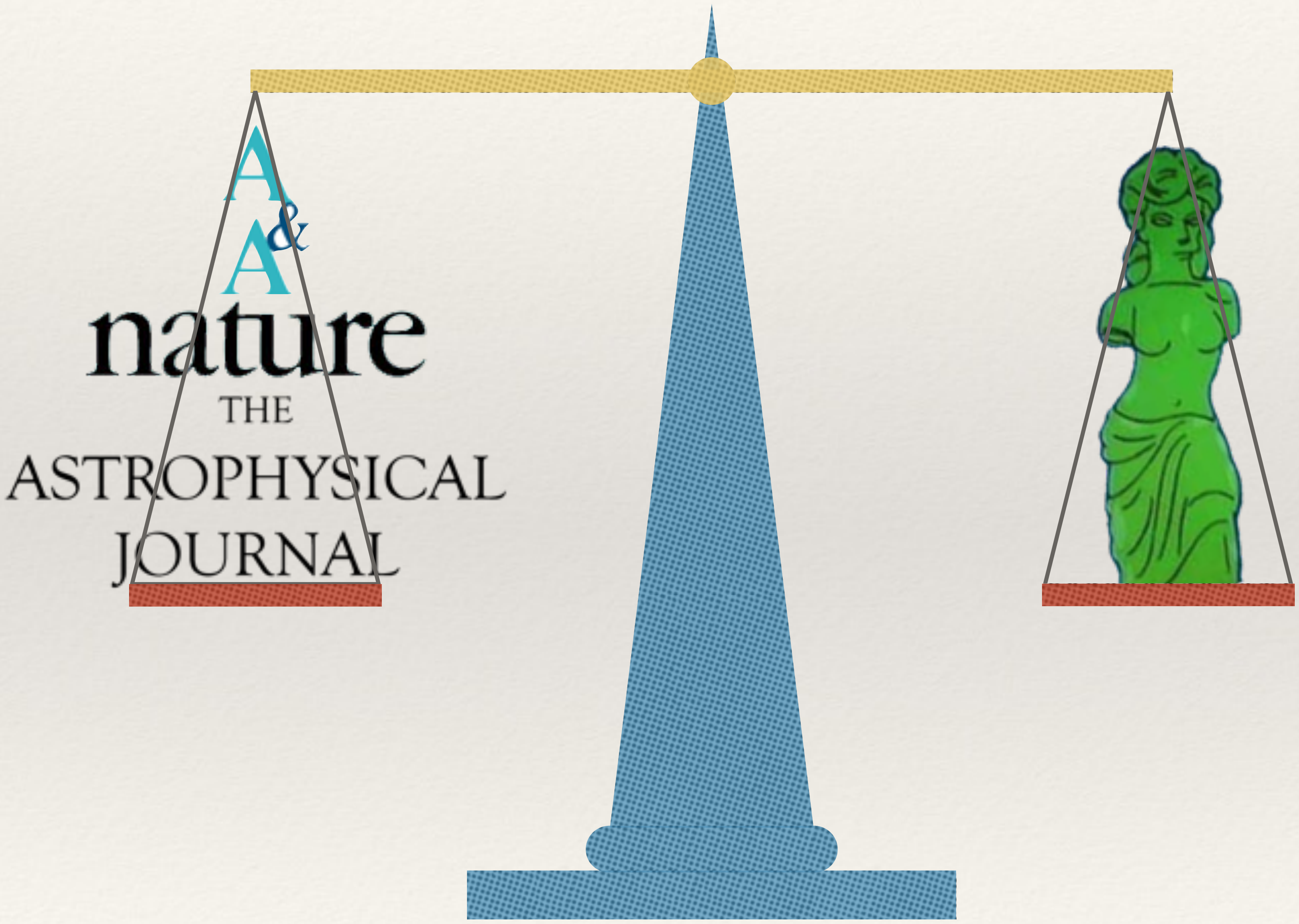
What do I do?

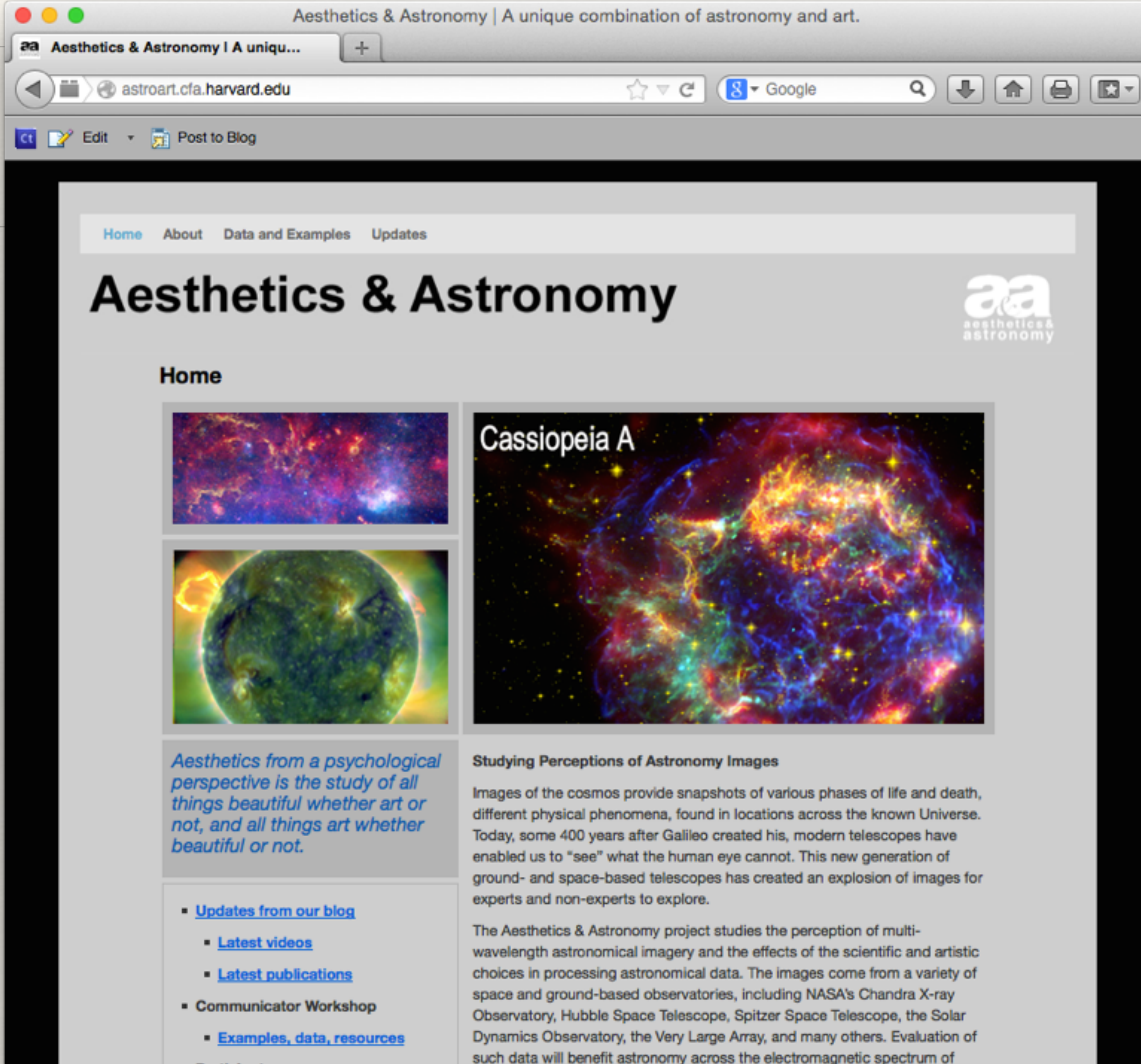


Striking a Balance

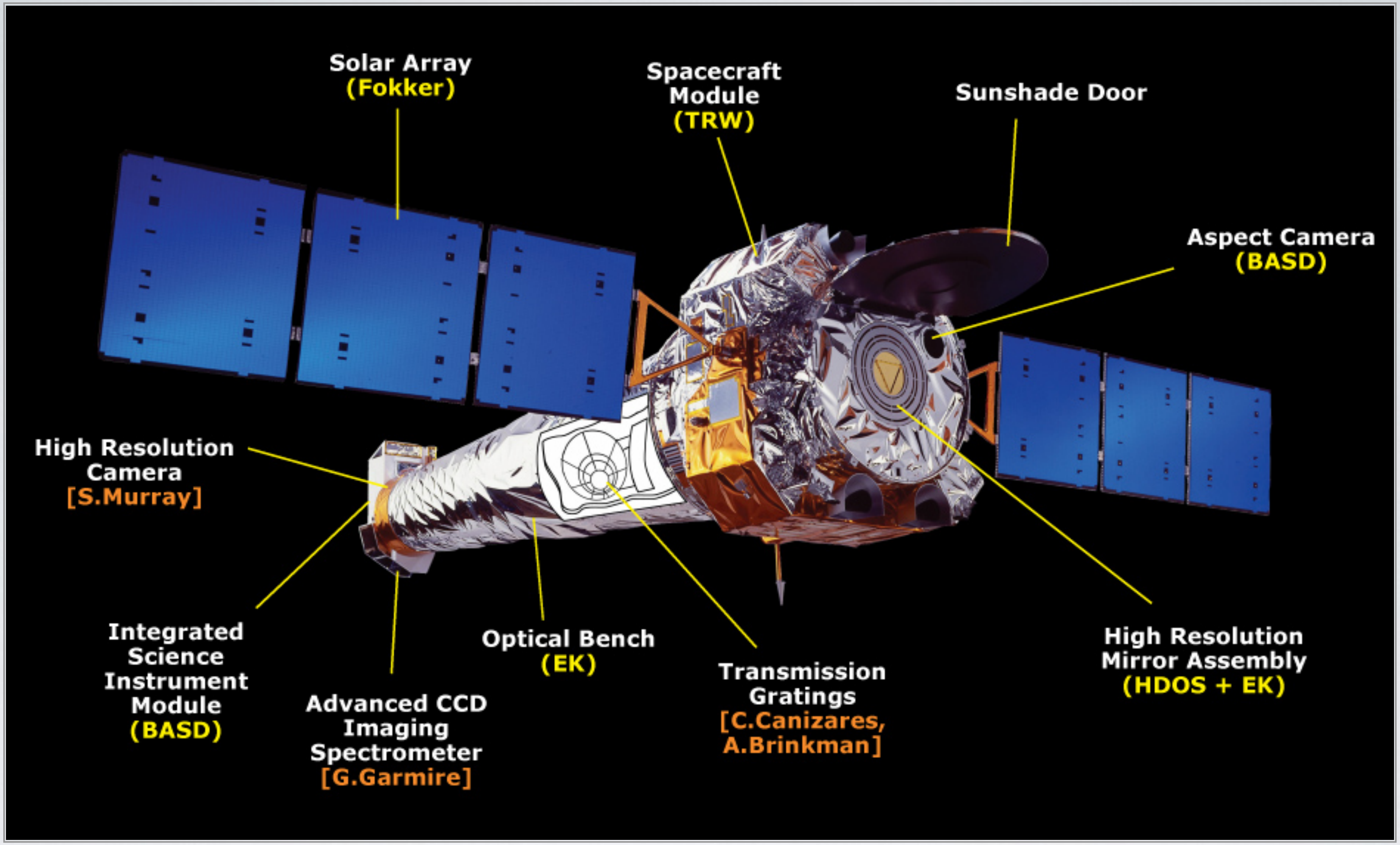


Striking a Balance

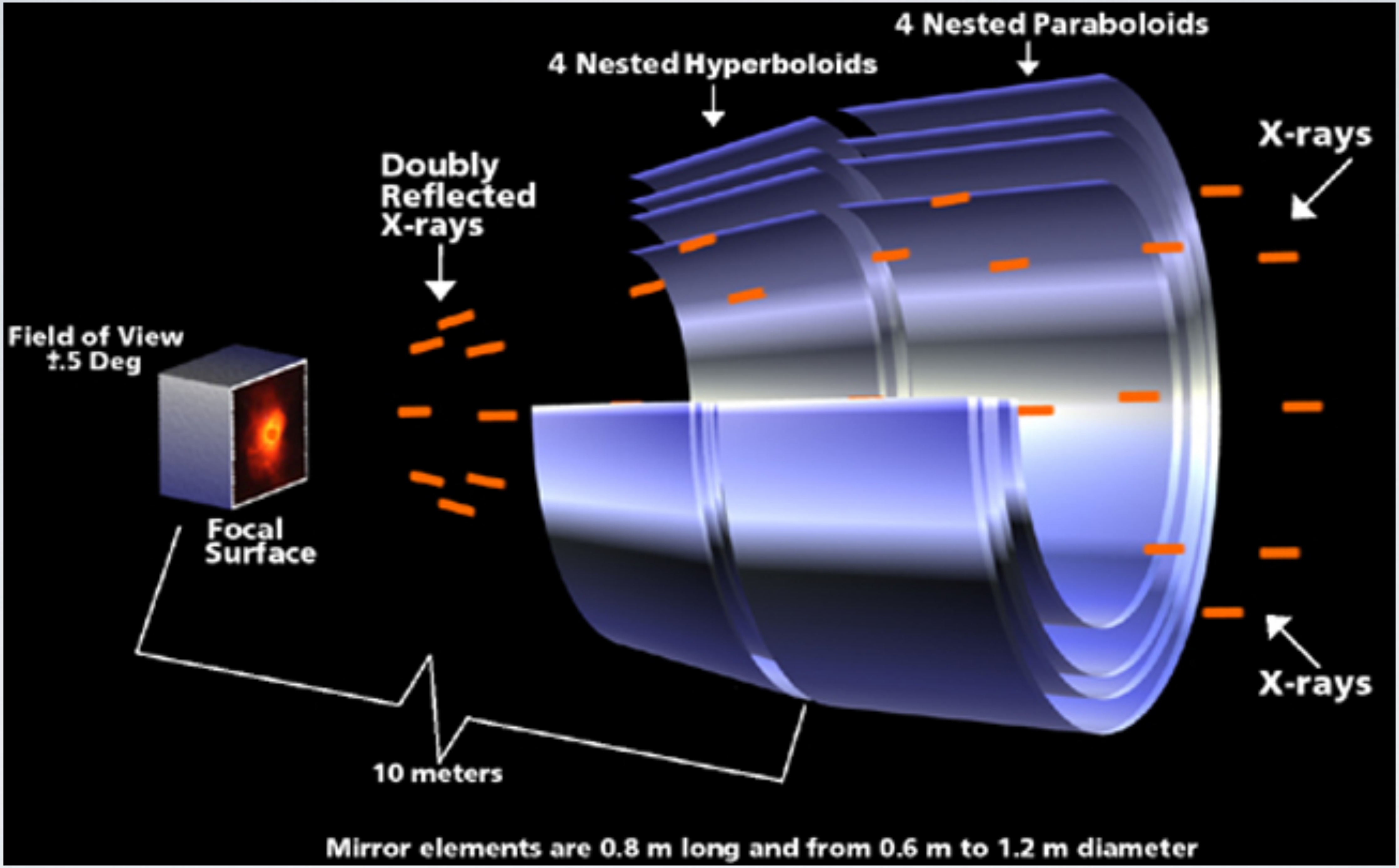



Aesthetics & Astronomy | A unique combination of astronomy and art.
Aesthetics & Astronomy | A uniqu...
astroart.cfa.harvard.edu
Google
Edit
Post to Blog
Home
About
Data and Examples
Updates
Aesthetics & Astronomy
aesthetics & astronomy
Home
Cassiopeia A
Aesthetics from a psychological perspective is the study of all things beautiful whether art or not, and all things art whether beautiful or not.
Updates from our blog
Latest videos
Latest publications
Communicator Workshop
Examples, data, resources
Participate
Studying Perceptions of Astronomy Images
Images of the cosmos provide snapshots of various phases of life and death, different physical phenomena, found in locations across the known Universe. Today, some 400 years after Galileo created his, modern telescopes have enabled us to "see" what the human eye cannot. This new generation of ground- and space-based telescopes has created an explosion of images for experts and non-experts to explore.
The Aesthetics & Astronomy project studies the perception of multi-wavelength astronomical imagery and the effects of the scientific and artistic choices in processing astronomical data. The images come from a variety of space and ground-based observatories, including NASA's Chandra X-ray Observatory, Hubble Space Telescope, Spitzer Space Telescope, the Solar Dynamics Observatory, the Very Large Array, and many others. Evaluation of such data will benefit astronomy across the electromagnetic spectrum of

CHANDRA X-RAY OBSERVATORY

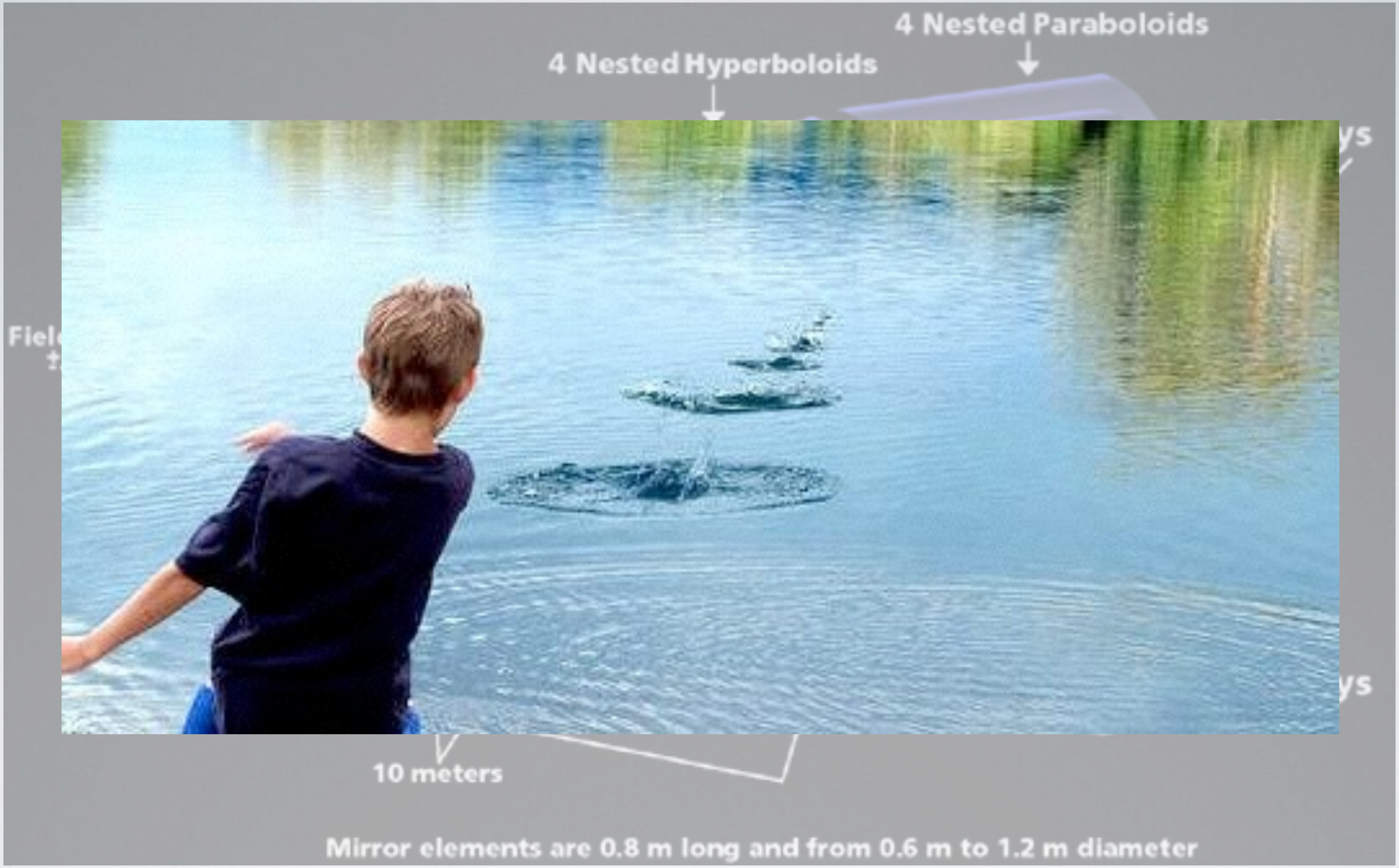


CHANDRA X-RAY OBSERVATORY



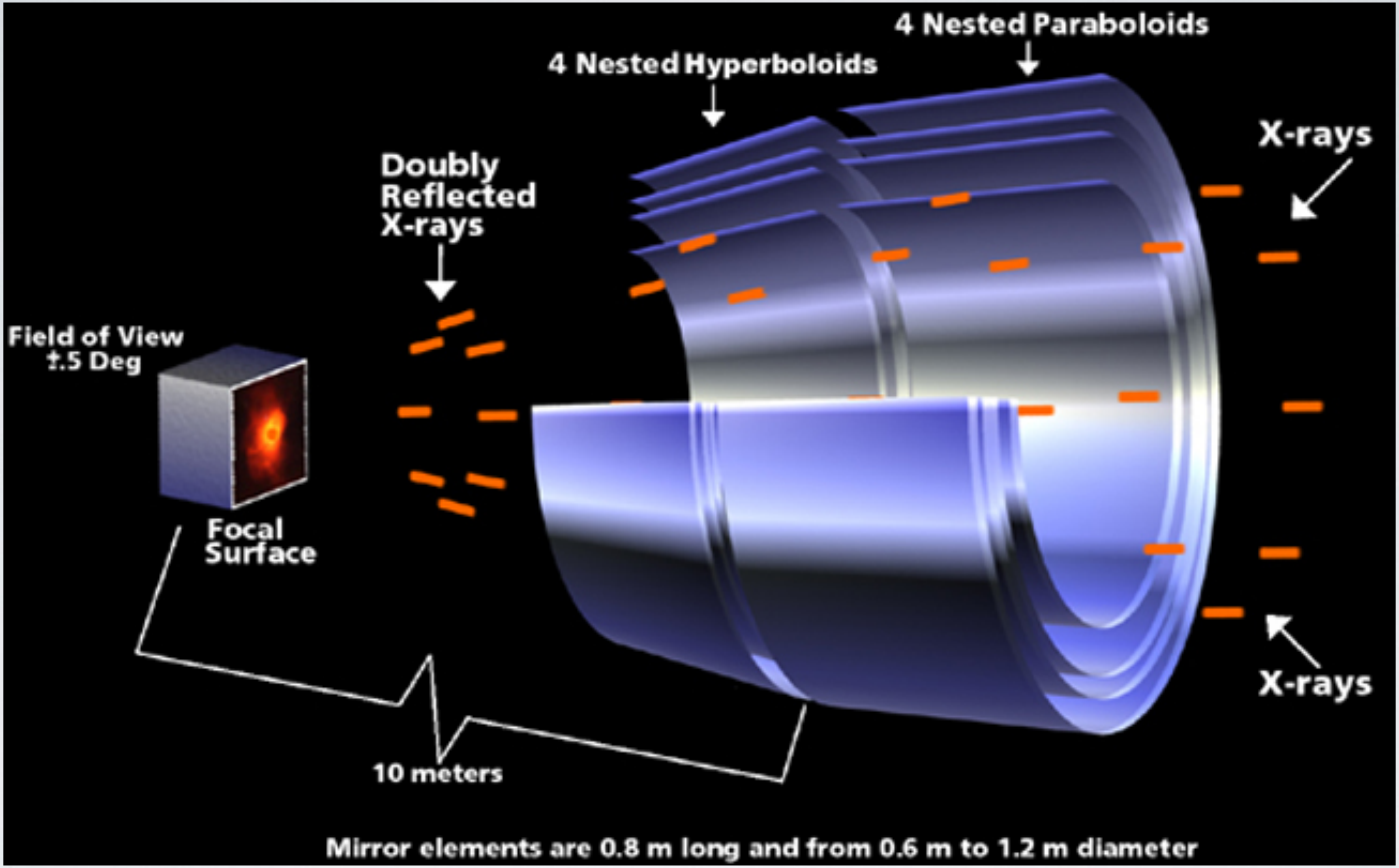
Grazing Incidence, X-ray Mirrors

CHANDRA X-RAY OBSERVATORY



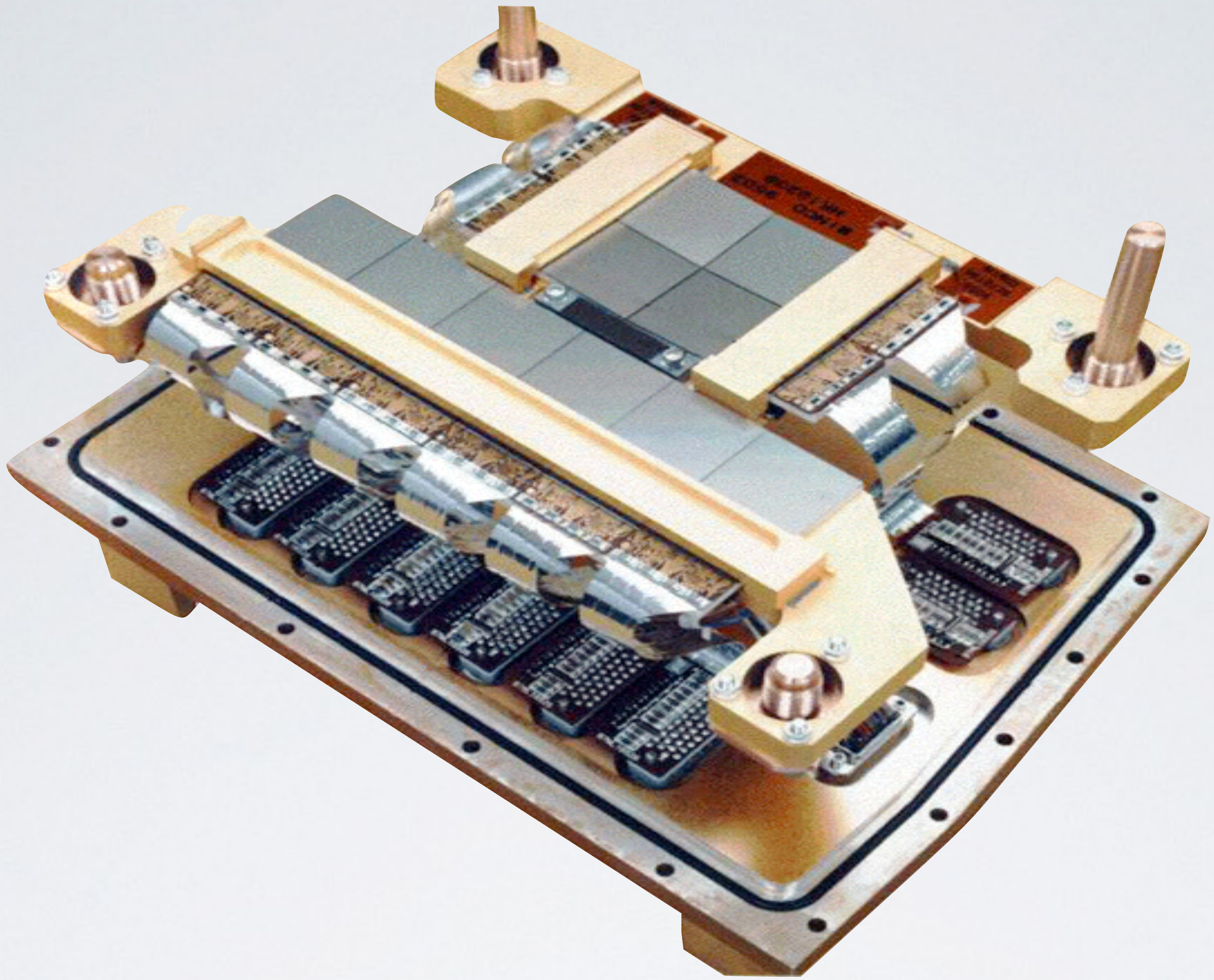
Grazing Incidence, X-ray Mirrors

CHANDRA X-RAY OBSERVATORY



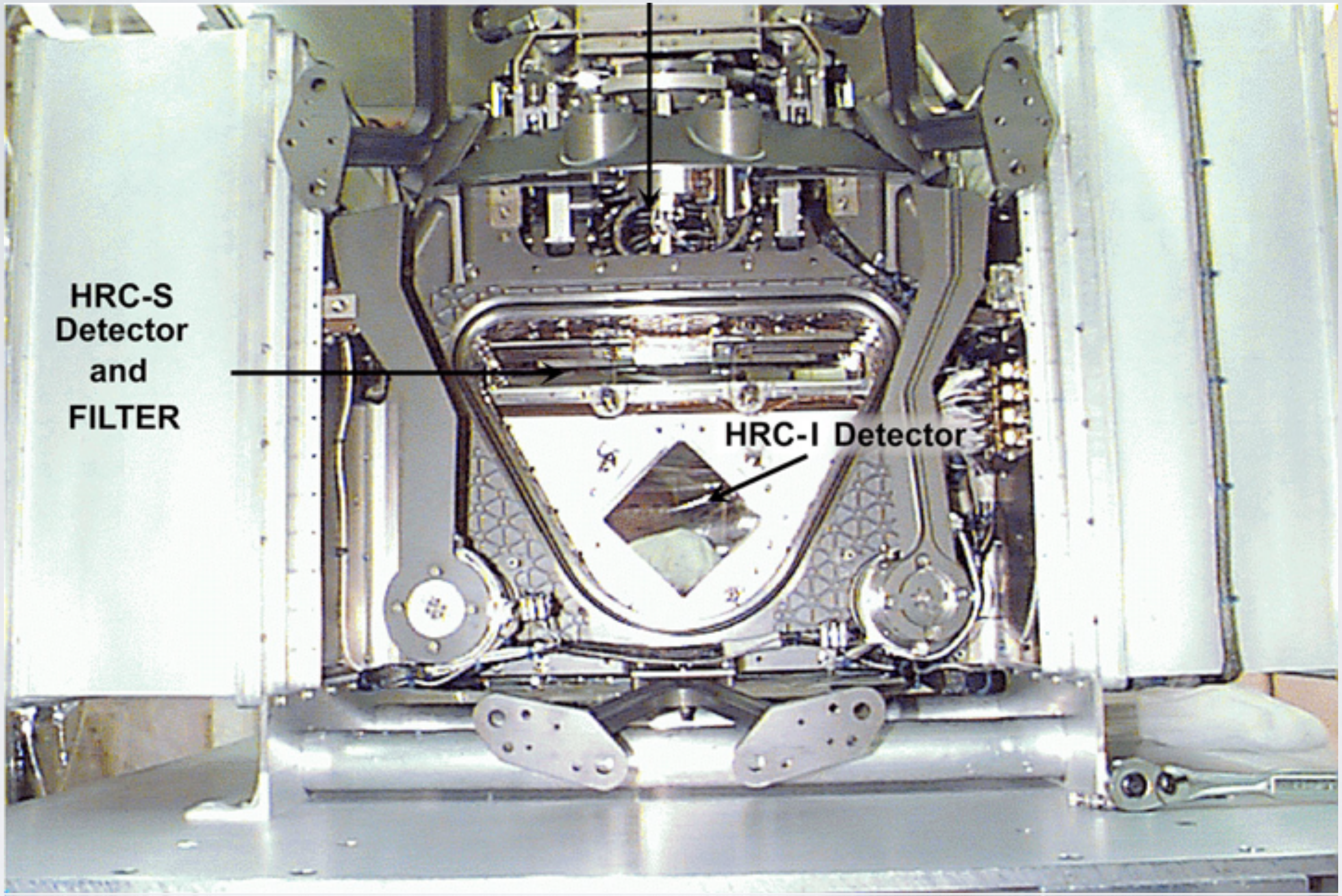
Grazing Incidence, X-ray Mirrors

CHANDRA X-RAY OBSERVATORY



Advanced CCD Imaging Spectrometer

CHANDRA X-RAY OBSERVATORY



High Resolution Camera

CHANDRA X-RAY OBSERVATORY

Data Format

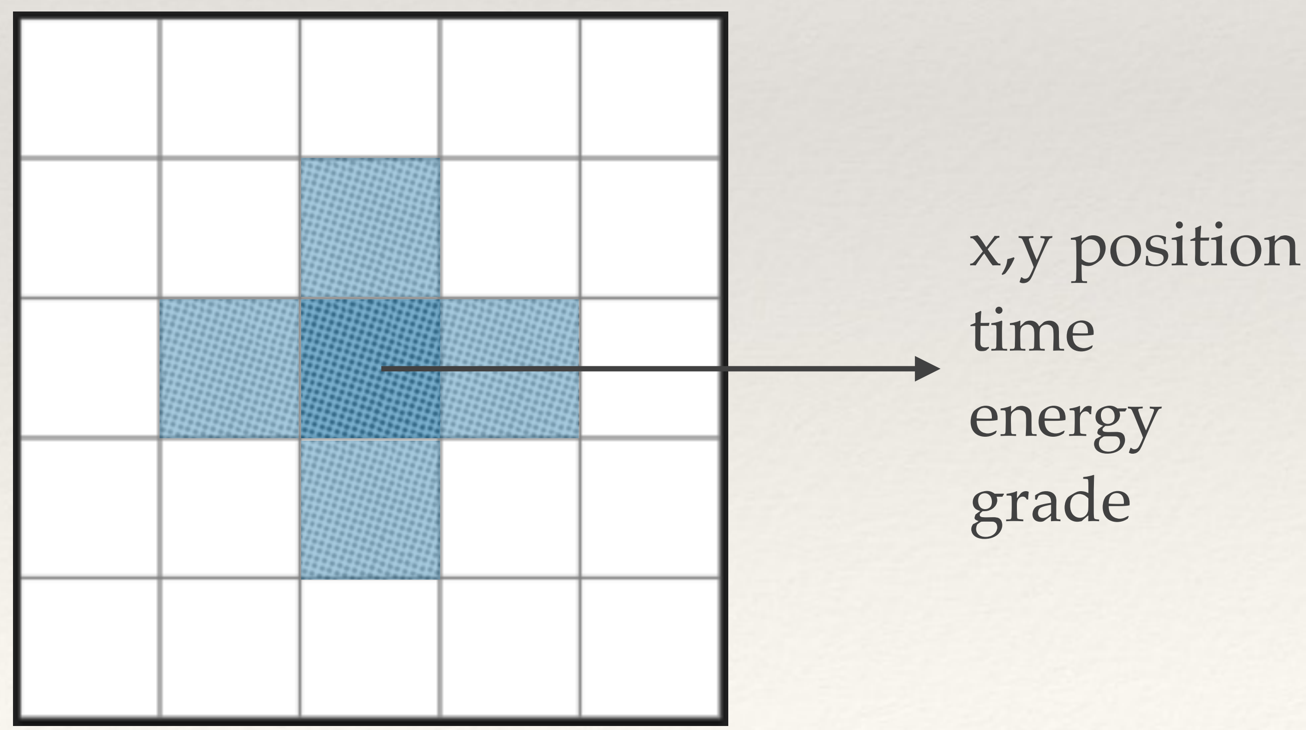
	time s	ccd_id	node_id	expno	chipx pixel	chipy pixel	tdetx pixel	tdety pixel	detx pixel	dety pixel	x pixel	y pixel	pha adu	pha_ro adu	corn_pha	energy eV	pi chan	fltgrade	grade	status
1	1.995197353739404E+08	7	0	582	175	19	4092	1721	4.0619429E+03	4.5887188E+03	4.5073301E+03	4.3782568E+03	142	140	5	7.0569946E+02	49	80	6	
2	1.995197353739404E+08	7	0	582	237	97	4154	1799	4.1230400E+03	4.5115591E+03	4.4723101E+03	4.2862783E+03	381	378	0	1.7980546E+03	124	11	6	
3	1.995197353739404E+08	7	2	582	644	101	4561	1803	4.5295107E+03	4.5065186E+03	4.6760068E+03	3.9344949E+03	1567	1558	-1	7.4039917E+03	508	104	6	
4	1.995197353739404E+08	7	1	582	314	104	4231	1806	4.2003442E+03	4.5044873E+03	4.5057979E+03	4.2162456E+03	306	302	1	1.5412102E+03	106	2	2	
5	1.995197353739404E+08	7	2	582	568	105	4485	1807	4.4543657E+03	4.5033232E+03	4.6348032E+03	3.9974172E+03	3769	3759	6	1.7601096E+04	1024	22	6	
6	1.995197353739404E+08	7	2	582	750	106	4667	1808	4.6357476E+03	4.5018452E+03	4.7263628E+03	3.8408335E+03	257	255	1	1.3026378E+03	90	0	0	
7	1.995197353739404E+08	7	2	582	624	117	4541	1819	4.5099131E+03	4.4909370E+03	4.6525903E+03	3.9433569E+03	329	325	1	1.6134098E+03	111	0	0	
8	1.995197353739404E+08	7	2	582	562	127	4479	1829	4.4476099E+03	4.4809883E+03	4.6121577E+03	3.9917910E+03	351	348	3	1.6985310E+03	117	8	3	
9	1.995197353739404E+08	7	2	582	570	129	4487	1831	4.4559795E+03	4.4789863E+03	4.6147207E+03	3.9835757E+03	211	209	1	1.0488915E+03	72	0	0	
10	1.995197353739404E+08	7	1	582	433	149	4350	1851	4.3187788E+03	4.4590967E+03	4.5274165E+03	4.0912671E+03	250	246	-1	1.2470641E+03	86	8	3	
11	1.995197353739404E+08	7	2	582	663	158	4580	1860	4.5488350E+03	4.4499692E+03	4.6373145E+03	3.8889519E+03	499	494	-1	2.4125427E+03	166	0	0	
12	1.995197353739404E+08	7	1	582	396	164	4313	1866	4.2824512E+03	4.4438838E+03	4.4957544E+03	4.1146909E+03	3659	3640	3	1.7377172E+04	1024	80	6	
13	1.995197353739404E+08	7	2	582	533	164	4450	1866	4.4190083E+03	4.4440562E+03	4.5657910E+03	3.9974612E+03	266	263	-1	1.2981259E+03	89	0	0	
14	1.995197353739404E+08	7	3	582	800	170	4717	1872	4.6856406E+03	4.4379023E+03	4.6969634E+03	3.7652446E+03	201	200	-2	1.0075438E+03	70	0	0	
15	1.995197353739404E+08	7	1	582	385	181	4302	1883	4.2712007E+03	4.4275449E+03	4.4759595E+03	4.1159941E+03	250	244	-2	1.2557699E+03	87	2	2	
16	1.995197353739404E+08	7	1	582	320	182	4237	1884	4.2059106E+03	4.4258330E+03	4.4410742E+03	4.1712095E+03	2508	2497	-3	1.2016417E+04	824	104	6	
17	1.995197353739404E+08	7	2	582	715	207	4632	1909	4.6007339E+03	4.4010044E+03	4.6218096E+03	3.8193052E+03	273	271	1	1.3760067E+03	95	0	0	
18	1.995197353739404E+08	7	1	582	506	214	4423	1916	4.3920146E+03	4.3937993E+03	4.5087993E+03	3.9949307E+03	409	405	-2	1.9892632E+03	137	64	2	
19	1.995197353739404E+08	7	2	582	555	215	4472	1917	4.4409473E+03	4.3931128E+03	4.5332529E+03	3.9525408E+03	269	266	0	1.3205133E+03	91	0	0	
20	1.995197353739404E+08	7	0	582	50	220	3967	1922	3.9366343E+03	4.3880845E+03	4.2708315E+03	4.3832285E+03	397	393	1	1.8420740E+03	127	64	2	

Events List

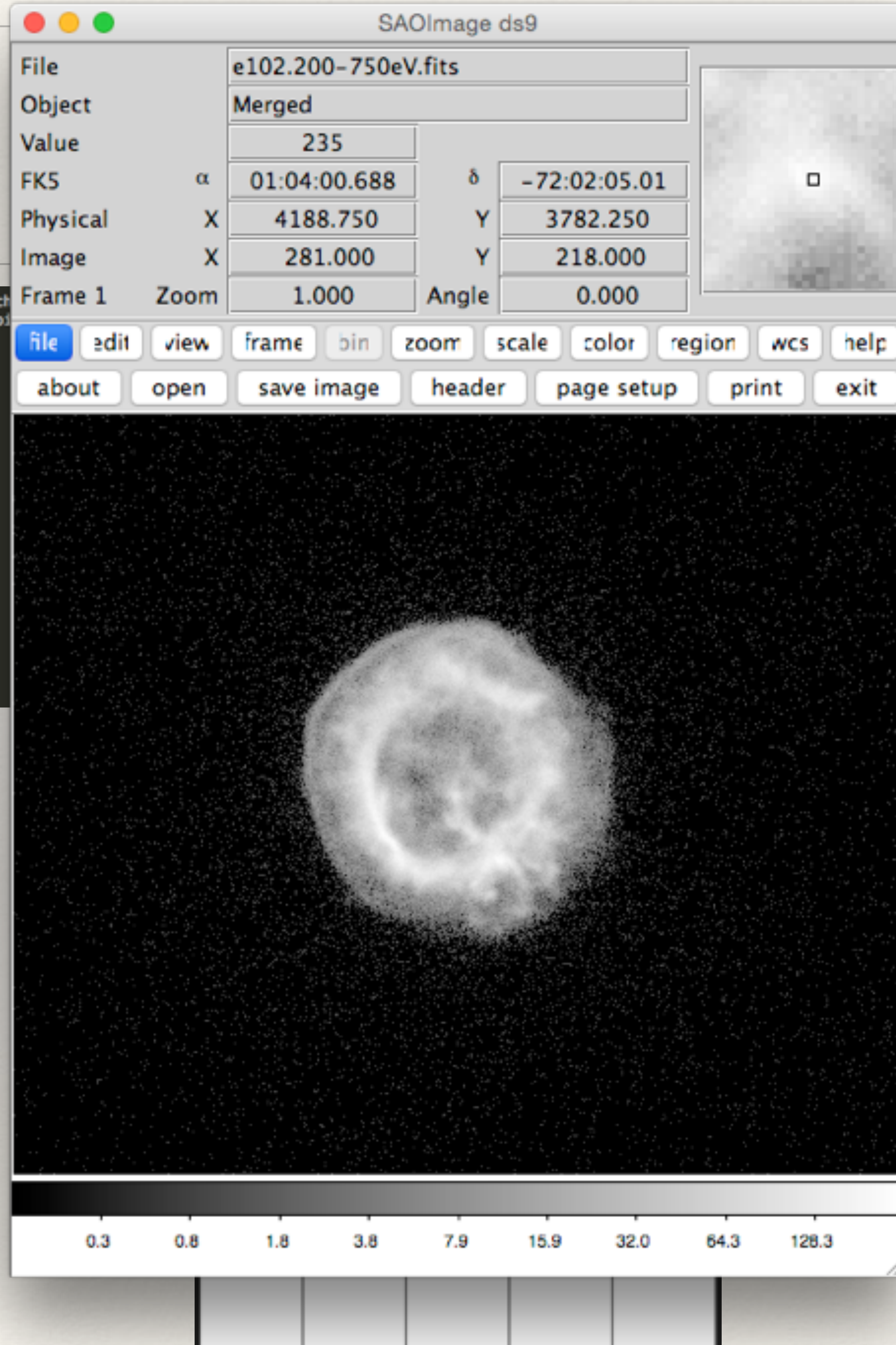
Data Format

	time s	ccd_id	node_id	expno	chipx pixel	chipy pixel	tdetx pixel	tdety pixel	detx pixel	dety pixel	x pixel	y pixel	pha adu	pha_ro adu	corn_pha	energy eV	pi chan	fltgrade	grade	status
1	1.995197353739404E+08	7	0	582	175	19	4092	1721	4.0619429E+03	4.5887188E+03	4.5073301E+03	4.3782568E+03	142	140	5	7.0569946E+02	49	80	6	
2	1.995197353739404E+08	7	0	582	237	97	4154	1799	4.1230400E+03	4.5115591E+03	4.4723101E+03	4.2862783E+03	381	378	0	1.7980546E+03	124	11	6	
3	1.995197353739404E+08	7	2	582	644	101	4561	1803	4.5295107E+03	4.5065186E+03	4.6760068E+03	3.9344949E+03	1567	1558	-1	7.4039917E+03	508	104	6	
4	1.995197353739404E+08	7	1	582	314	104	4231	1806	4.2003442E+03	4.5044873E+03	4.5057979E+03	4.2162456E+03	306	302	1	1.5412102E+03	106	2	2	
5	1.995197353739404E+08	7	2	582	568	105	4485	1807	4.4543657E+03	4.5033232E+03	4.6348032E+03	3.9974172E+03	3769	3759	6	1.7601096E+04	1024	22	6	
6	1.995197353739404E+08	7	2	582	750	106	4667	1808	4.6357476E+03	4.5018452E+03	4.7263628E+03	3.8408335E+03	257	255	1	1.3026378E+03	90	0	0	
7	1.995197353739404E+08	7	2	582	624	117	4541	1819	4.5099131E+03	4.4909370E+03	4.6525903E+03	3.9433569E+03	329	325	1	1.6134098E+03	111	0	0	
8	1.995197353739404E+08	7	2	582	562	127	4479	1829	4.4476099E+03	4.4809883E+03	4.6121577E+03	3.9917910E+03	351	348	3	1.6985310E+03	117	8	3	
9	1.995197353739404E+08	7	2	582	570	129	4487	1831	4.4559795E+03	4.4789863E+03	4.6147207E+03	3.9835757E+03	211	209	1	1.0488915E+03	72	0	0	
10	1.995197353739404E+08	7	1	582	433	149	4350	1851	4.3187788E+03	4.4590967E+03	4.5274165E+03	4.0912671E+03	250	246	-1	1.2470641E+03	86	8	3	
11	1.995197353739404E+08	7	2	582	663	158	4580	1860	4.5488350E+03	4.4499692E+03	4.6373145E+03	3.8889519E+03	499	494	-1	2.4125427E+03	166	0	0	
12	1.995197353739404E+08	7	1	582	396	164	4313	1866	4.2824512E+03	4.4438838E+03	4.4957544E+03	4.1146909E+03	3659	3640	3	1.7377172E+04	1024	80	6	
13	1.995197353739404E+08	7	2	582	533	164	4450	1866	4.4190083E+03	4.4440562E+03	4.5657910E+03	3.9974612E+03	266	263	-1	1.2981259E+03	89	0	0	
14	1.995197353739404E+08	7	3	582	800	170	4717	1872	4.6856406E+03	4.4379023E+03	4.6969634E+03	3.7652446E+03	201	200	-2	1.0075438E+03	70	0	0	
15	1.995197353739404E+08	7	1	582	385	181	4302	1883	4.2712007E+03	4.4275449E+03	4.4759595E+03	4.1159941E+03	250	244	-2	1.2557699E+03	87	2	2	
16	1.995197353739404E+08	7	1	582	320	182	4237	1884	4.2059106E+03	4.4258330E+03	4.4410742E+03	4.1712095E+03	2508	2497	-3	1.2016417E+04	824	104	6	
17	1.995197353739404E+08	7	2	582	715	207	4632	1909	4.6007339E+03	4.4010044E+03	4.6218096E+03	3.8193052E+03	273	271	1	1.3760067E+03	95	0	0	
18	1.995197353739404E+08	7	1	582	506	214	4423	1916	4.3920146E+03	4.3937993E+03	4.5087993E+03	3.9949307E+03	409	405	-2	1.9892632E+03	137	64	2	
19	1.995197353739404E+08	7	2	582	555	215	4472	1917	4.4409473E+03	4.3931128E+03	4.5332529E+03	3.9525408E+03	269	266	0	1.3205133E+03	91	0	0	
20	1.995197353739404E+08	7	0	582	50	220	3967	1922	3.9366343E+03	4.3880845E+03	4.2708315E+03	4.3832285E+03	397	393	1	1.8420740E+03	127	64	2	

Sample event at the pixel scale



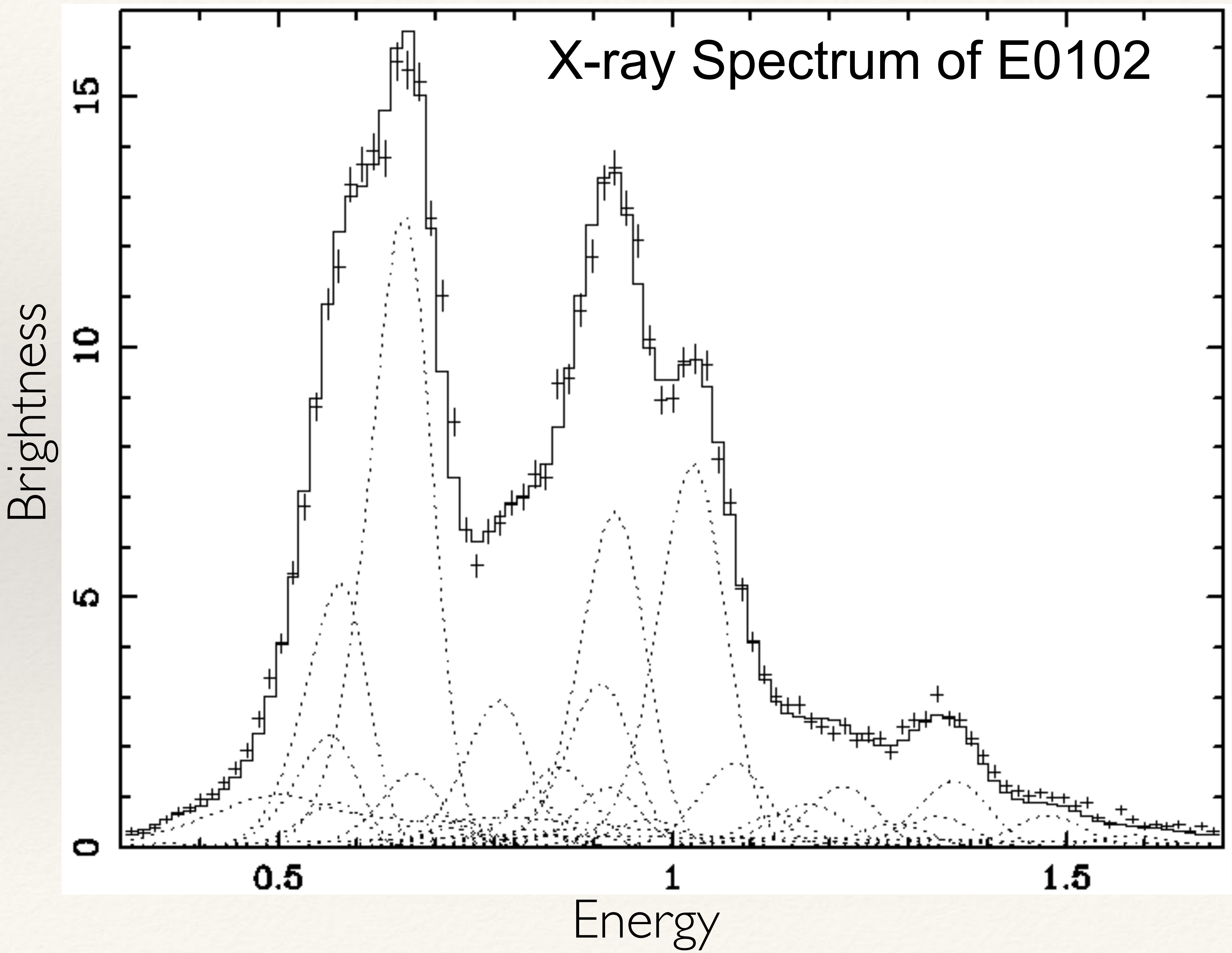
	time s	ccd_id	node_id	expno	chipx pixel	ch… pi…
1	1.995197353739404E+08	7	0	582	175	
2	1.995197353739404E+08	7	0	582	237	
3	1.995197353739404E+08	7	2	582	644	
4	1.995197353739404E+08	7	1	582	314	
5	1.995197353739404E+08	7	2	582	568	
6	1.995197353739404E+08	7	2	582	750	
7	1.995197353739404E+08	7	2	582	624	
8	1.995197353739404E+08	7	2	582	562	
9	1.995197353739404E+08	7	2	582	570	
10	1.995197353739404E+08	7	1	582	433	
11	1.995197353739404E+08	7	2	582	663	
12	1.995197353739404E+08	7	1	582	396	
13	1.995197353739404E+08	7	2	582	533	
14	1.995197353739404E+08	7	3	582	800	
15	1.995197353739404E+08	7	1	582	385	
16	1.995197353739404E+08	7	1	582	320	
17	1.995197353739404E+08	7	2	582	715	
18	1.995197353739404E+08	7	1	582	506	
19	1.995197353739404E+08	7	2	582	555	
20	1.995197353739404E+08	7	0	582	50	



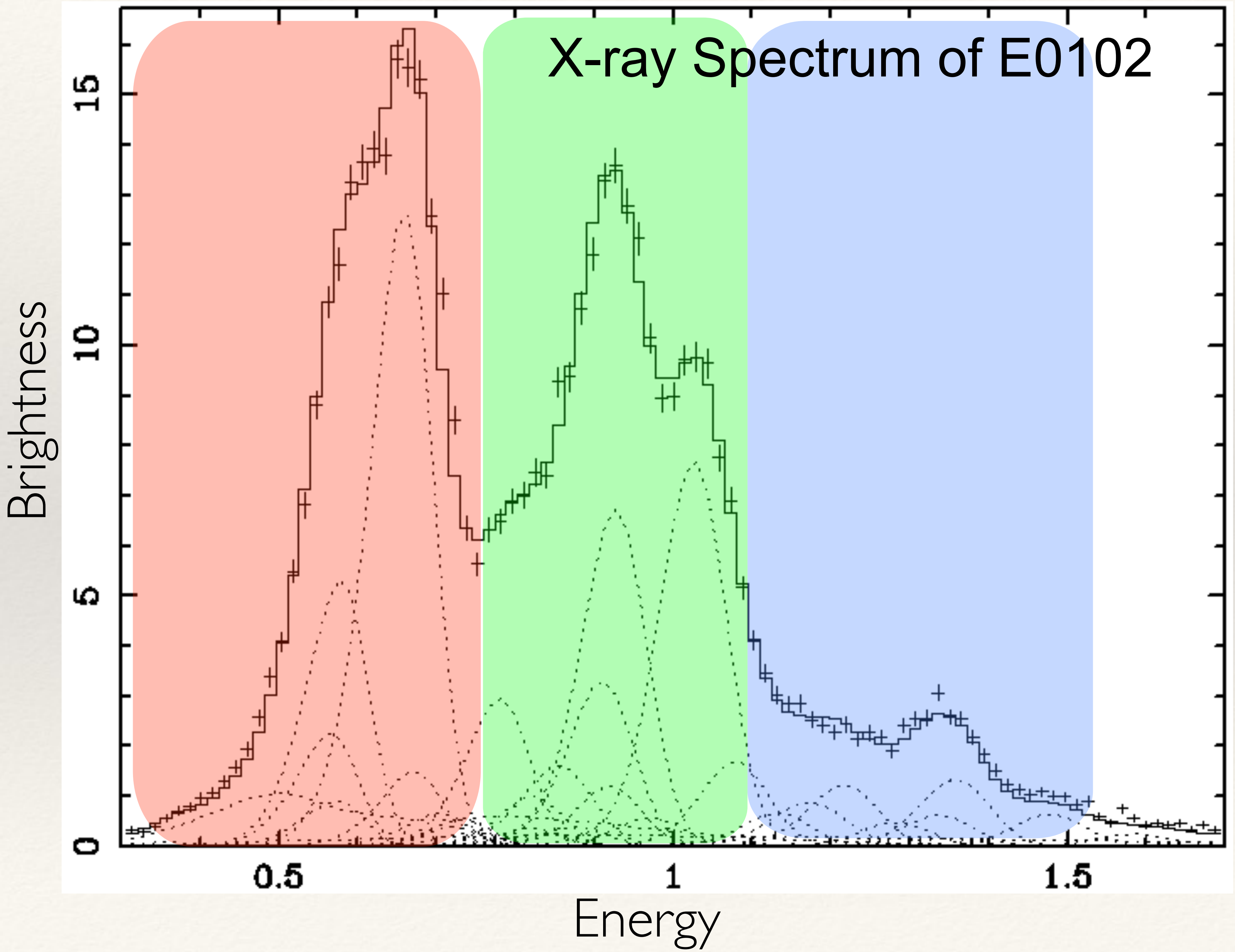
	corn_pha	energy eV	pi chan	fltgrade	grade	status
140	5	7.0569946E+02	49	80	6	
378	0	1.7980546E+03	124	11	6	
558	-1	7.4039917E+03	508	104	6	
302	1	1.5412102E+03	106	2	2	
759	6	1.7601096E+04	1024	22	6	
255	1	1.3026378E+03	90	0	0	
325	1	1.6134098E+03	111	0	0	
348	3	1.6985310E+03	117	8	3	
209	1	1.0488915E+03	72	0	0	
246	-1	1.2470641E+03	86	8	3	
494	-1	2.4125427E+03	166	0	0	
640	3	1.7377172E+04	1024	80	6	
263	-1	1.2981259E+03	89	0	0	
200	-2	1.0075438E+03	70	0	0	
244	-2	1.2557699E+03	87	2	2	
497	-3	1.2016417E+04	824	104	6	
271	1	1.3760067E+03	95	0	0	
405	-2	1.9892632E+03	137	64	2	
266	0	1.3205133E+03	91	0	0	
393	1	1.8420740E+03	127	64	2	

x,y position
time
energy
grade

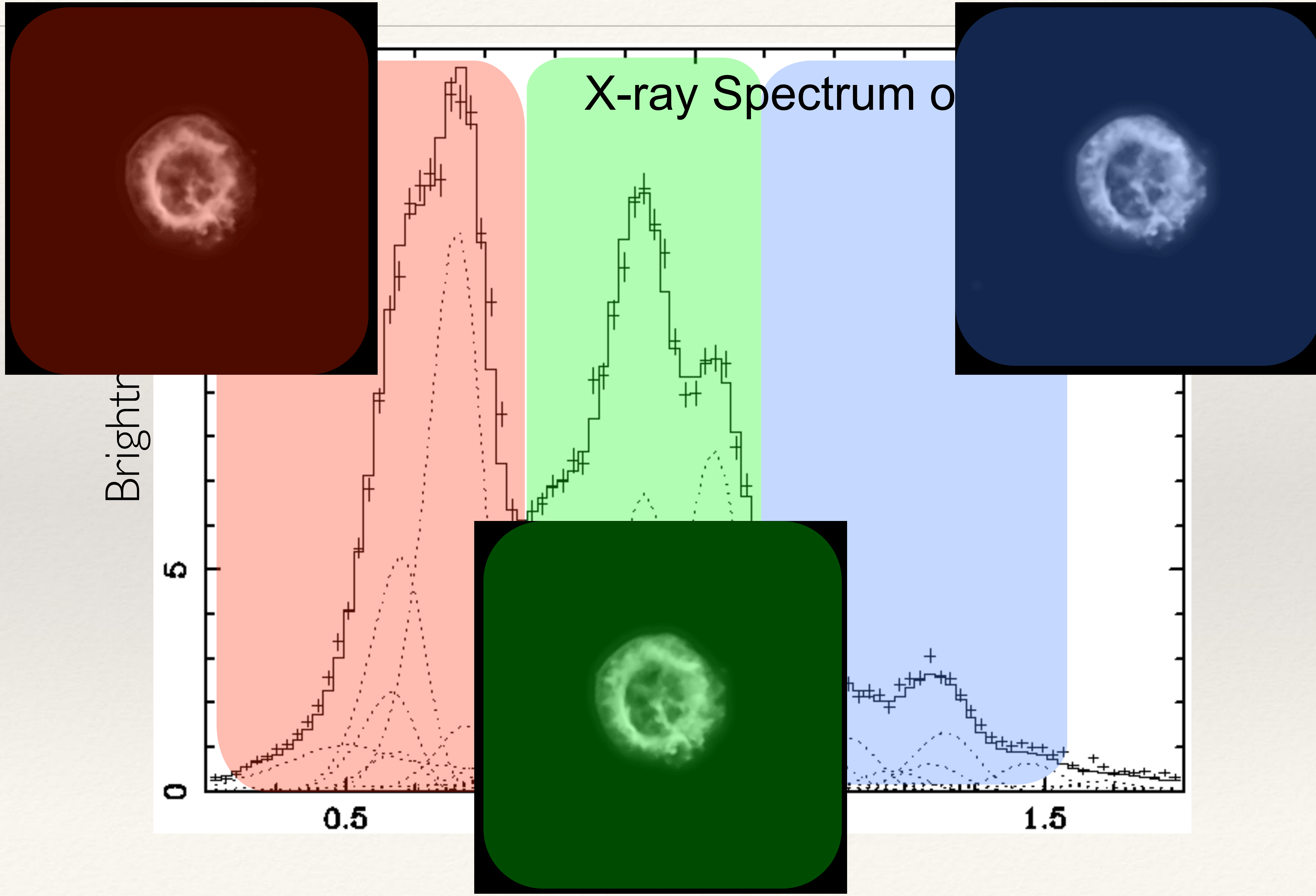
A Splash of Color



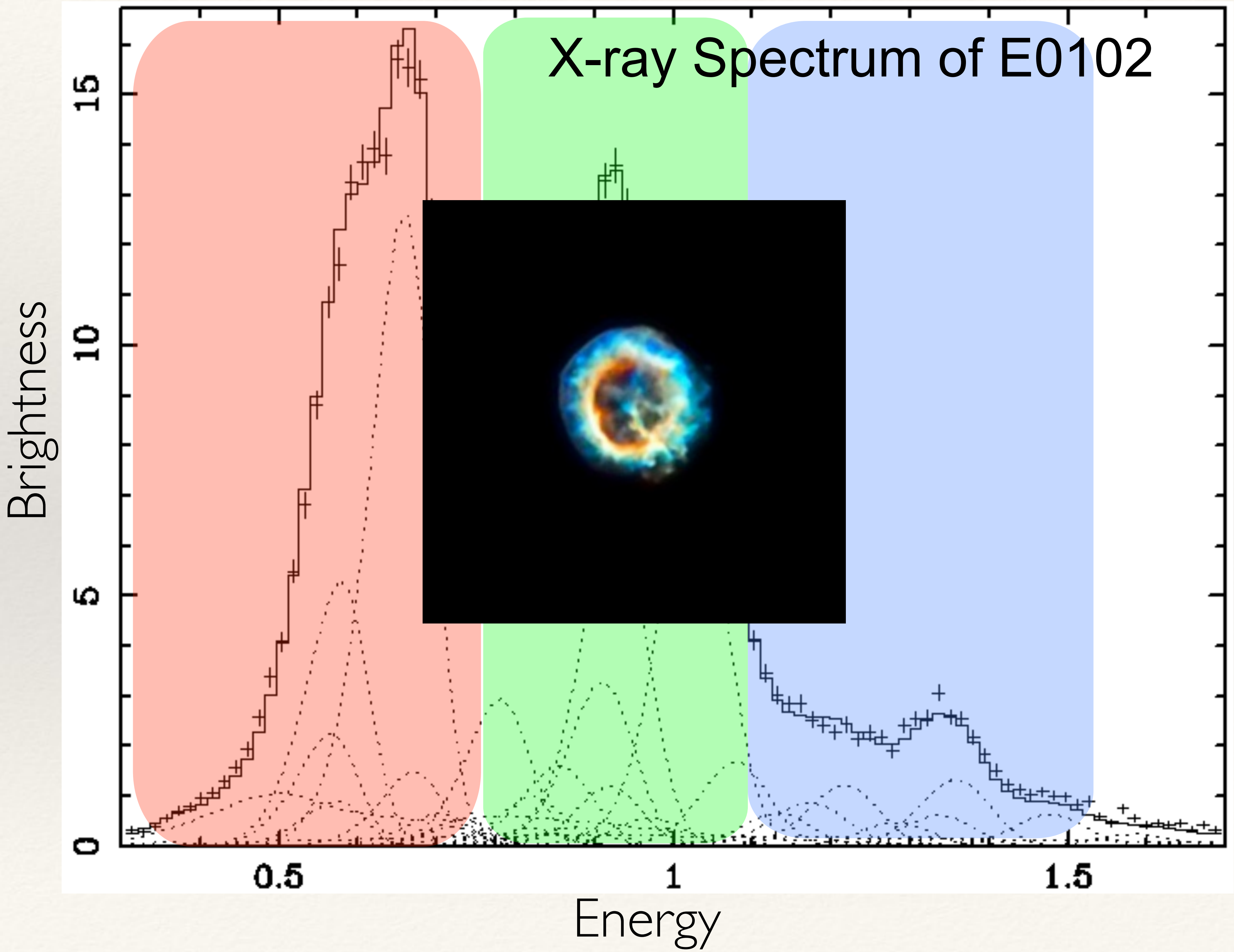
A Splash of Color

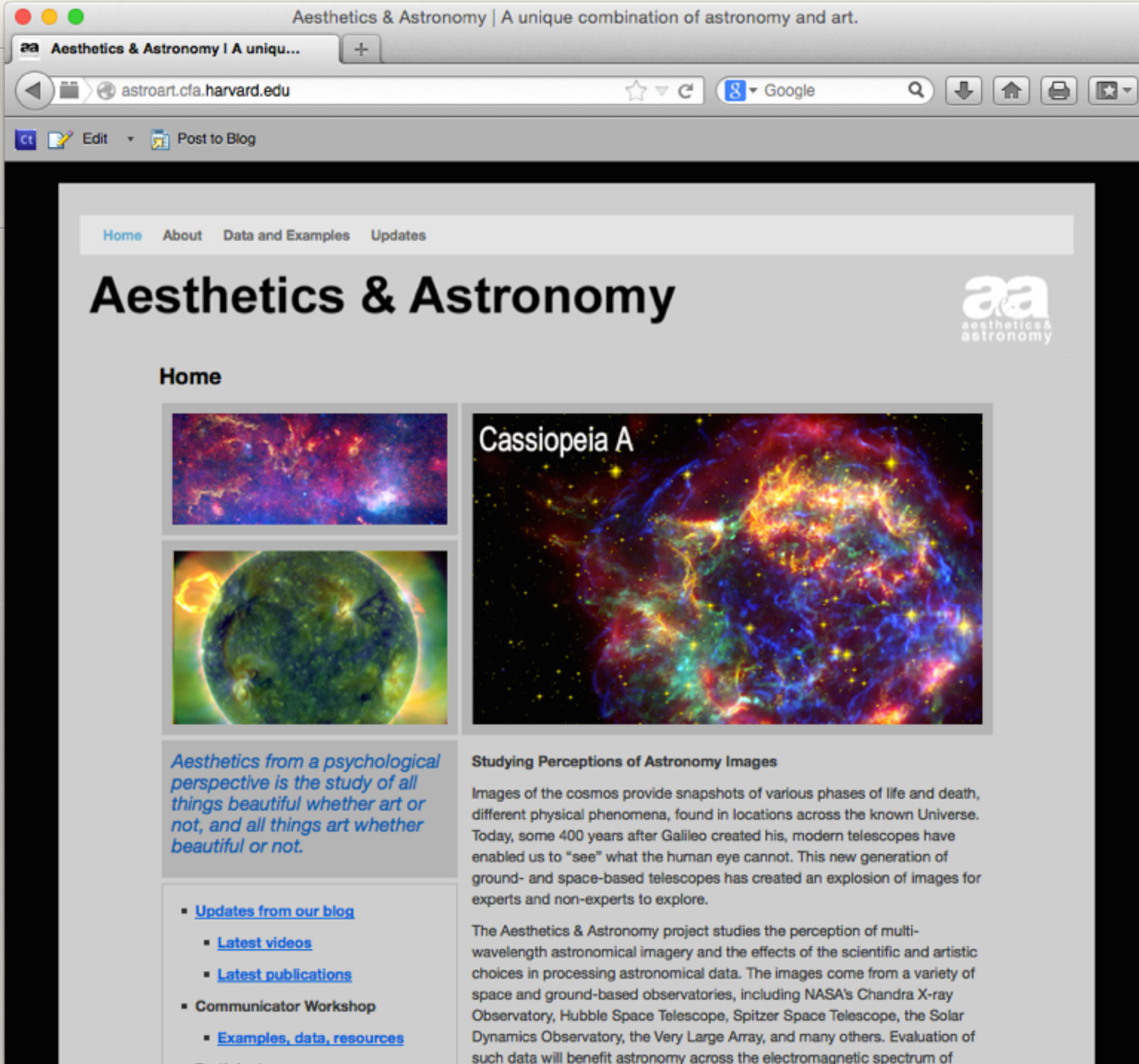


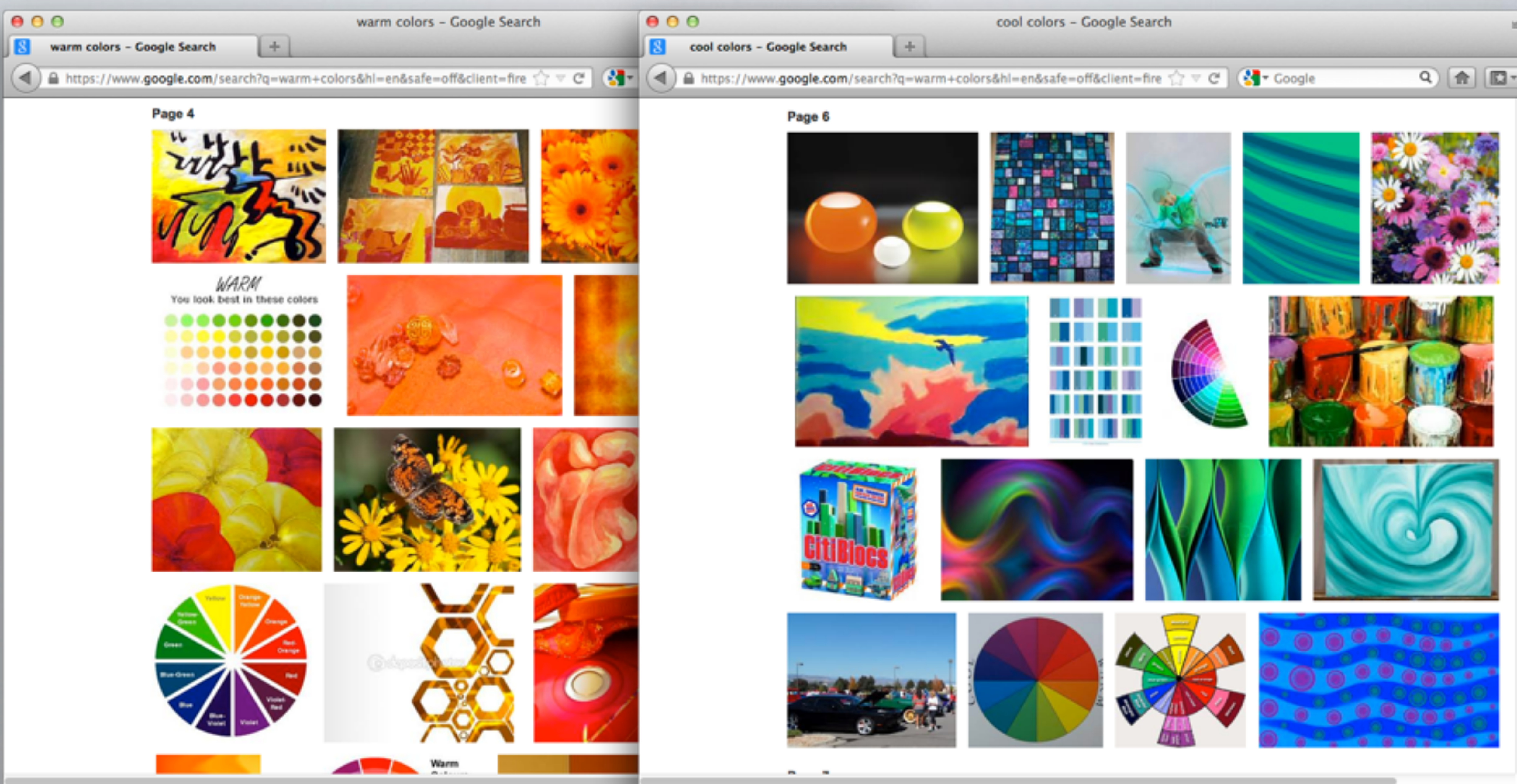
A Splash of Color



A Splash of Color

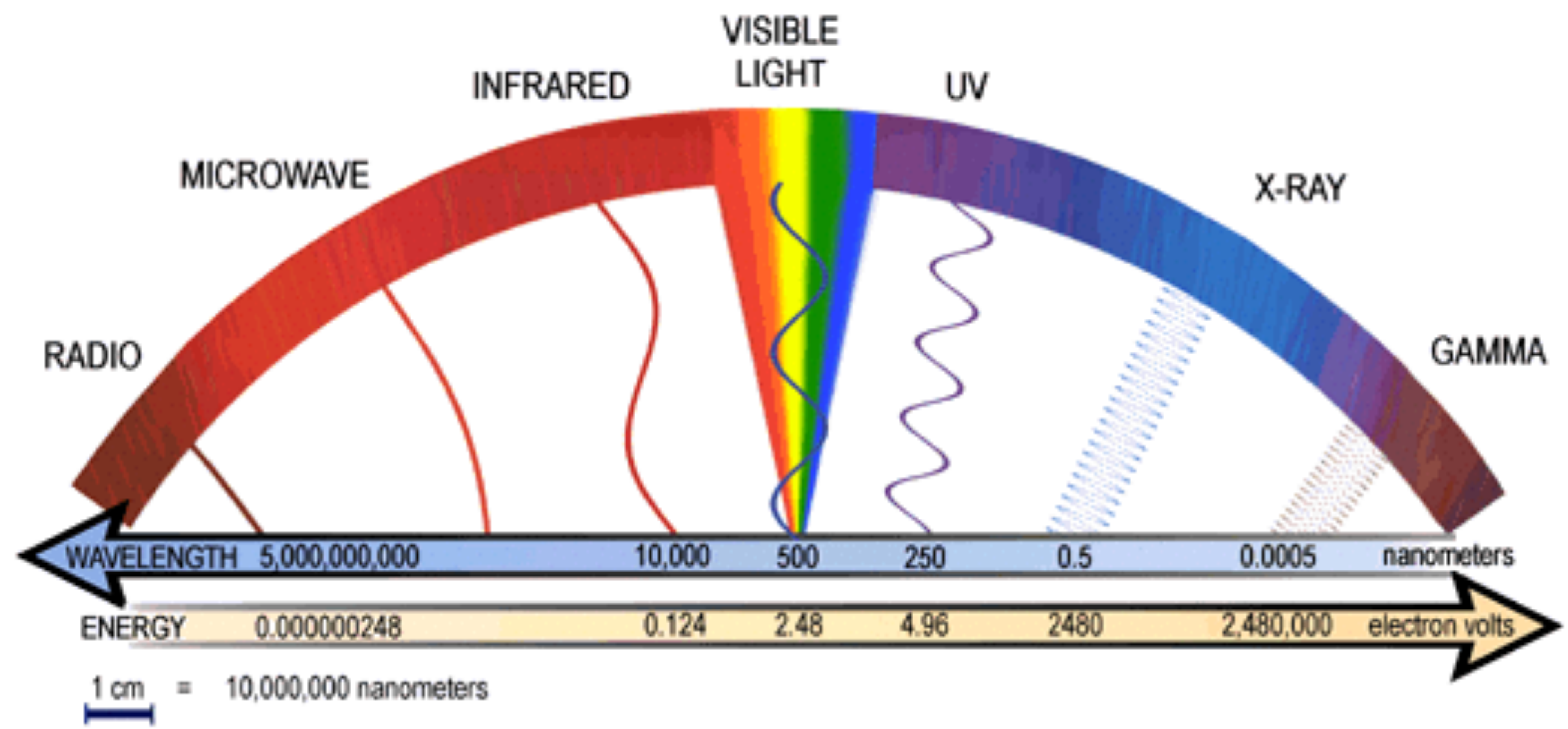



Aesthetics & Astronomy | A unique combination of astronomy and art.
Aesthetics & Astronomy I A uniqu...
astroart.cfa.harvard.edu
Google
Edit
Post to Blog
Home
About
Data and Examples
Updates
Aesthetics & Astronomy
aesthetics & astronomy
Home
Cassiopeia A
Aesthetics from a psychological perspective is the study of all things beautiful whether art or not, and all things art whether beautiful or not.
Updates from our blog
Latest videos
Latest publications
Communicator Workshop
Examples, data, resources
Participate
Studying Perceptions of Astronomy Images
Images of the cosmos provide snapshots of various phases of life and death, different physical phenomena, found in locations across the known Universe. Today, some 400 years after Galileo created his, modern telescopes have enabled us to "see" what the human eye cannot. This new generation of ground- and space-based telescopes has created an explosion of images for experts and non-experts to explore.
The Aesthetics & Astronomy project studies the perception of multi-wavelength astronomical imagery and the effects of the scientific and artistic choices in processing astronomical data. The images come from a variety of space and ground-based observatories, including NASA's Chandra X-ray Observatory, Hubble Space Telescope, Spitzer Space Telescope, the Solar Dynamics Observatory, the Very Large Array, and many others. Evaluation of such data will benefit astronomy across the electromagnetic spectrum of



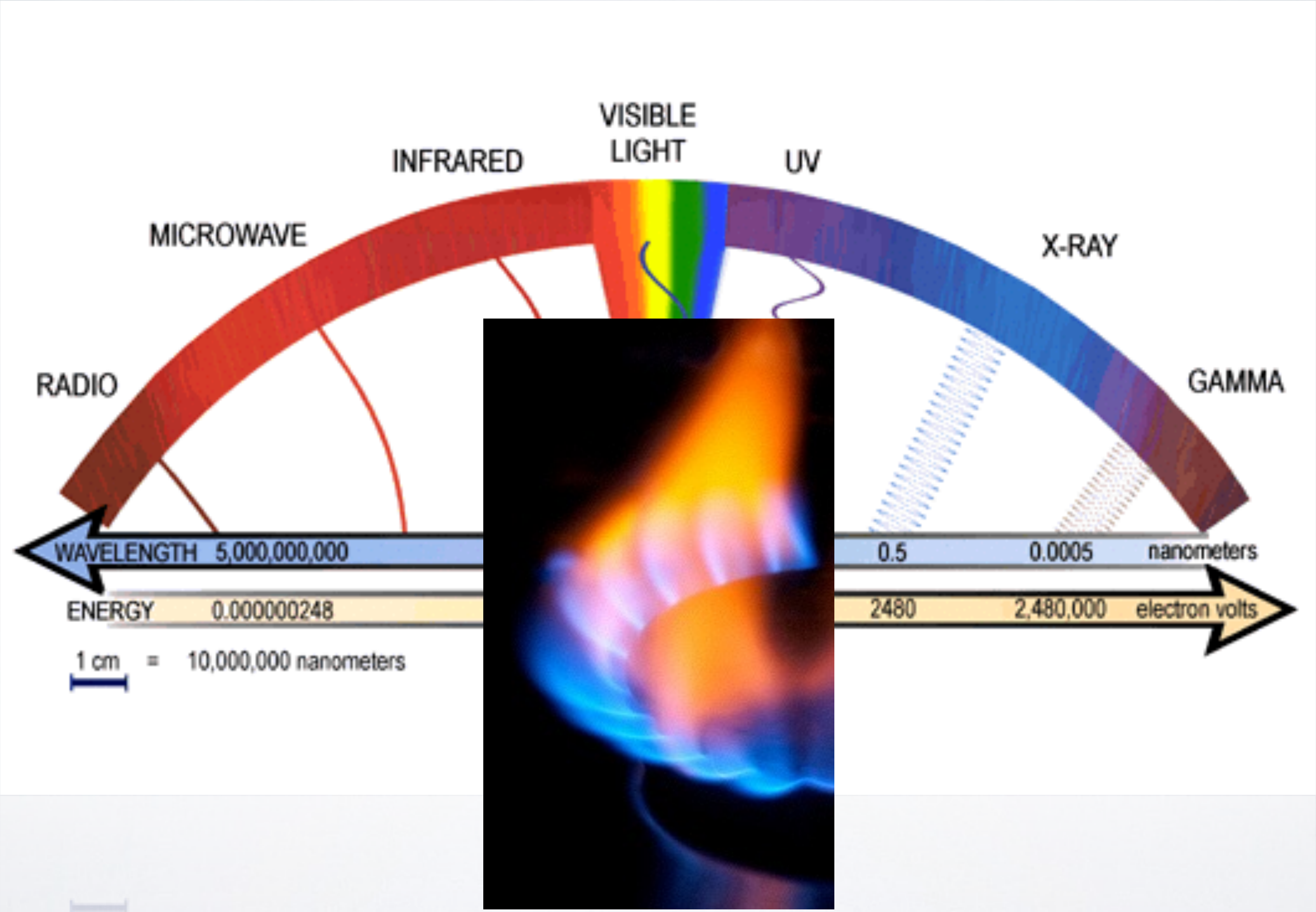
WARM ------------ COOL

COLOR CHOICE



COOL ------------- WARM

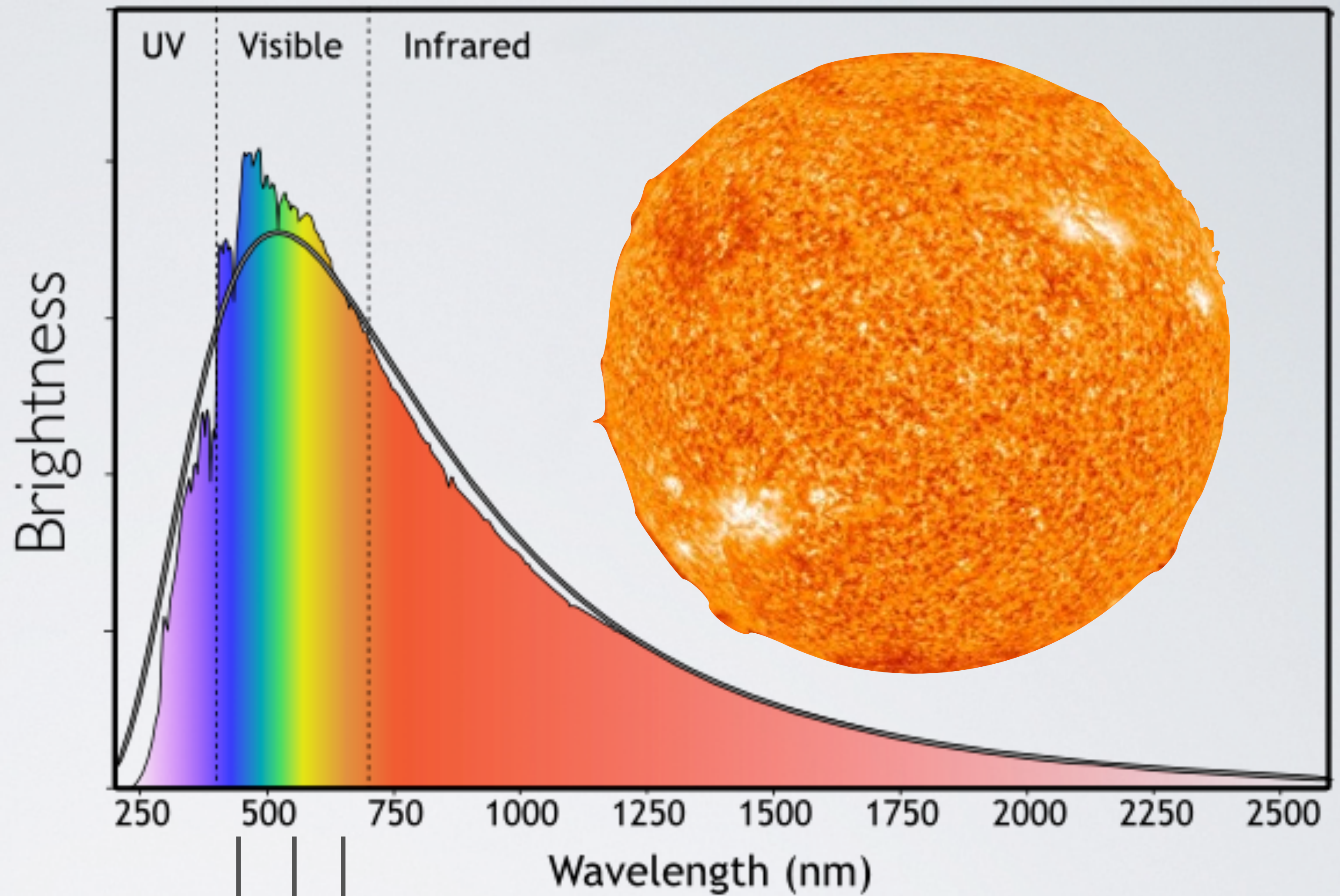
COLOR CHOICE



COOL - - - - - - - - - - - - WARM

COLOR CHOICE

It's Biological!



Red = 700 nm

Green = 550 nm

Blue = 440 nm

Core Qualities

Photogenic Resolution (Christensen et al, 2014)

$r_{photo} = FOV/\Theta_{effective}$

$\Theta_{diffraction} = \lambda/D$

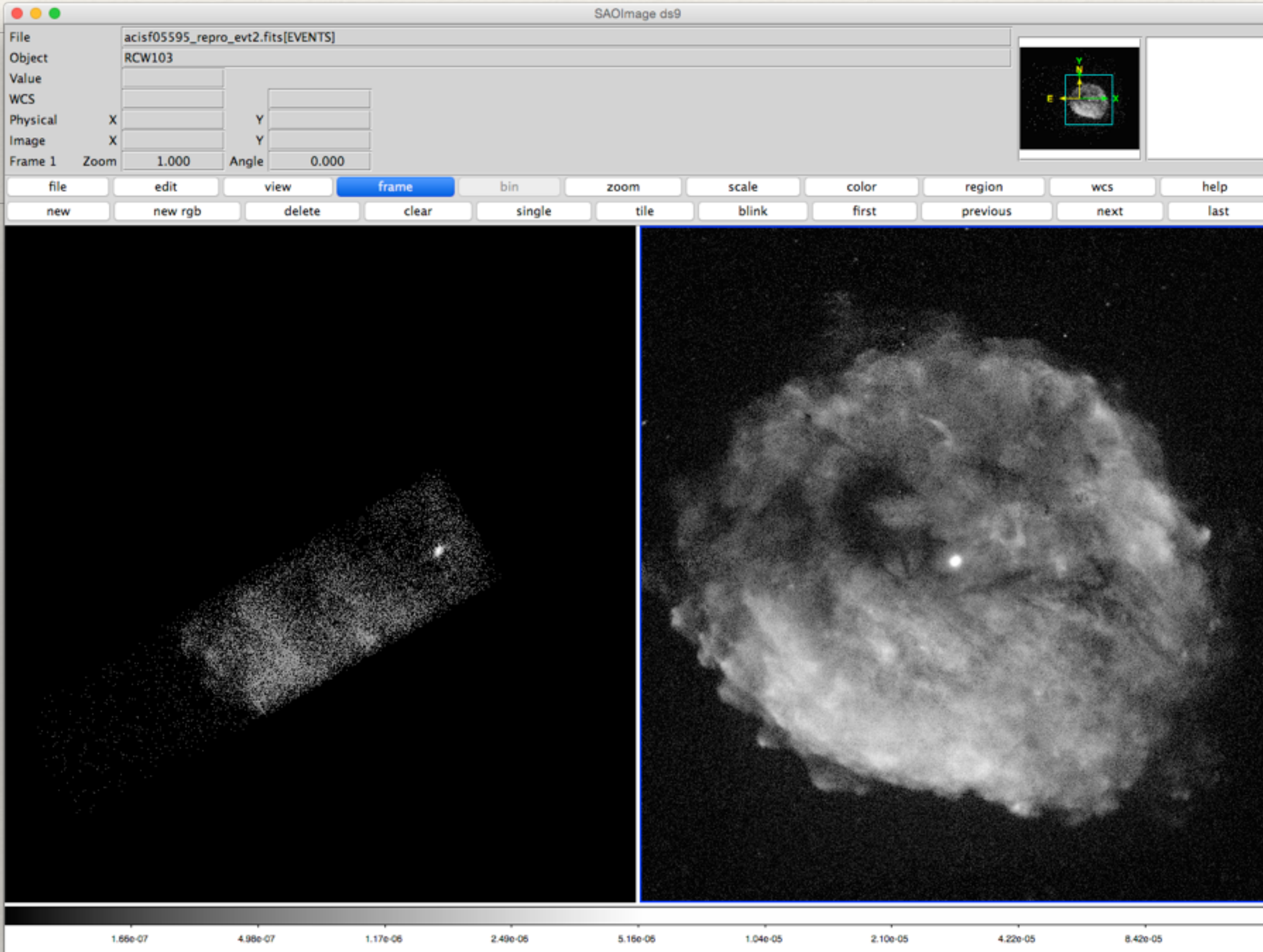
High Signal to Noise

$SNR = P_{signal}/P_{noise}$

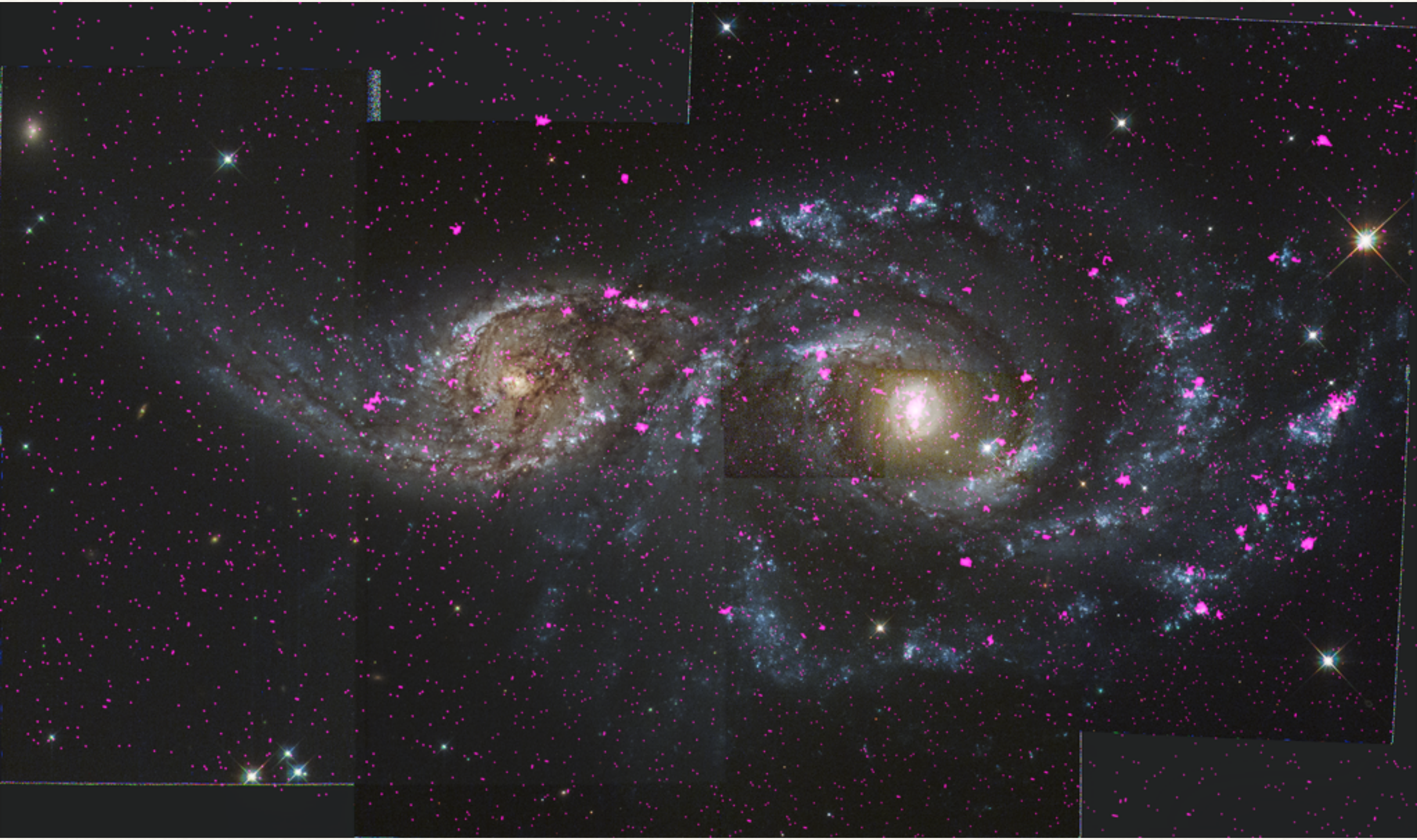
Clean of Artifacts

Color/Contrast

Composition


SAOImage ds9
File
acisf05595_repro_evt2.fits[EVENTS]
Object
RCW103
Value
WCS
Physical
X
Y
Image
X
Y
Frame 1
Zoom
1.000
Angle
0.000
file
edit
view
frame
bin
zoom
scale
color
region
wcs
help
new
new rgb
delete
clear
single
tile
blink
first
previous
next
last
1.66e-07
4.98e-07
1.17e-06
2.49e-06
5.16e-06
1.04e-05
2.10e-05
4.22e-05
8.42e-05

NGC 2207 - an example



NGC 2207 - an example

Core Processing Concepts

Pre-processing

CIAO/IDL
Python

Image Integration

Image Smoothing (De-noise)

Image Delinearization

High Dynamic Range Processing

Color Choice

Cropping/Composition

Post-processing

PixInsight
Photoshop

Metadata
(Python)

Core Processing Concepts

Pre-processing

CIAO/IDL
Python

Image Integration

Image Smoothing (De-noise)

Image Delinearization

High Dynamic Range Processing

Color Choice

Cropping/Composition

Post-processing

PixInsight
Photoshop

Metadata
(Python)

Image Smoothing

ASMOOTH

Adaptive kernel smoothing

Useful for suppressing noise while preserving real structure
(signal that is significant at a preset S/N level)

see: http://arxiv.org/abs/astro-ph/0601306

Image Smoothing

ASMOOTH

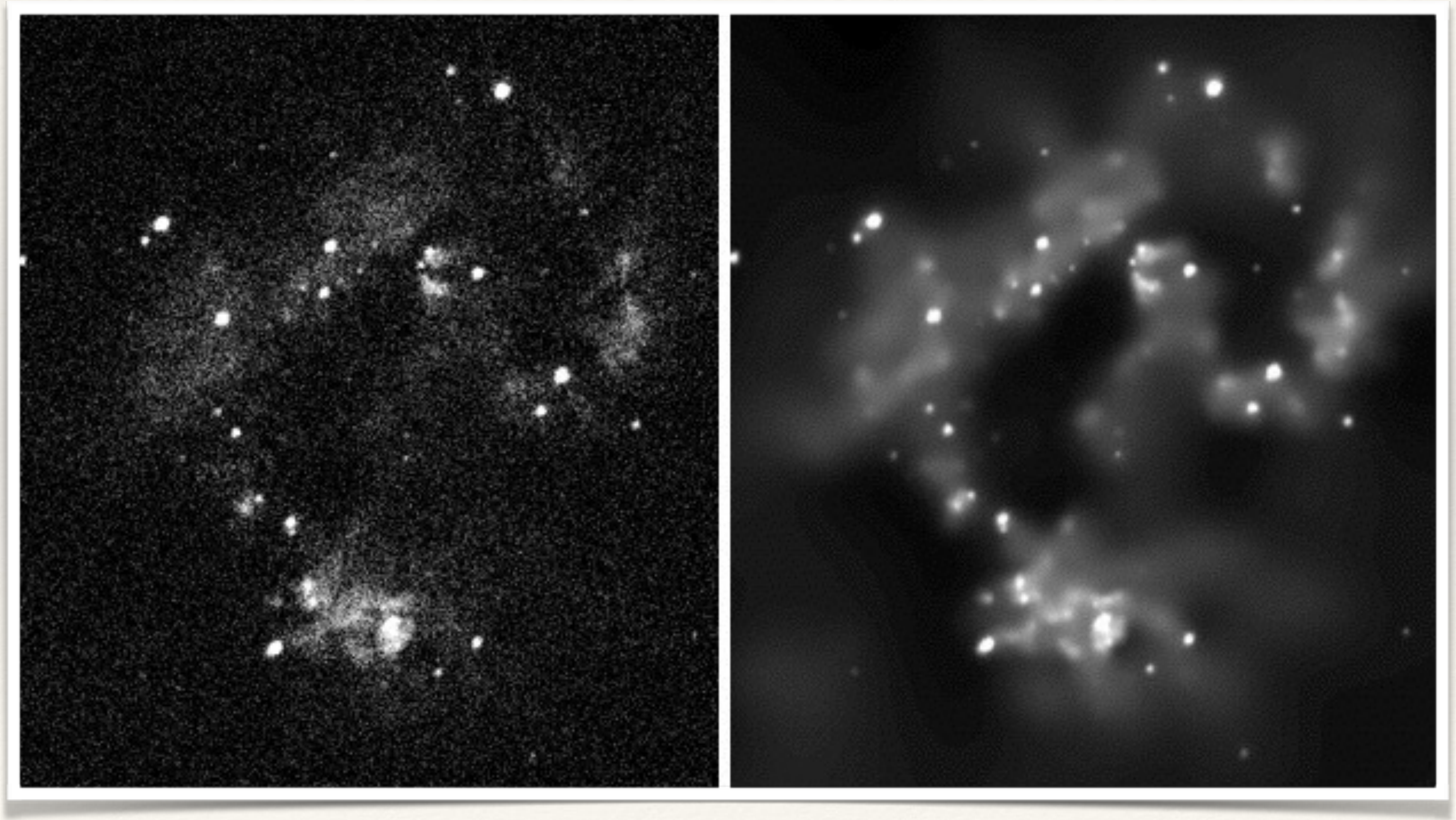


Image Smoothing

GREYCstoration
anisotropic smoothing using curvature-preserving PDEs

see: https://tschumperle.users.greyc.fr/publications/tschumperle_ijcv06.pdf

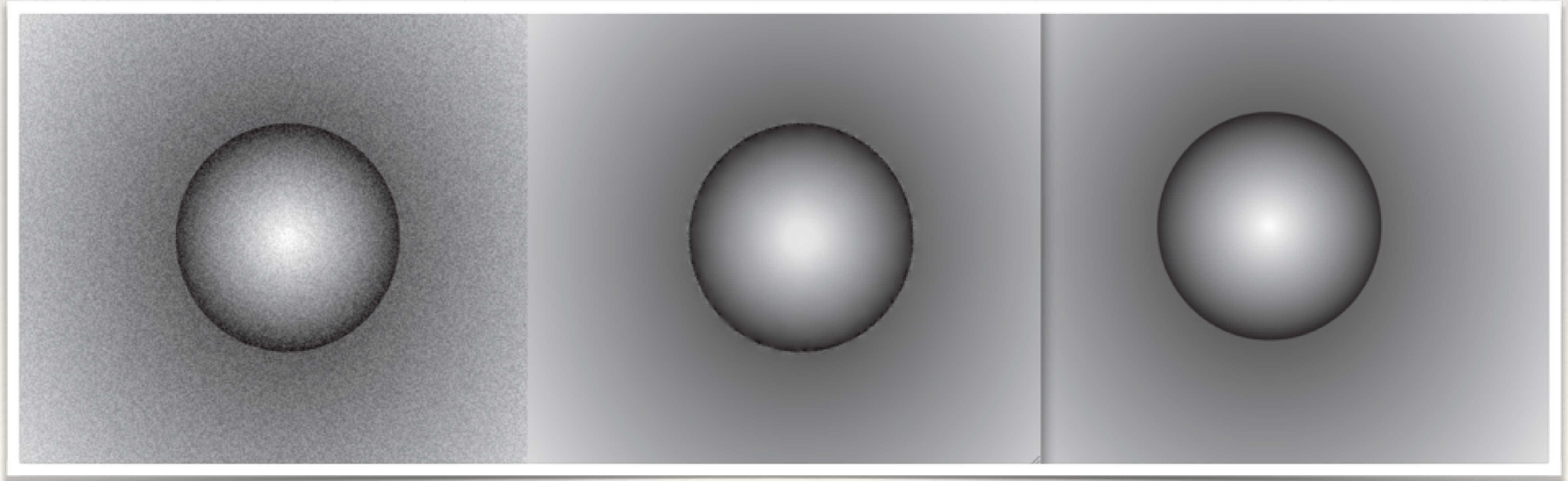
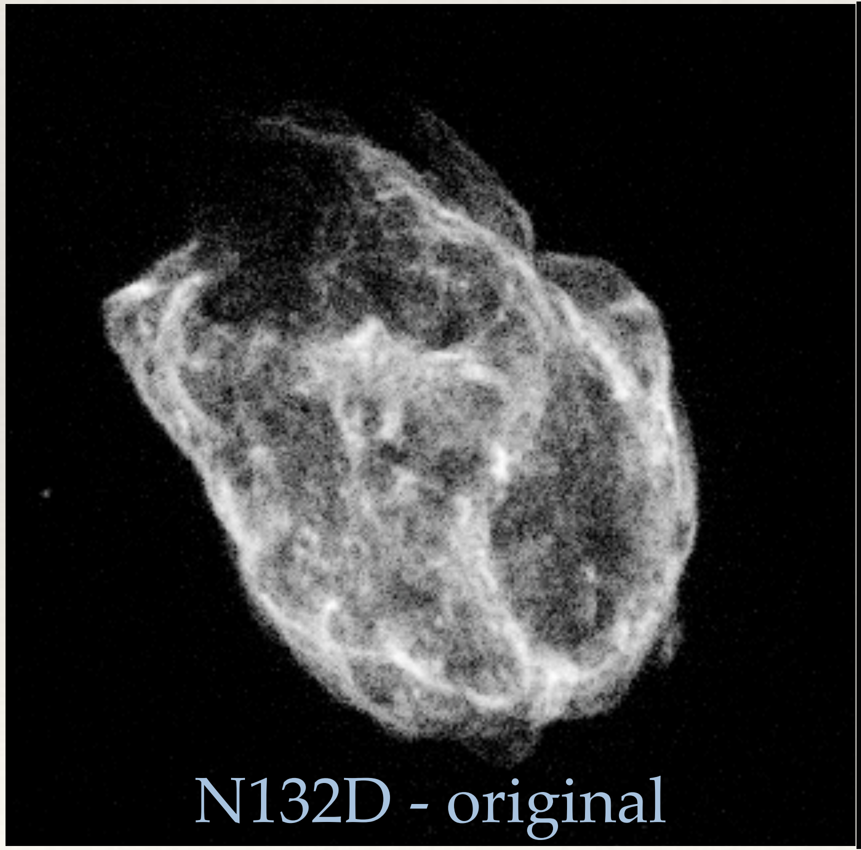
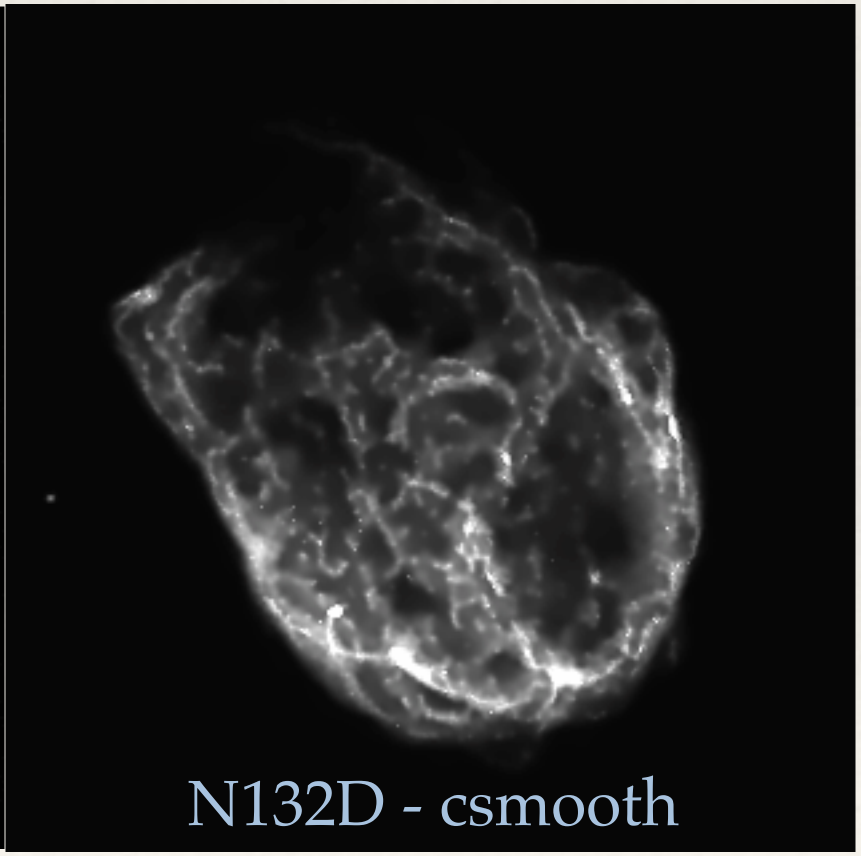


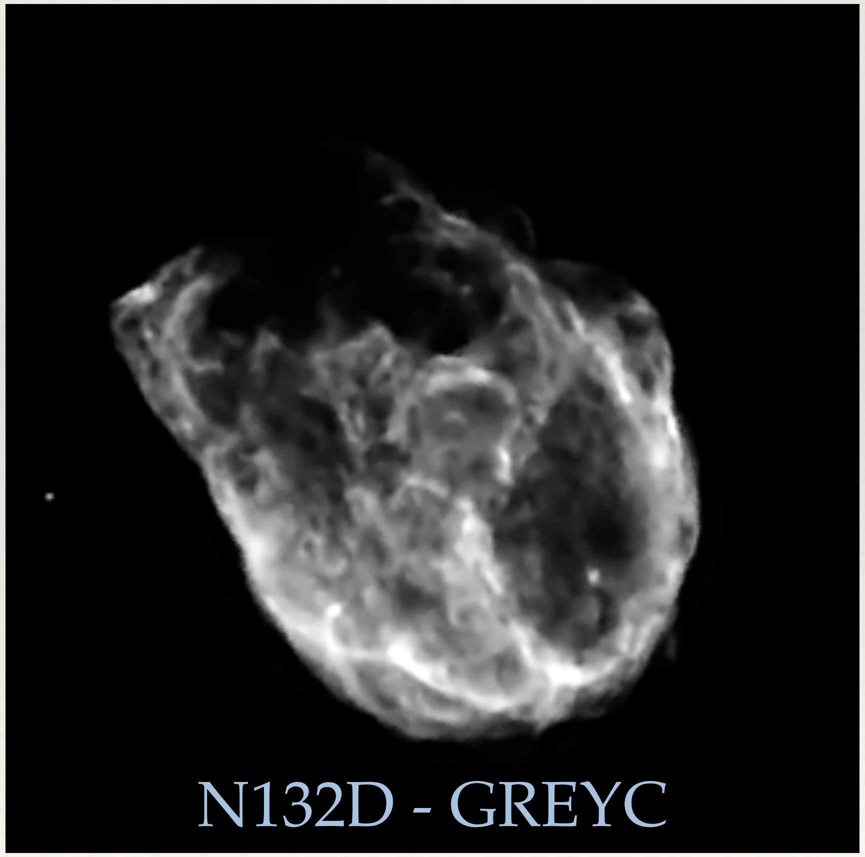
Image Smoothing

GREYCstoration
anisotropic smoothing using curvature-preserving PDEs

see: https://tschumperle.users.greyc.fr/publications/tschumperle_ijcv06.pdf



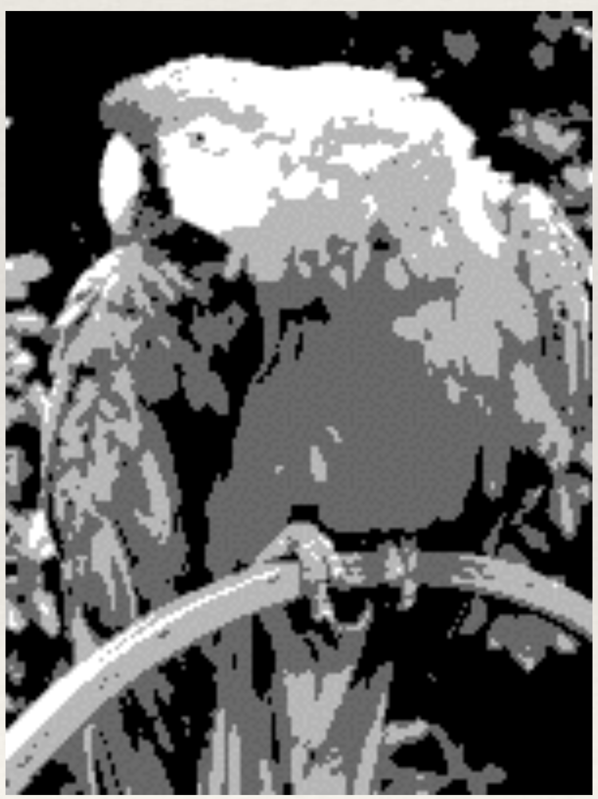




Intensity Scaling & Bit Values

bits work in powers of 2

A 2-bit grayscale image has 2^2 possible values of gray



2-bit

2*2=4

00, 01, 10, 11

8-bit? $2^8 = 256$ possible values

16-bit? $2^{16} = 65,536$ possible values

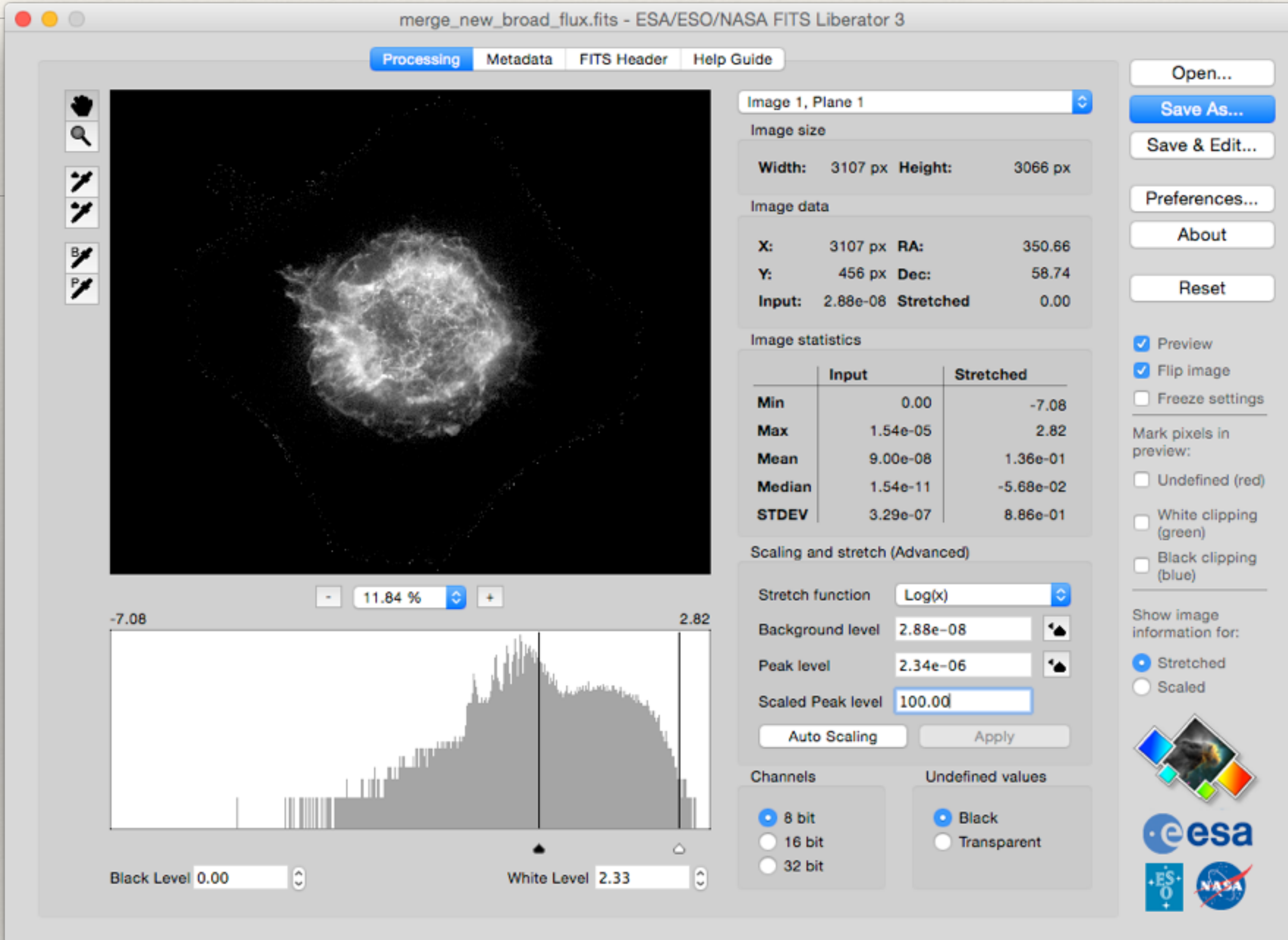
8-bit

Image Credit: wikipedia/Ricardo Cancho Niemietz

Intensity Scaling & HDR

FITS Liberator

PixInsight


merge_new_broad_flux.fits - ESA/ESO/NASA FITS Liberator 3
Processing
Metadata
FITS Header
Help Guide
Open...
Save As...
Save & Edit...
Preferences...
About
Reset
Image 1, Plane 1
Image size
Width: 3107 px Height: 3066 px
Image data
X: 3107 px RA: 350.66
Y: 456 px Dec: 58.74
Input: 2.88e-08 Stretched 0.00
Image statistics
Input Stretched
Min 0.00 -7.08
Max 1.54e-05 2.82
Mean 9.00e-08 1.36e-01
Median 1.54e-11 -5.68e-02
STDEV 3.29e-07 8.86e-01
Scaling and stretch (Advanced)
Stretch function Log(x)
Background level 2.88e-08
Peak level 2.34e-06
Scaled Peak level 100.00
Auto Scaling
Apply
Channels
8 bit
16 bit
32 bit
Undefined values
Black
Transparent
Preview
Flip image
Freeze settings
Mark pixels in preview:
Undefined (red)
White clipping (green)
Black clipping (blue)
Show image information for:
Stretched
Scaled
11.84 %
-7.08
2.82
Black Level 0.00
White Level 2.33
esa

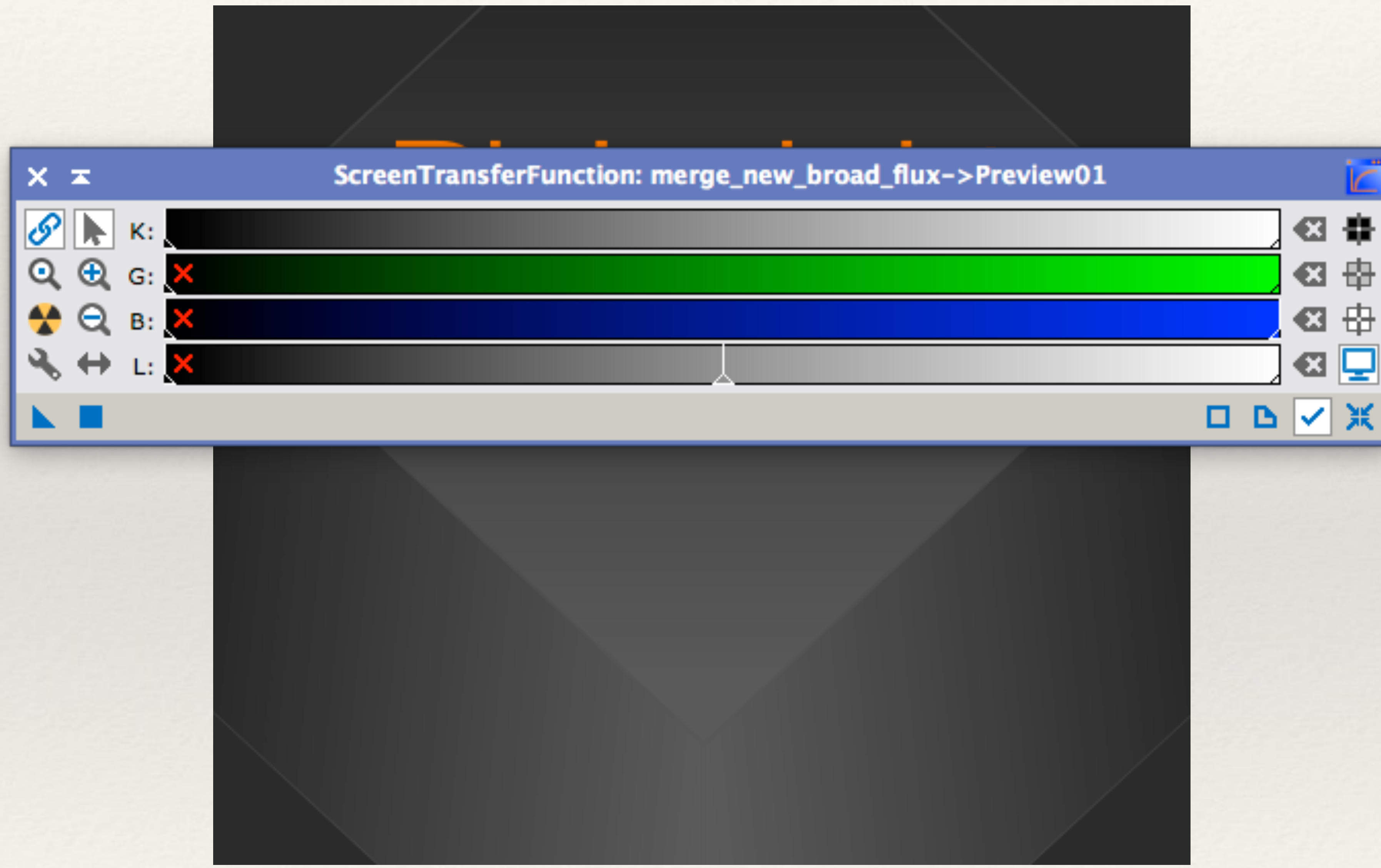
Intensity Scaling & HDR

~~FITS Liberator~~

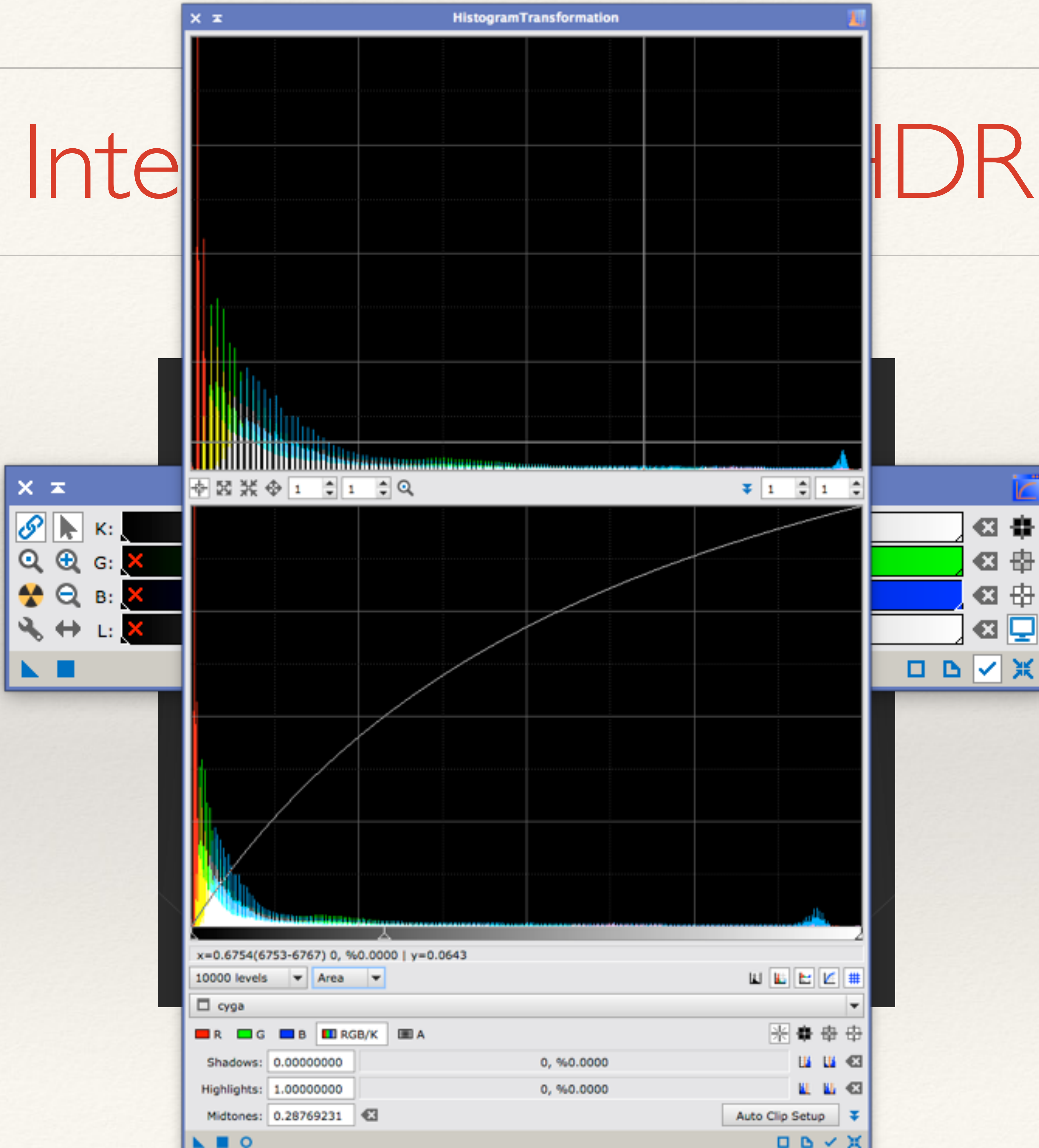
PixInsight

Intensity Scaling & HDR

Intensity Scaling & HDR



Inte … HDR

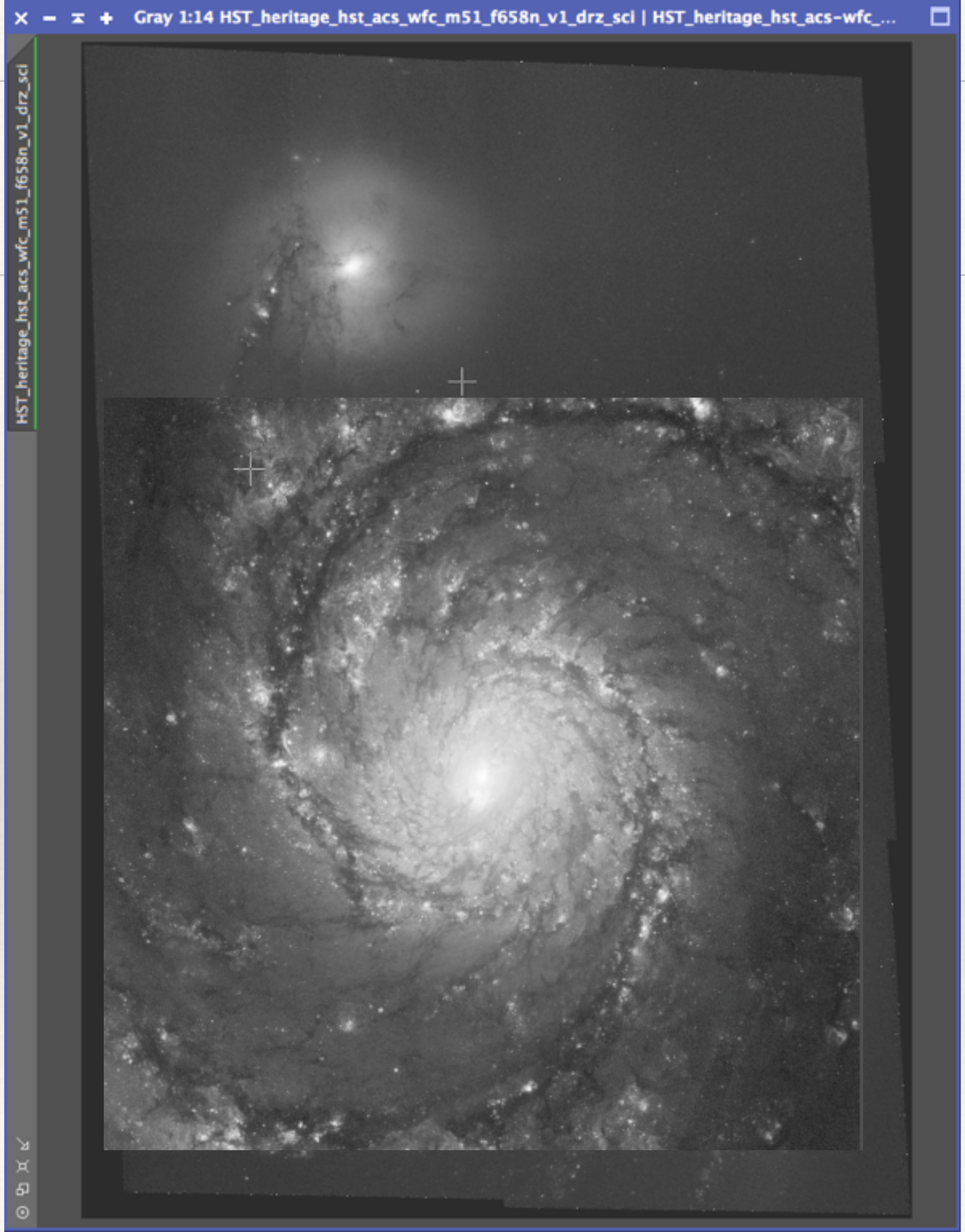


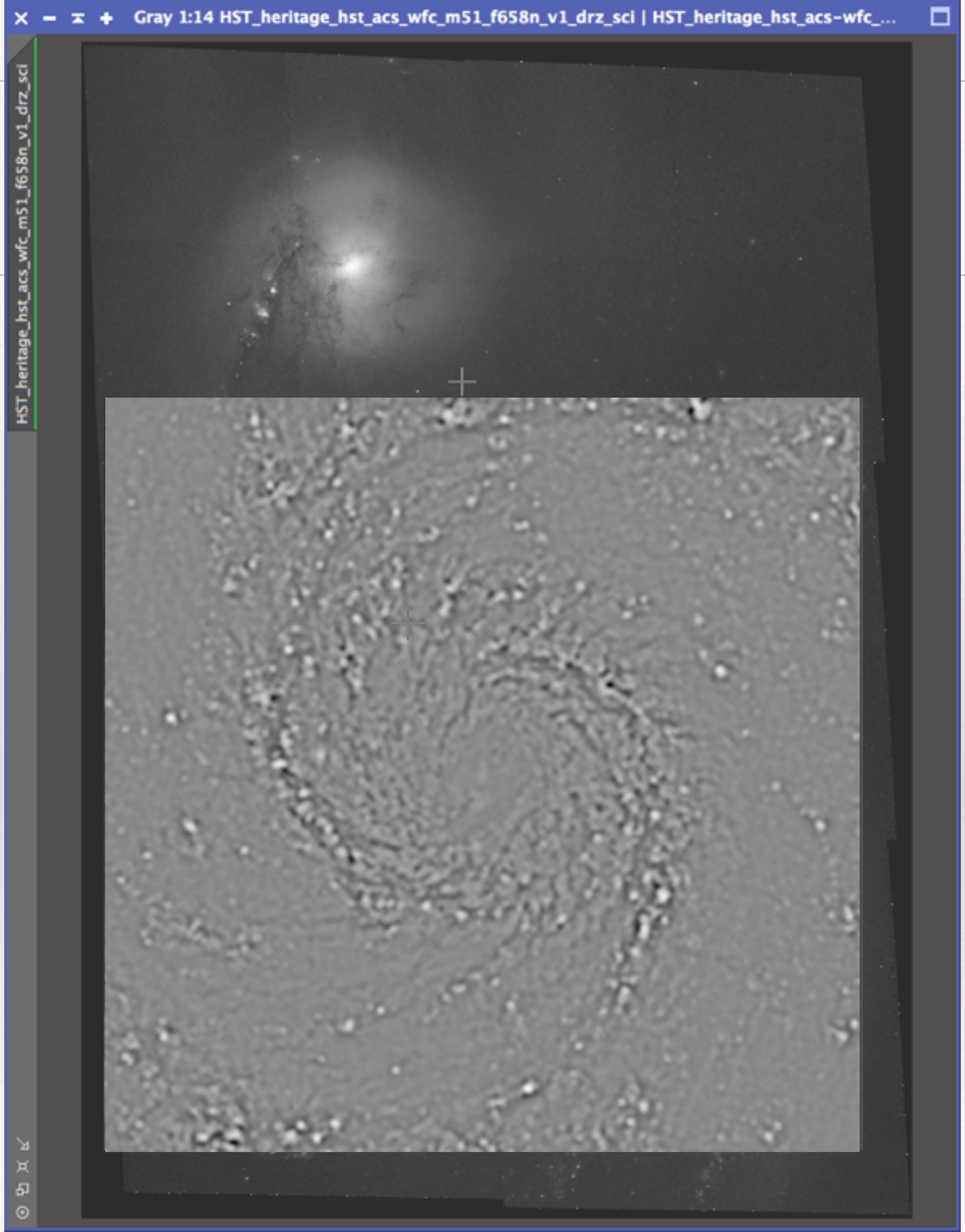
HistogramTransformation
K:
G:
B:
L:
x=0.6754(6753-6767) 0, %0.0000 | y=0.0643
10000 levels
Area
cyga
R
G
B
RGB/K
A
Shadows: 0.00000000
0, %0.0000
Highlights: 1.00000000
0, %0.0000
Midtones: 0.28769231
Auto Clip Setup

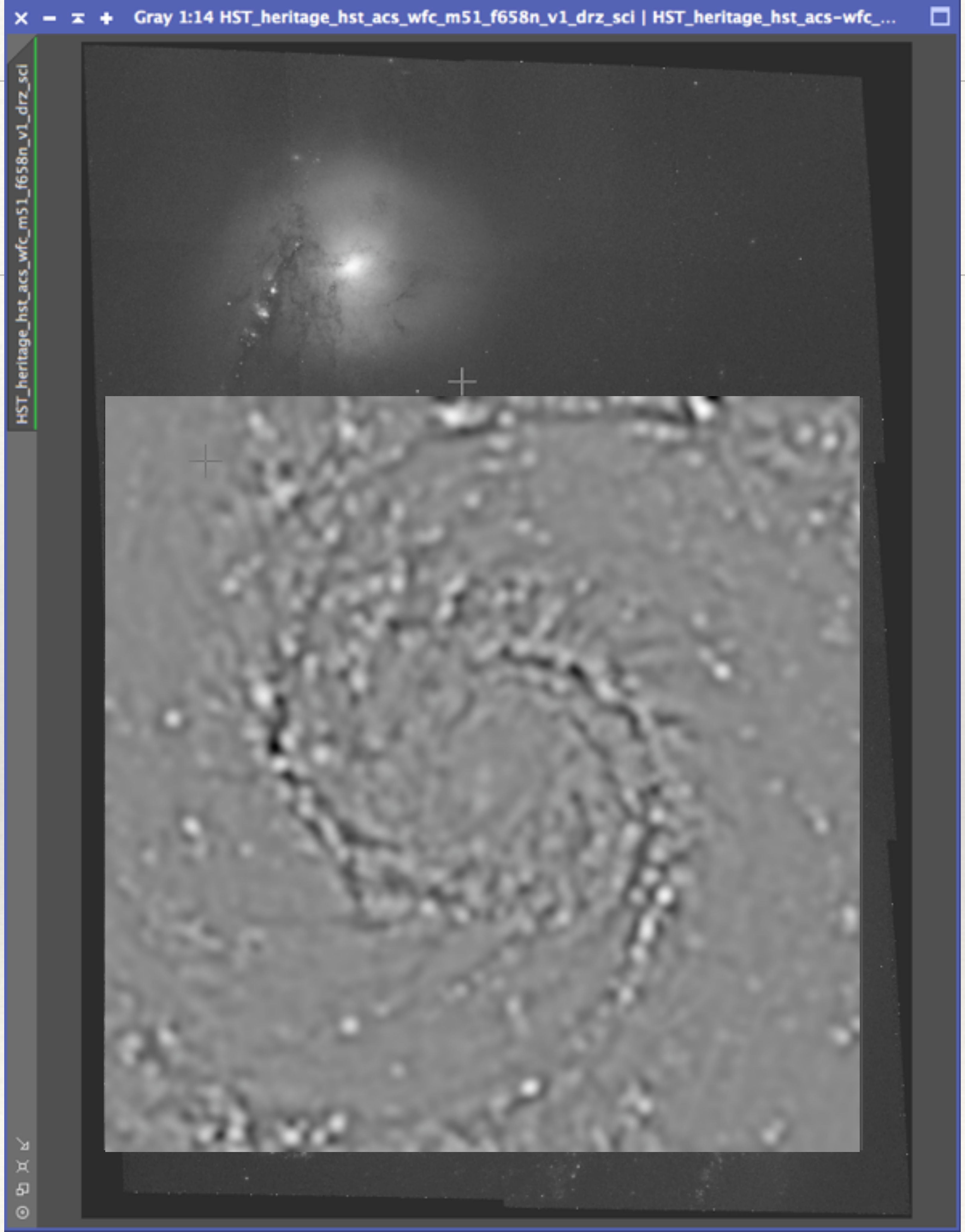
High Dynamic Range

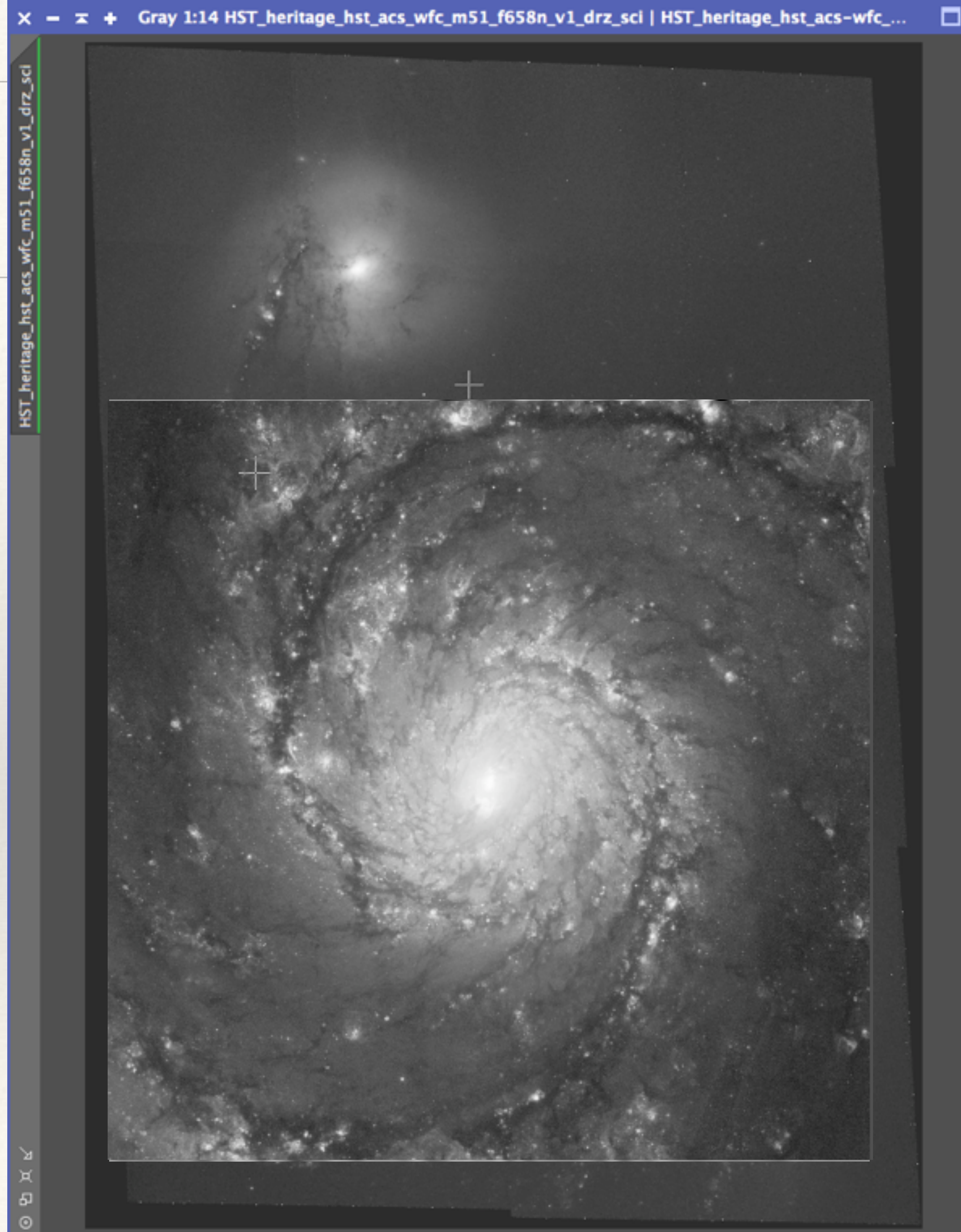
PixInsight's wavlet based approach

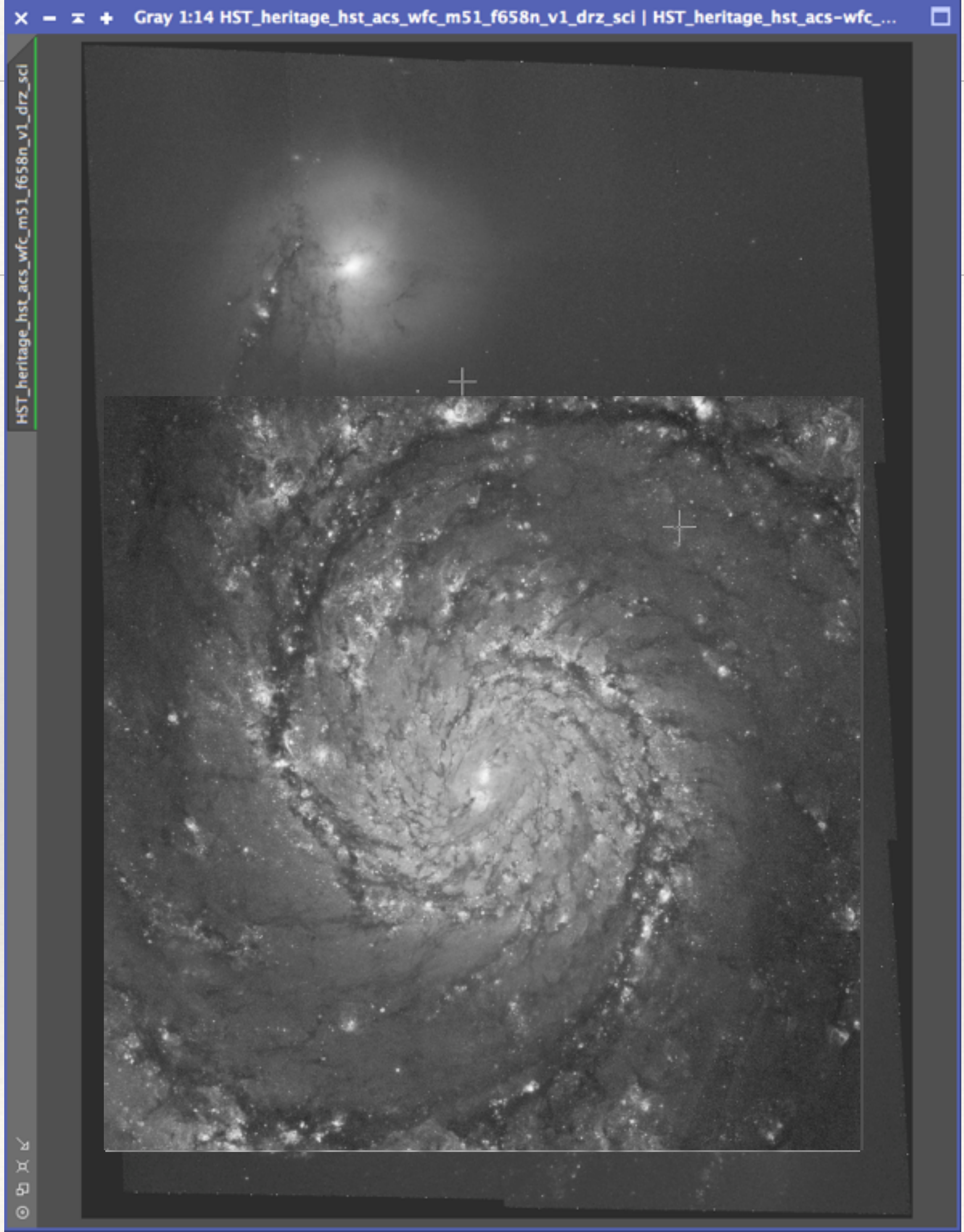

Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci

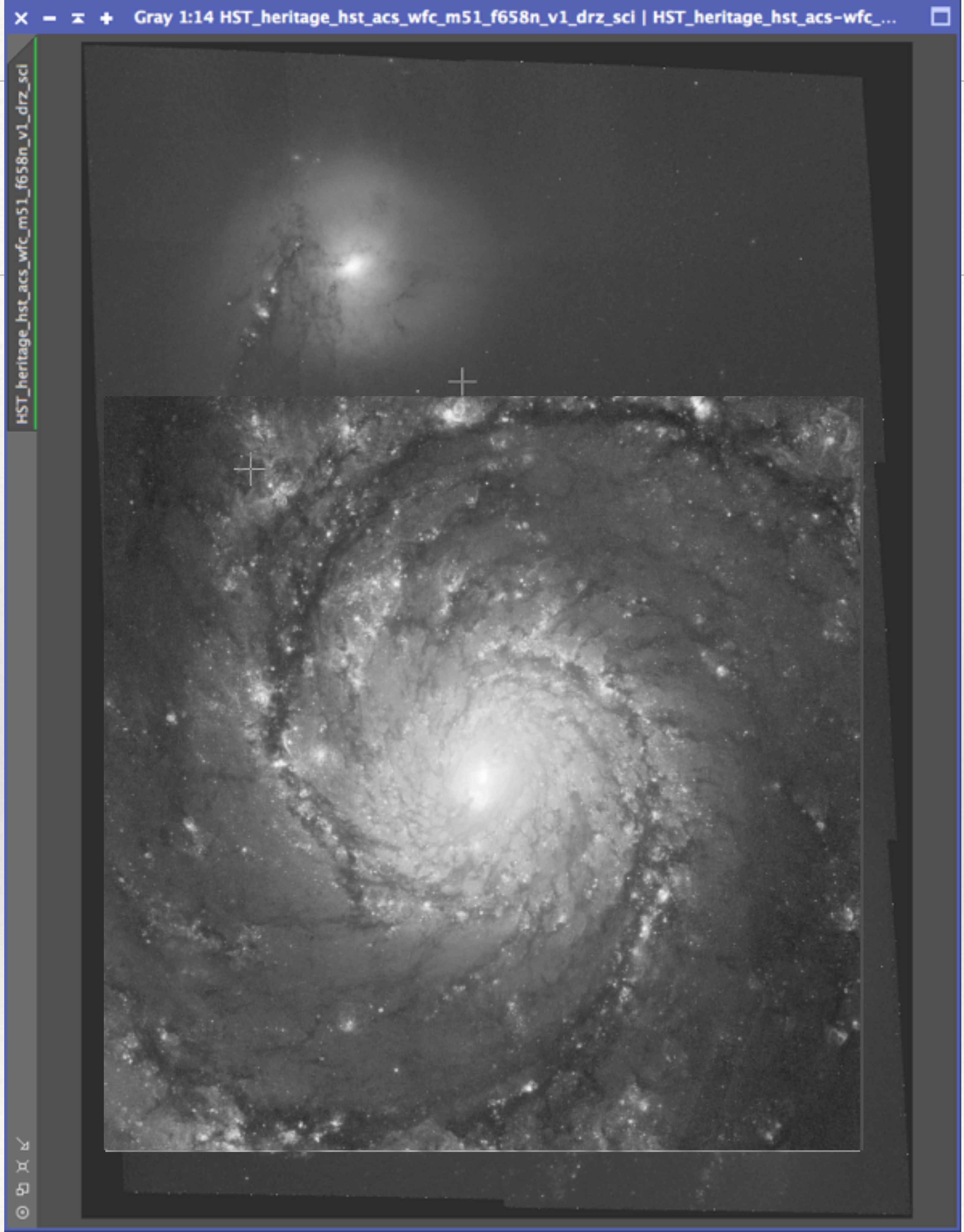

Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci

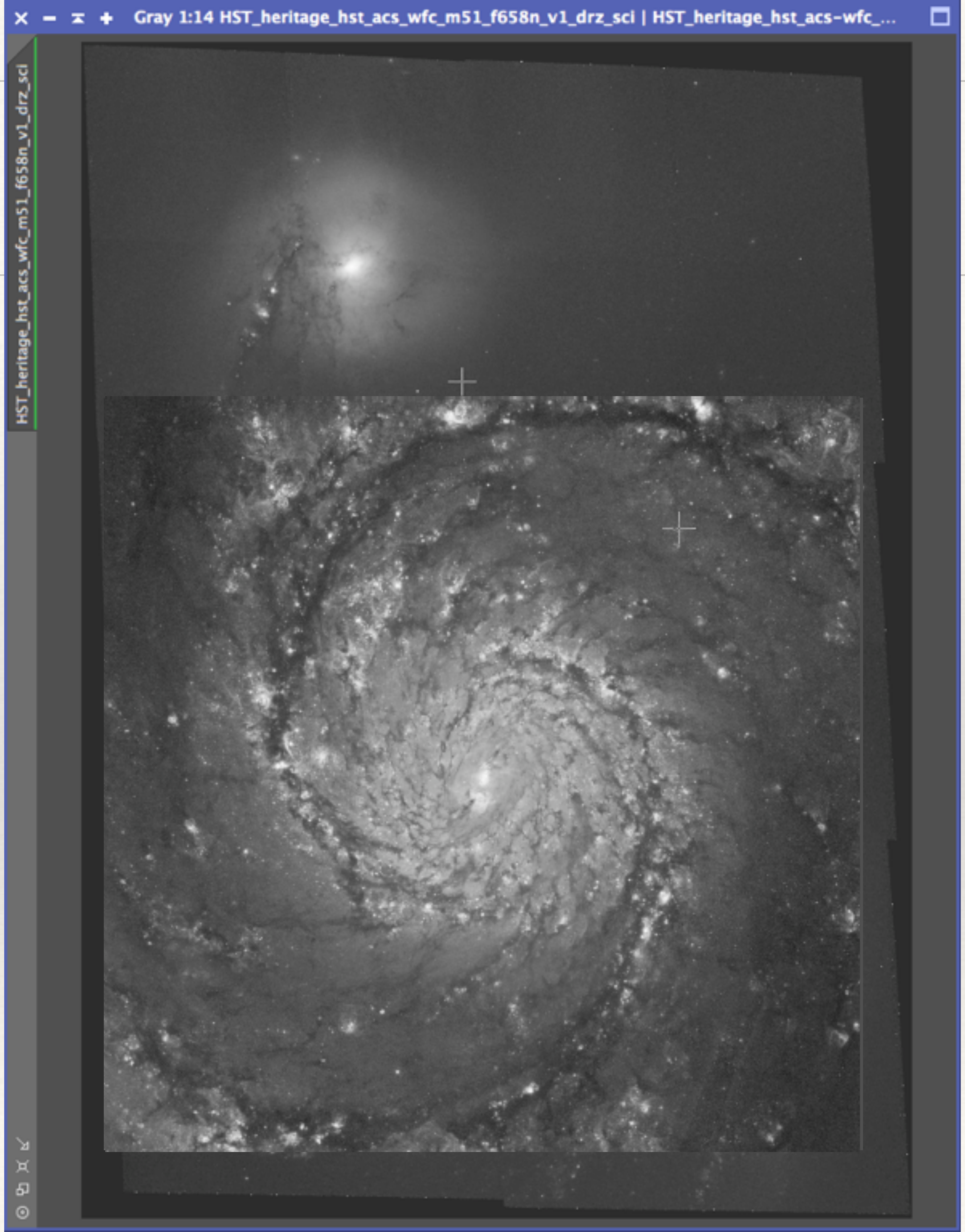

Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci


Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci


Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci

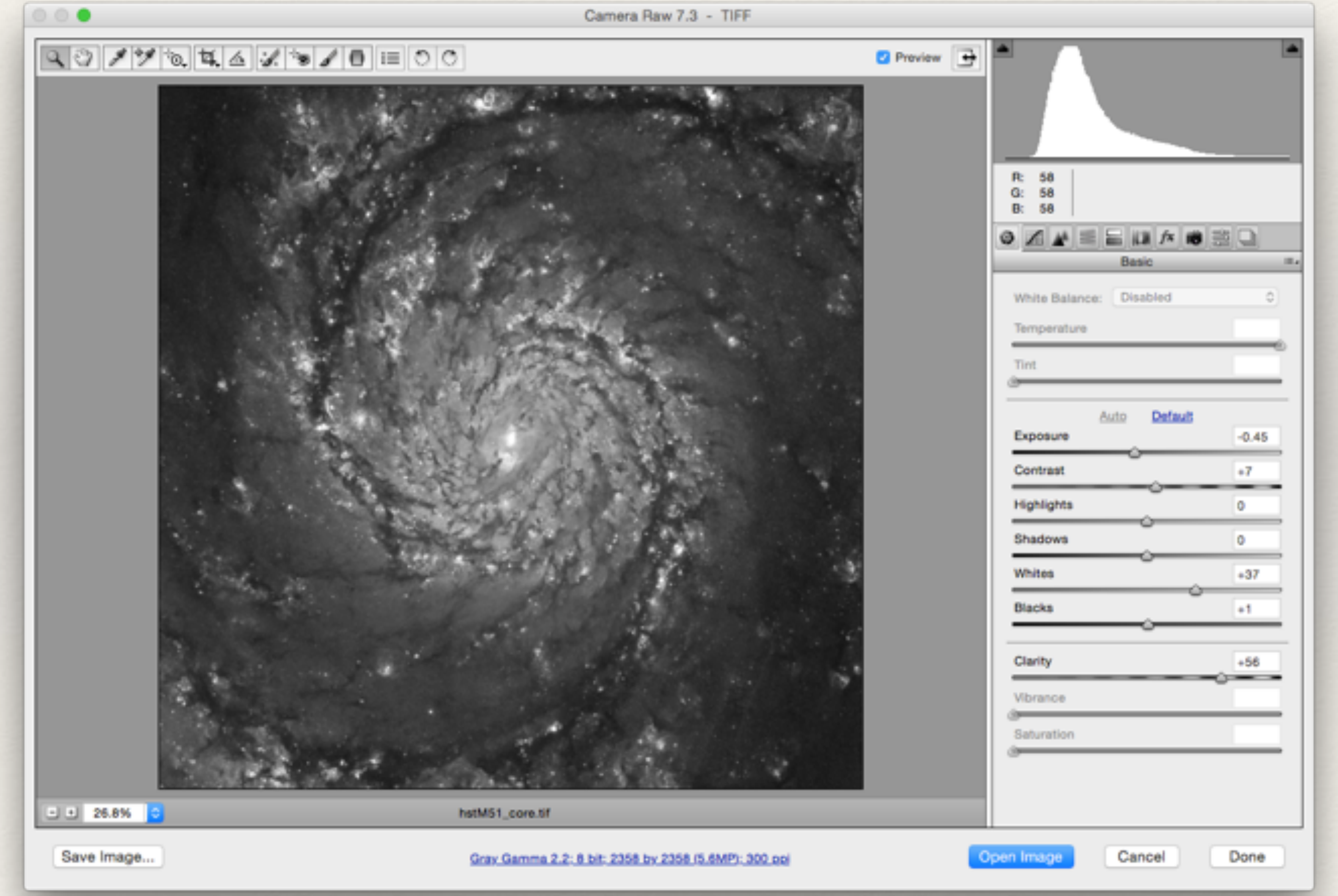

Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci


Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci


Gray 1:14 HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci | HST_heritage_hst_acs-wfc_...
HST_heritage_hst_acs_wfc_m51_f658n_v1_drz_sci

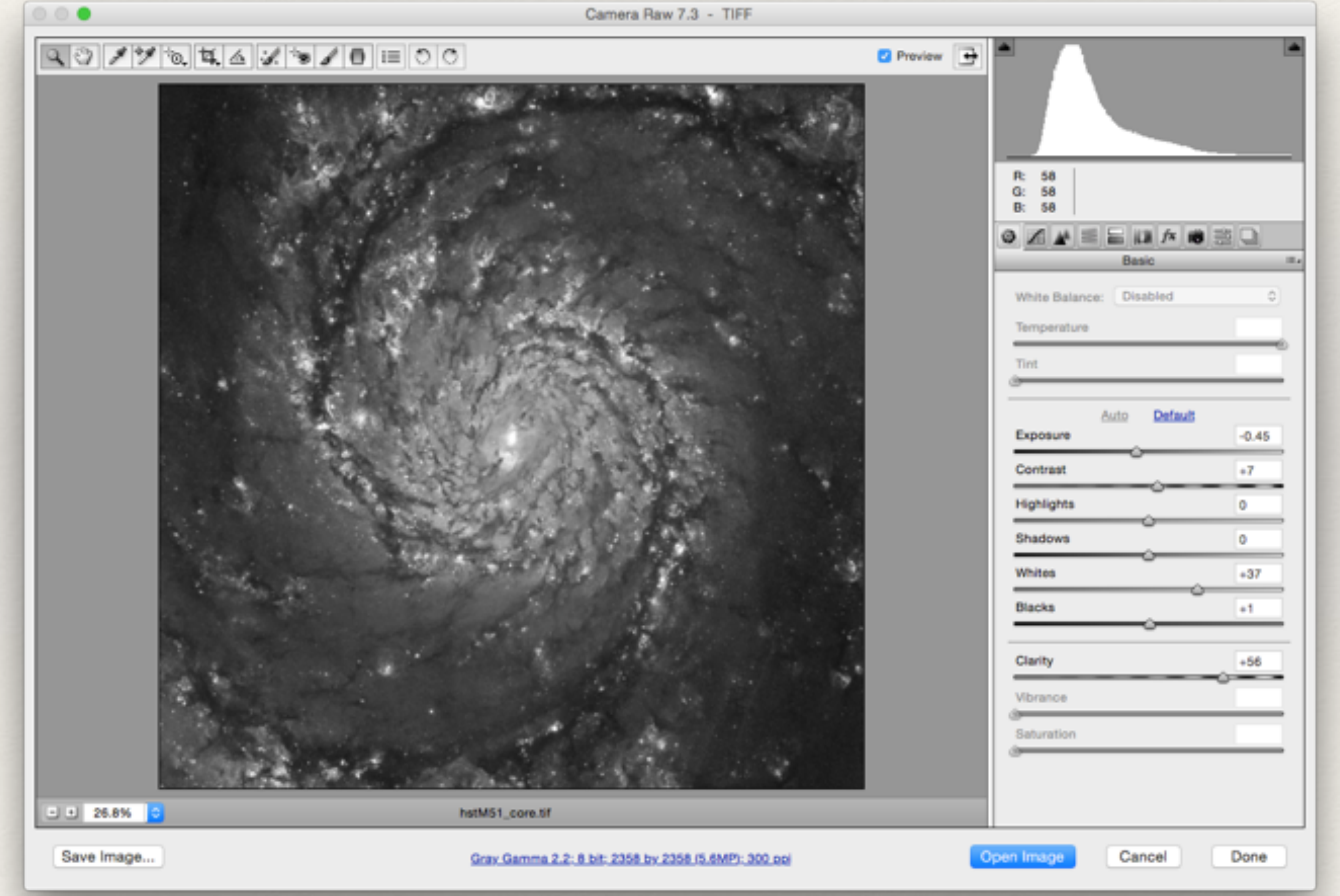
High Dynamic Range

Photoshop's open as Camera Raw "Trick"
and HDR Toning tool



High Dynamic Range

If you have access to Photoshop:
Start it up, choose File->Open and select a TIFF file
At the bottom of the dialog box, select "Format" and choose "Camera Raw"



Color & Composition

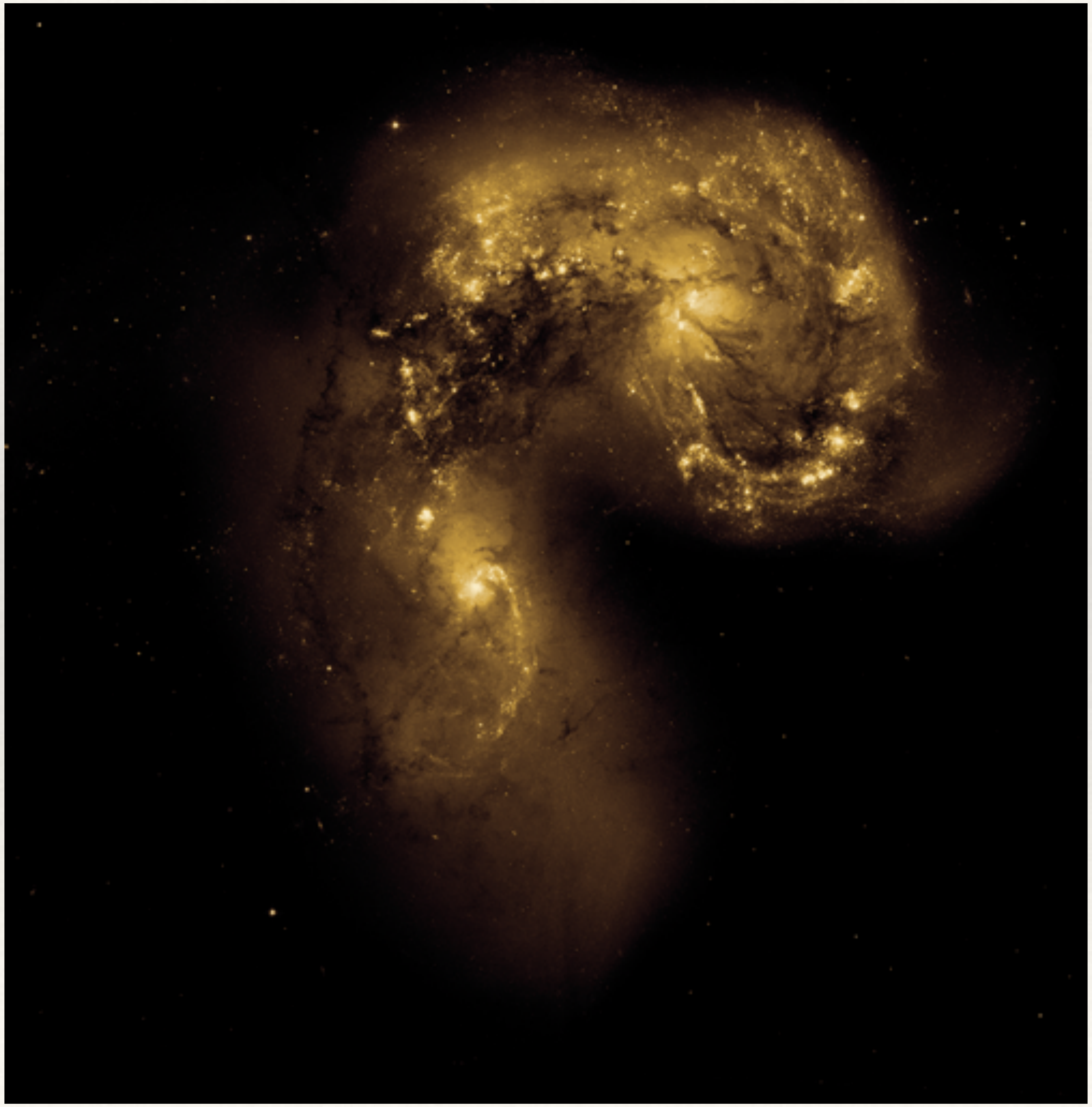
Avoiding Color Confusion: Antennae Galaxies

Color & Composition

Avoiding Color Confusion: Antennae Galaxies

Color & Composition

Avoiding Color Confusion: Antennae Galaxies

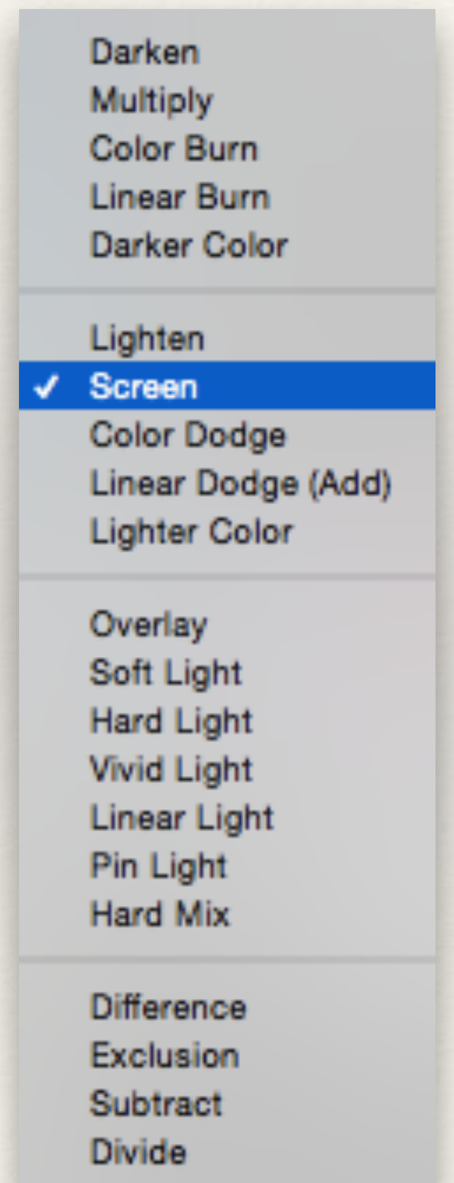


Color & Composition

Avoiding Color Confusion: Antennae Galaxies

Color & Composition

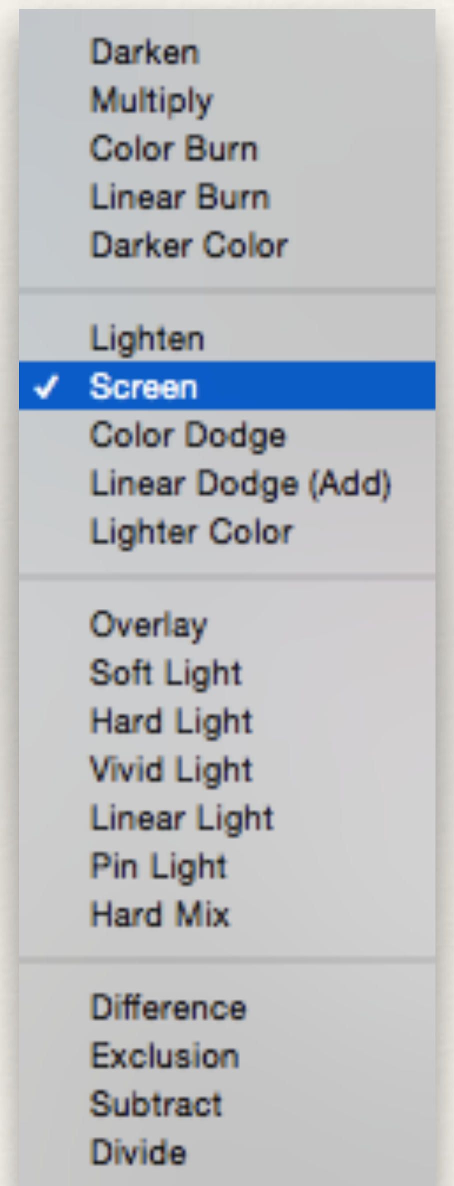
Blending Mode: Screen

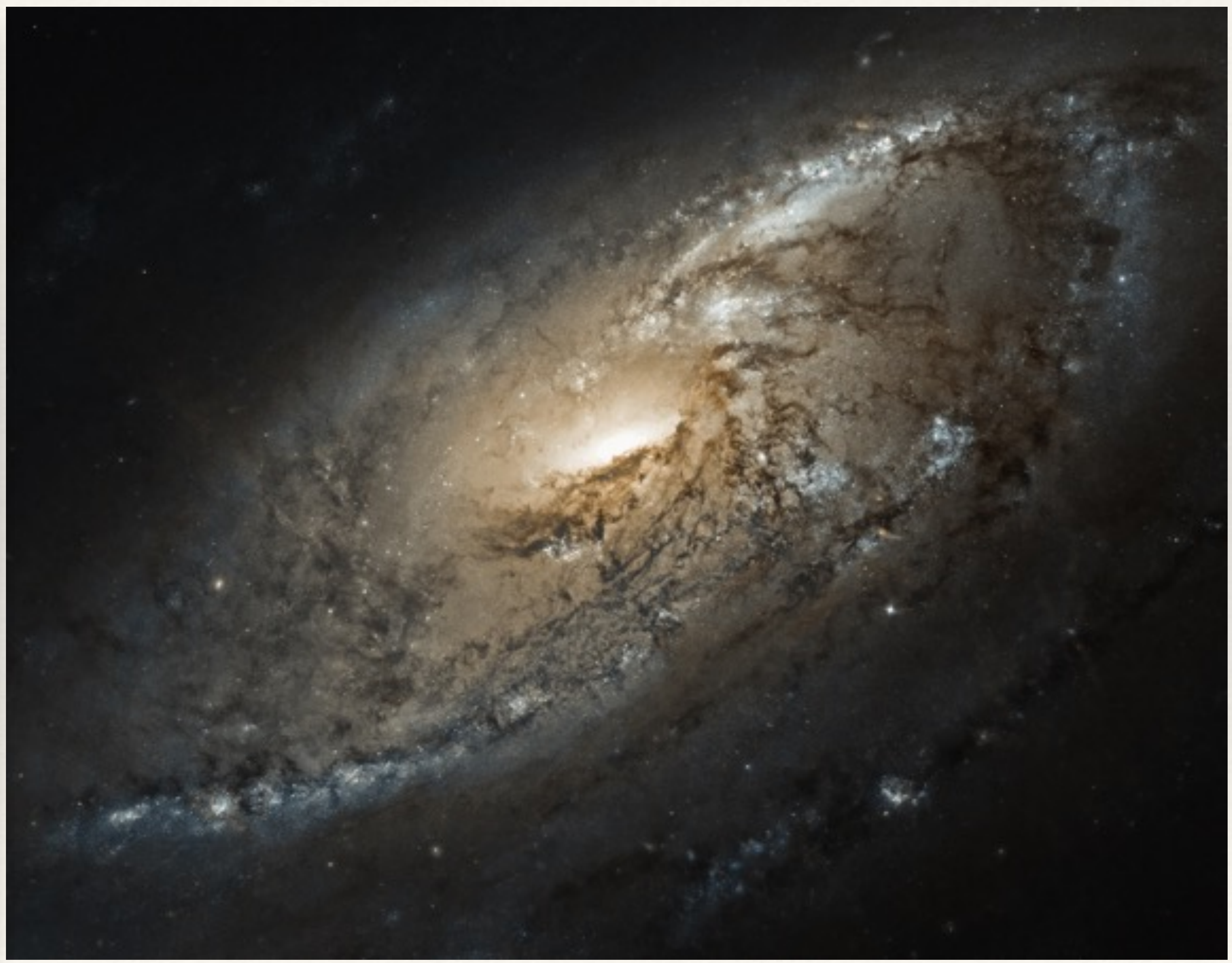


$$f(a,b) = 1 - (1 - a)(1 - b)$$

Color & Composition

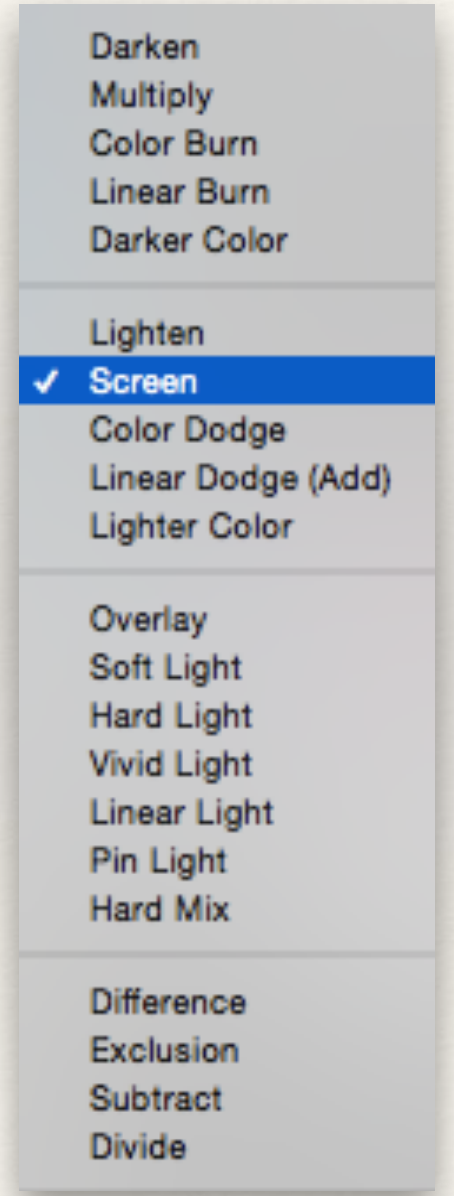
Blending Mode: Screen





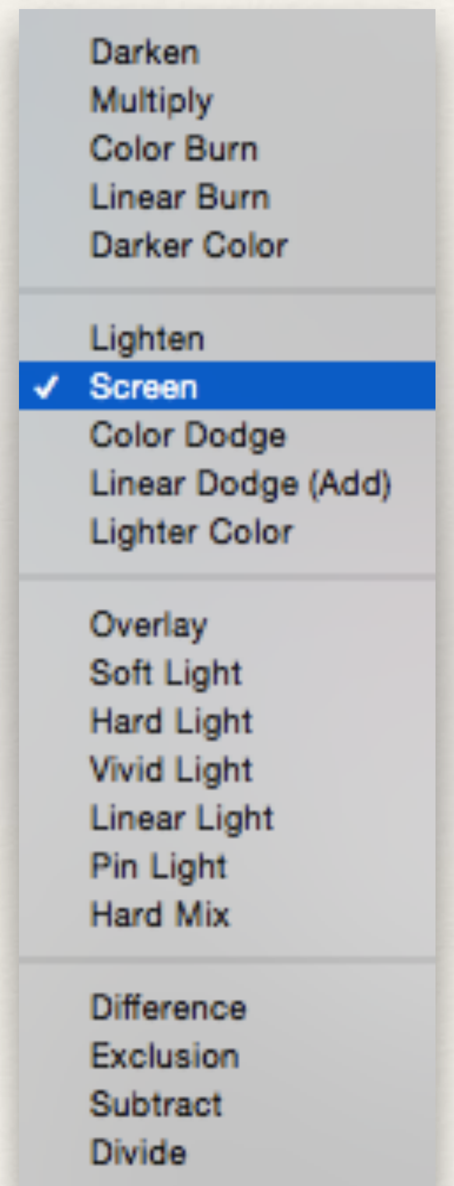
Color & Composition

Blending Mode: Screen



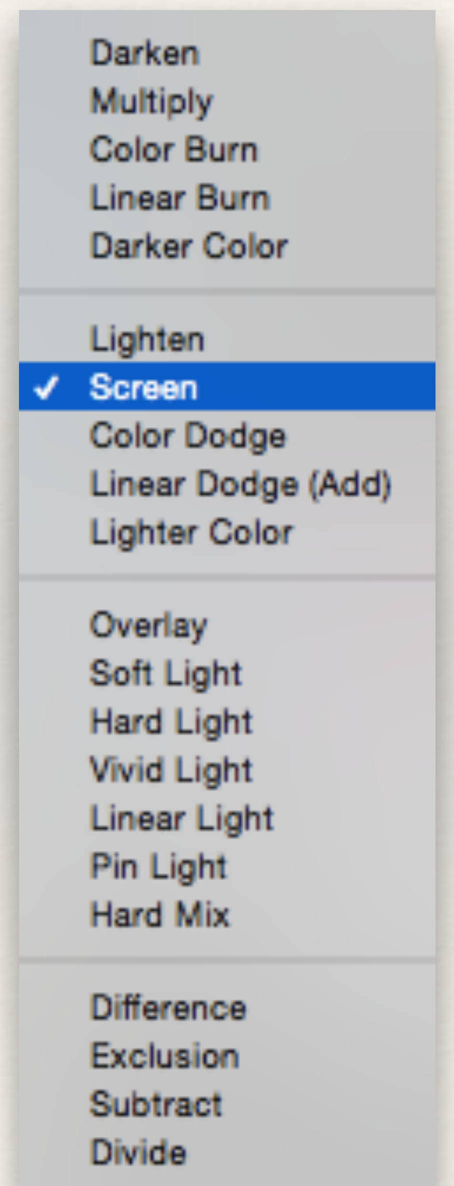
Color & Composition

Blending Mode: Screen



Color & Composition

Blending Mode: Screen

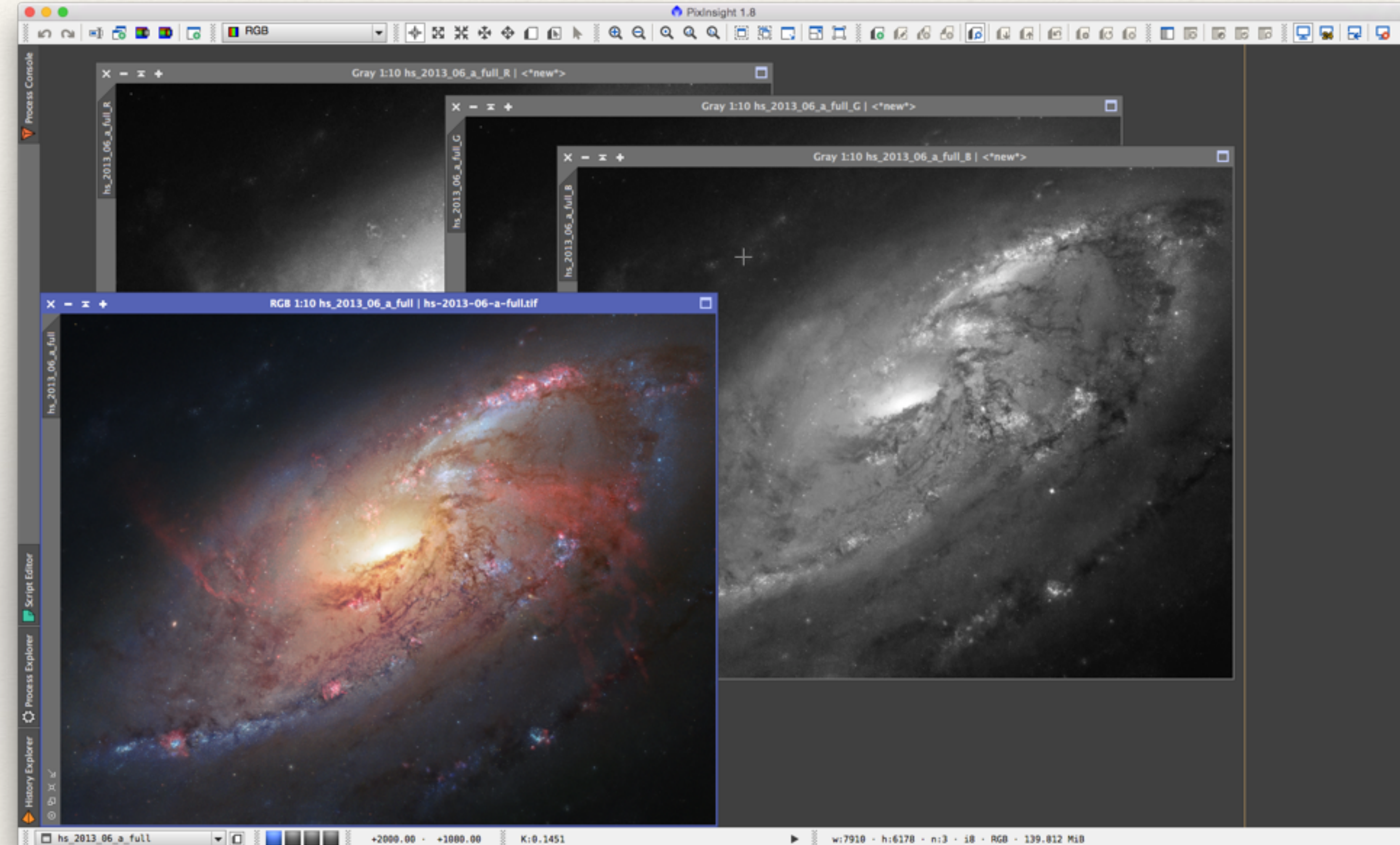


Color & Composition

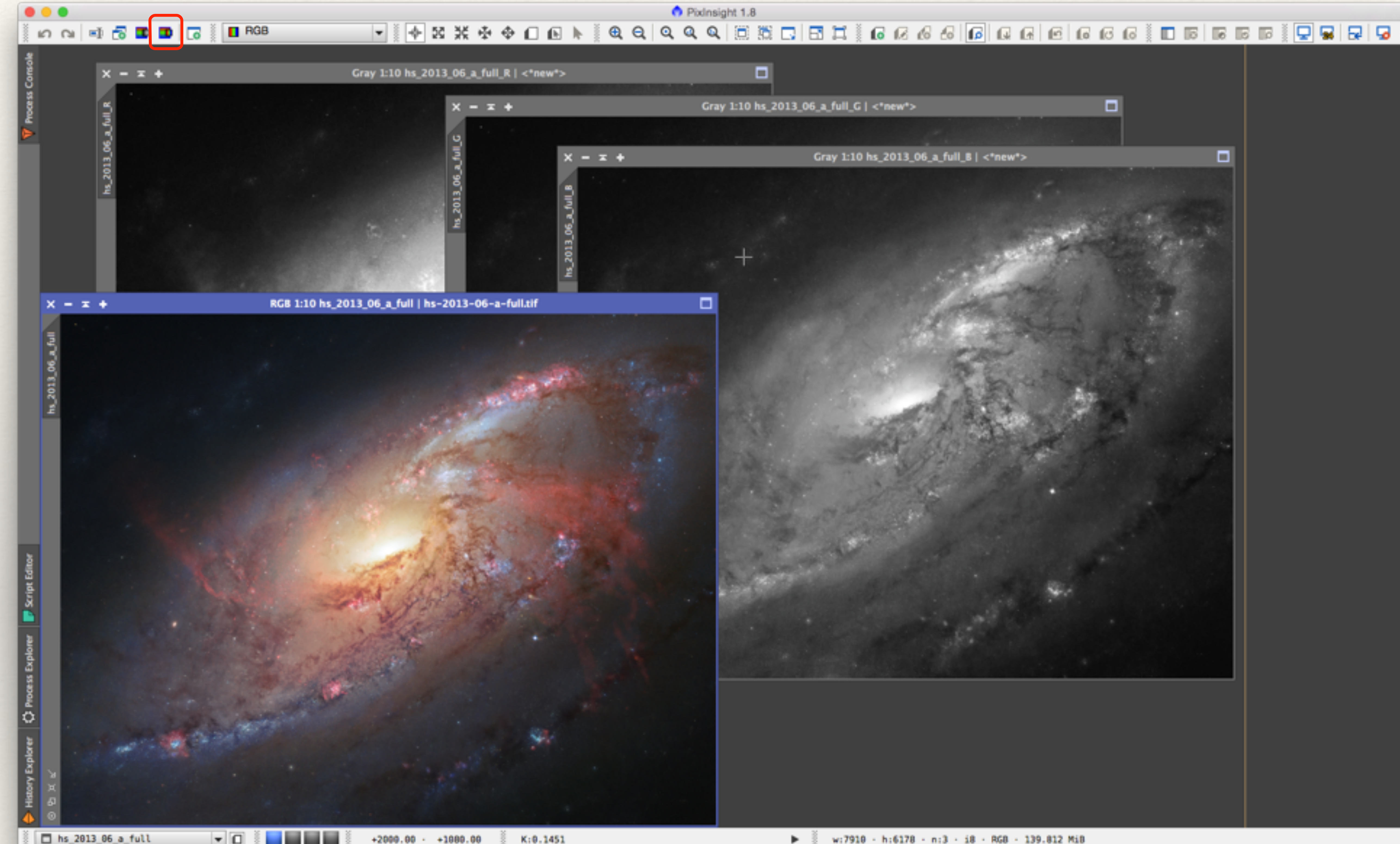
Processing example with M106

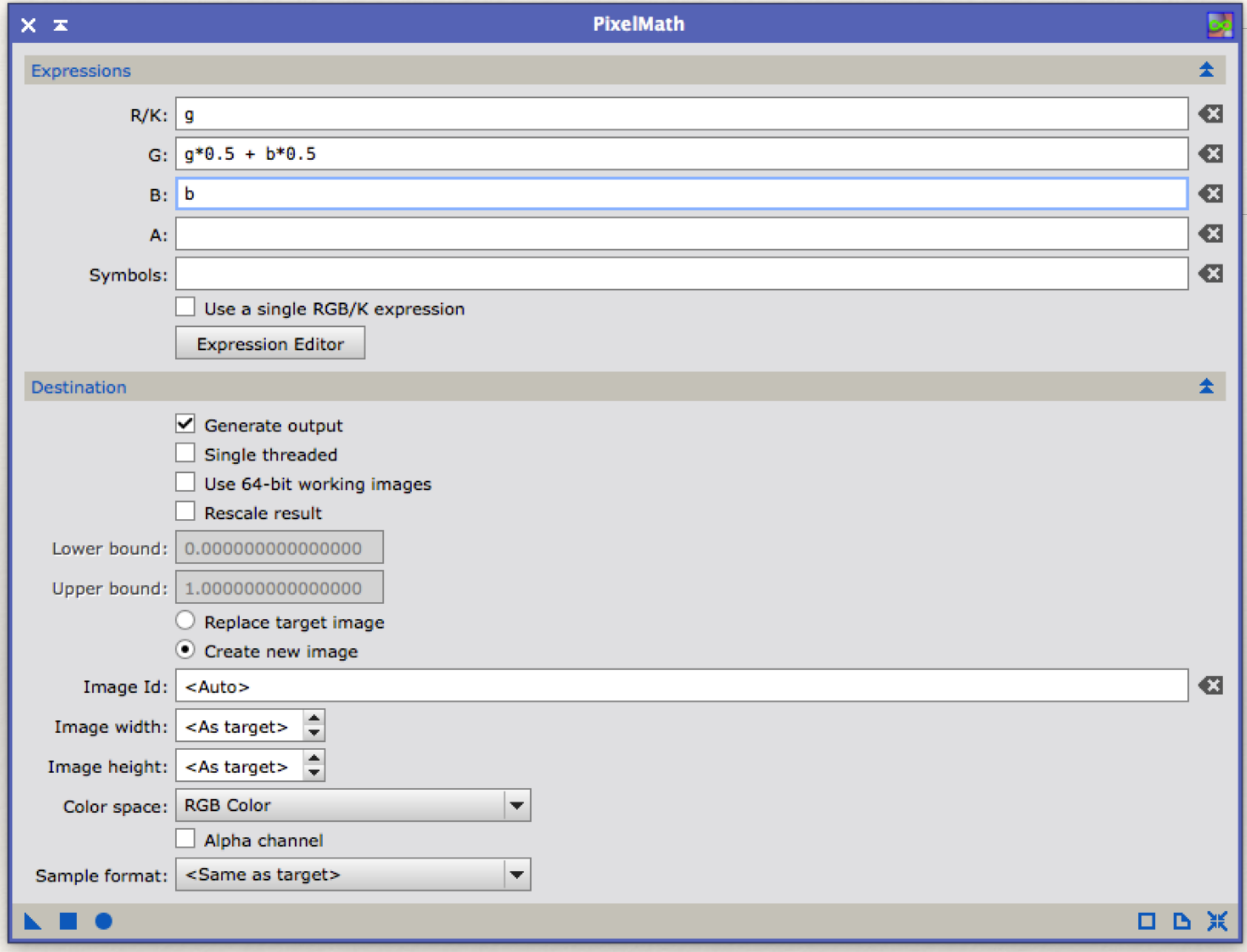
Color & Composition

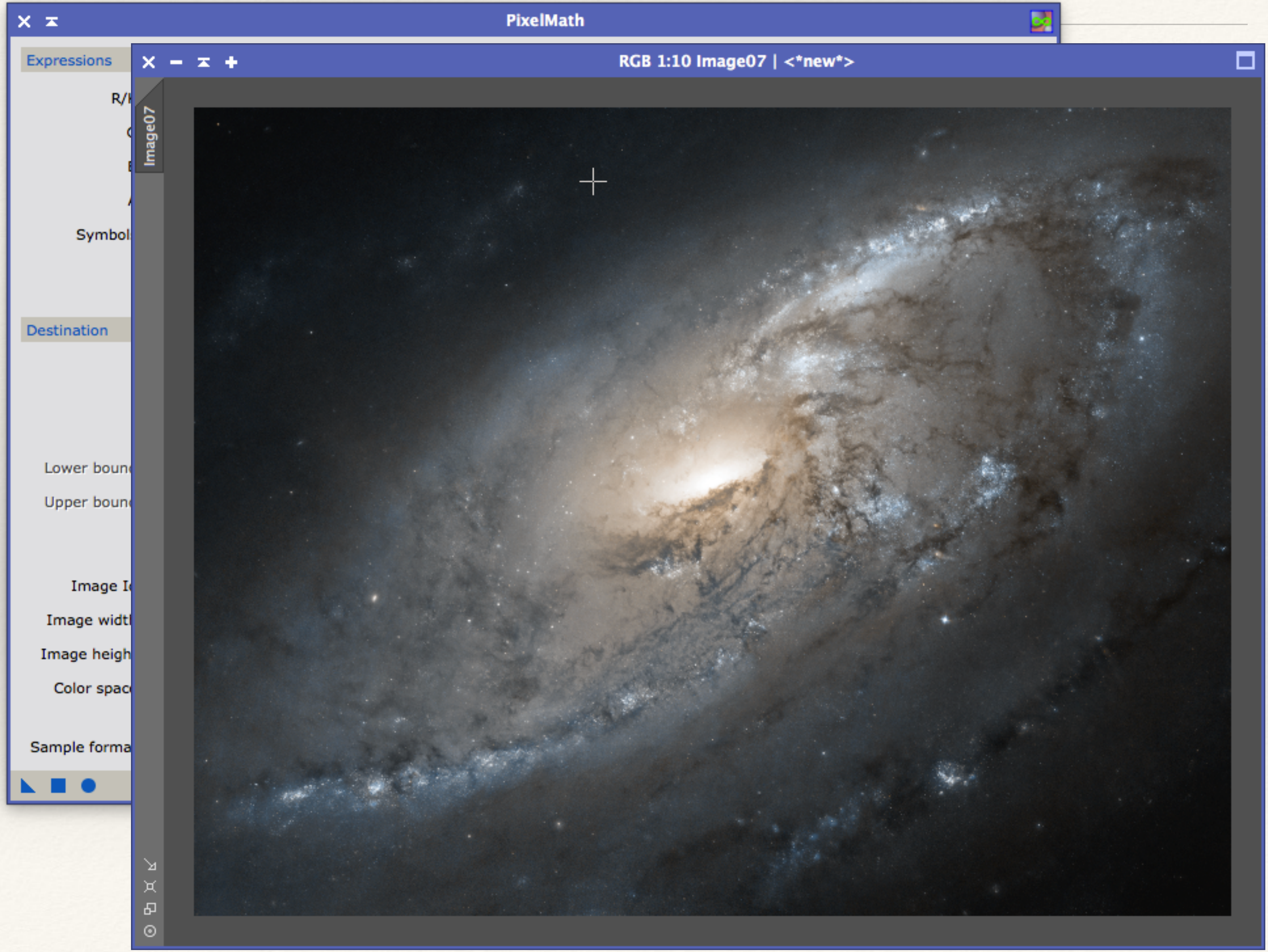
Processing example with M106

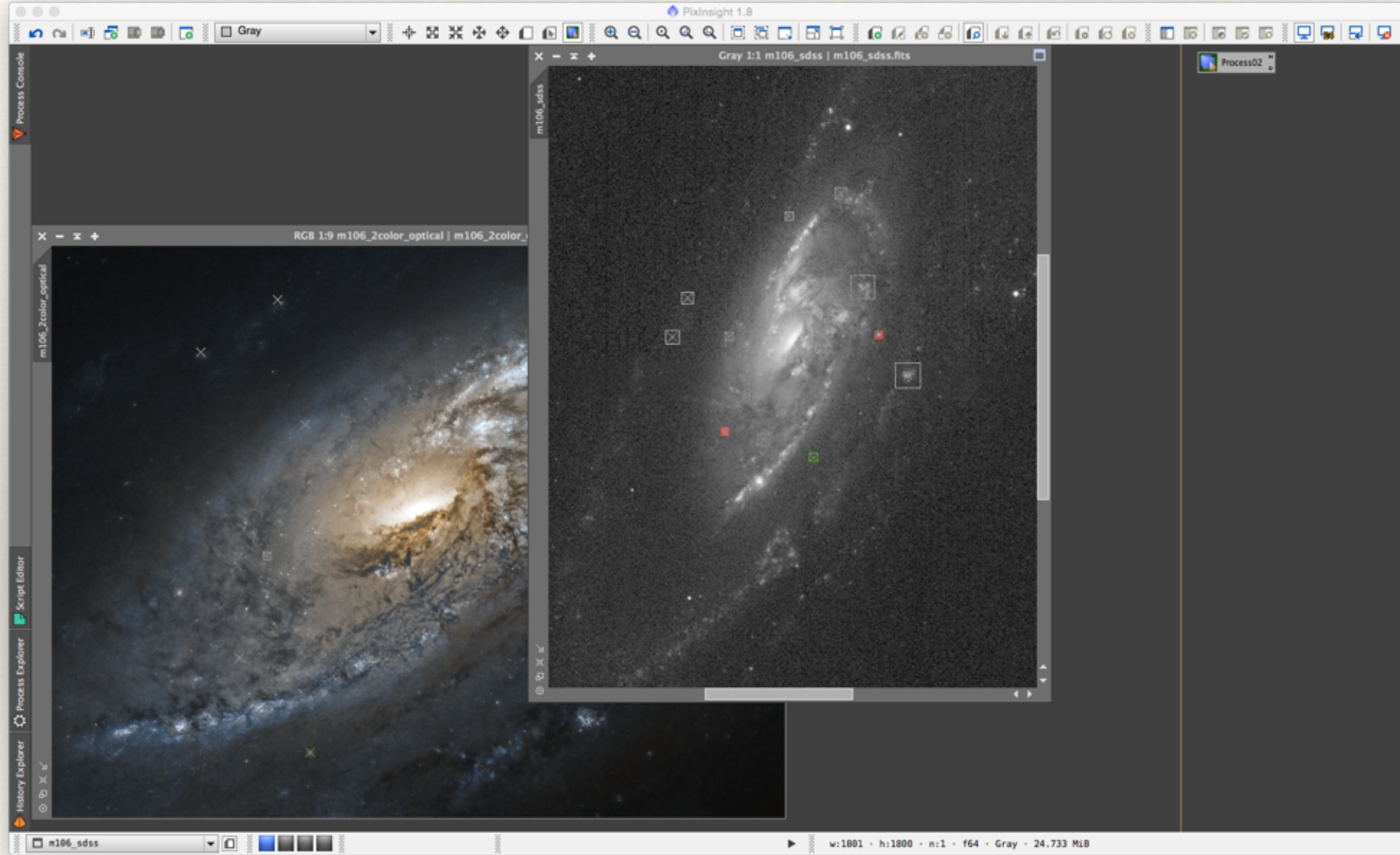


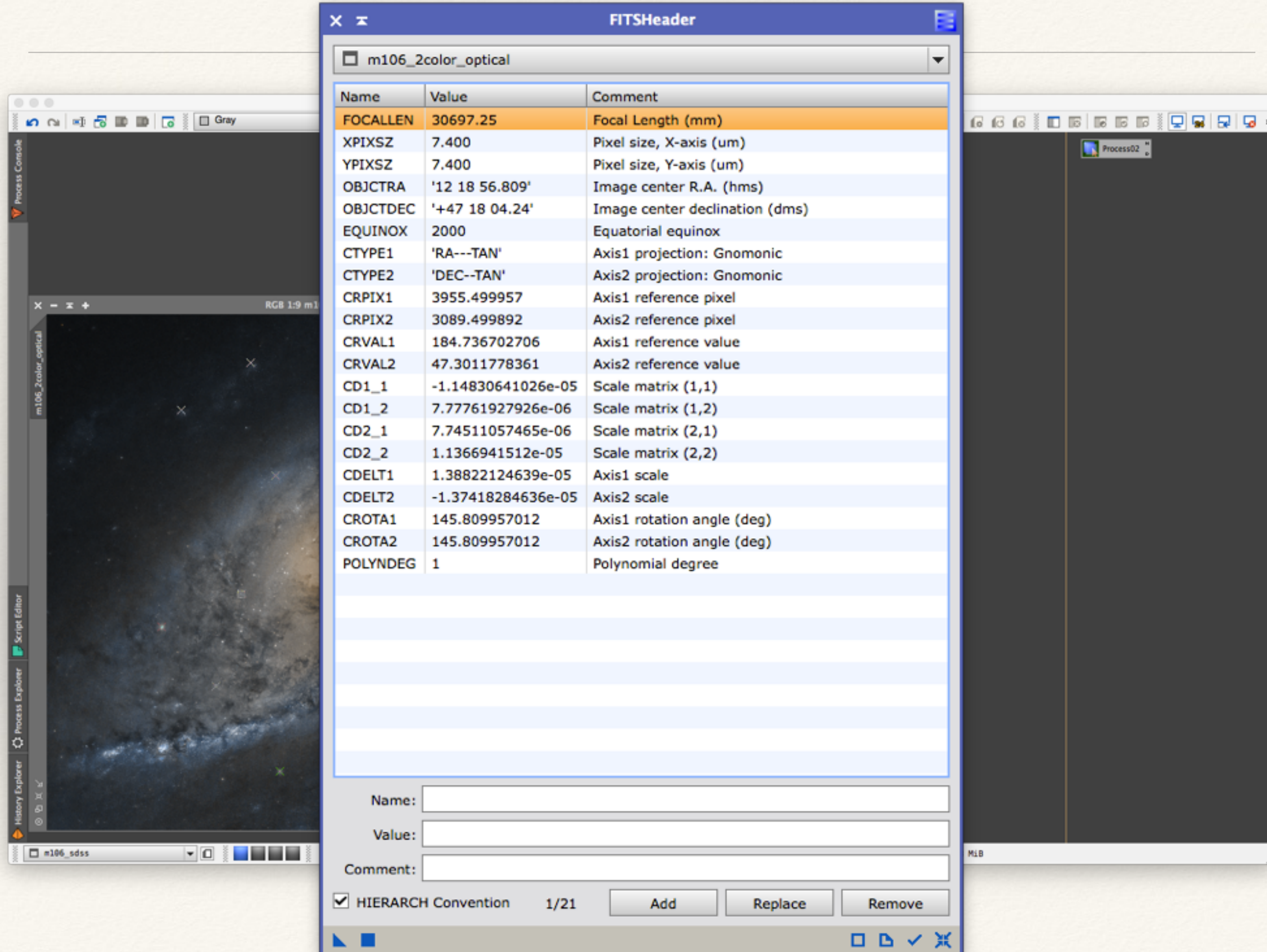
PixInsight 1.8
RGB
Gray 1:10 hs_2013_06_a_full_R | <*new*>
Gray 1:10 hs_2013_06_a_full_G | <*new*>
Gray 1:10 hs_2013_06_a_full_B | <*new*>
RGB 1:10 hs_2013_06_a_full | hs-2013-06-a-full.tif
Process Console
Script Editor
Process Explorer
History Explorer
hs_2013_06_a_full
+2000.00 · +1080.00
K:0.1451
w:7910 · h:6178 · n:3 · i8 · RGB · 139.812 MiB

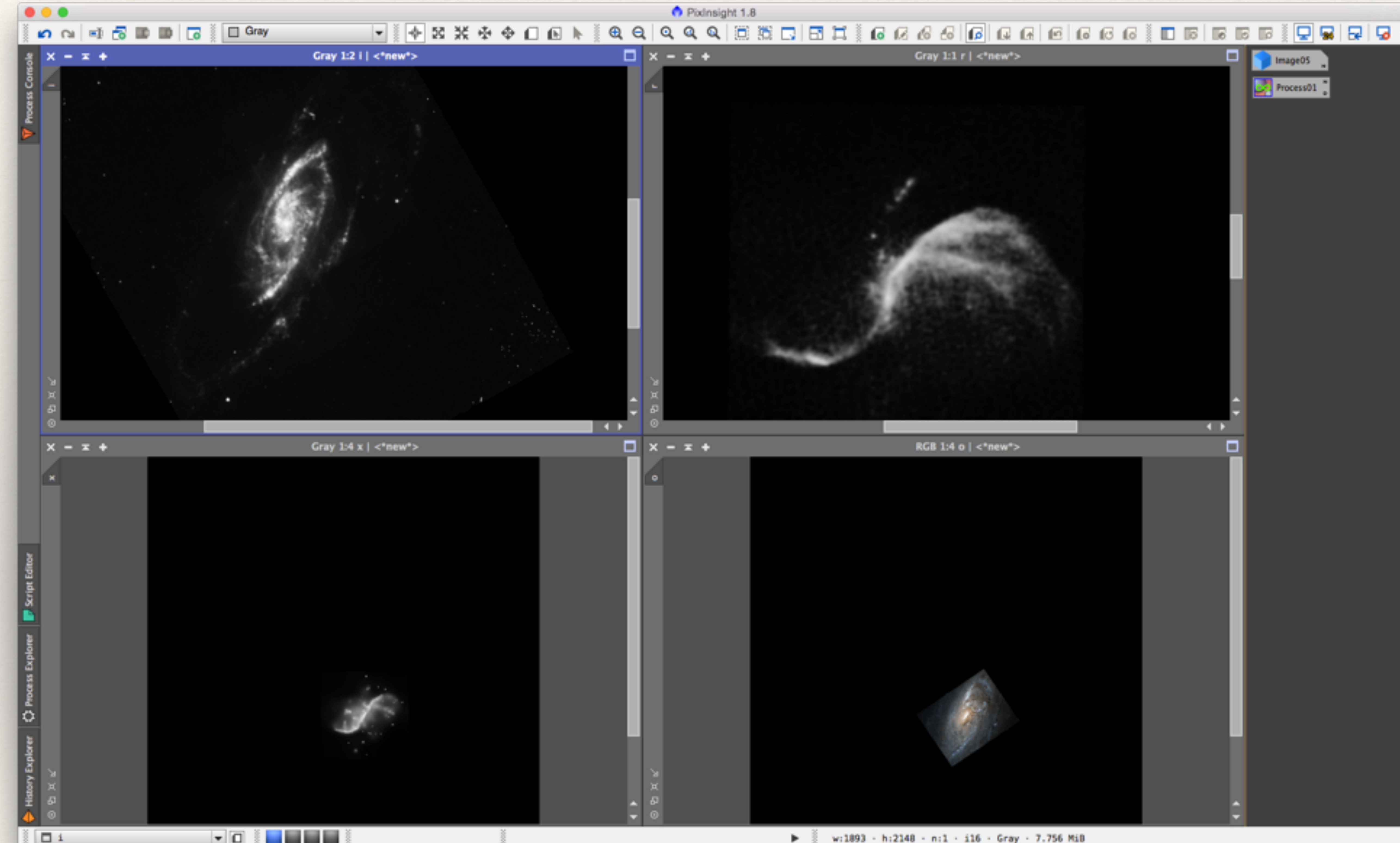

PixInsight 1.8
RGB
Gray 1:10 hs_2013_06_a_full_R | <*new*>
Gray 1:10 hs_2013_06_a_full_G | <*new*>
Gray 1:10 hs_2013_06_a_full_B | <*new*>
RGB 1:10 hs_2013_06_a_full | hs-2013-06-a-full.tif
hs_2013_06_a_full_R
hs_2013_06_a_full_G
hs_2013_06_a_full_B
hs_2013_06_a_full
Process Console
Script Editor
Process Explorer
History Explorer
hs_2013_06_a_full
+2000.00 · +1080.00
K:0.1451
w:7910 · h:6178 · n:3 · i8 · RGB · 139.812 MiB

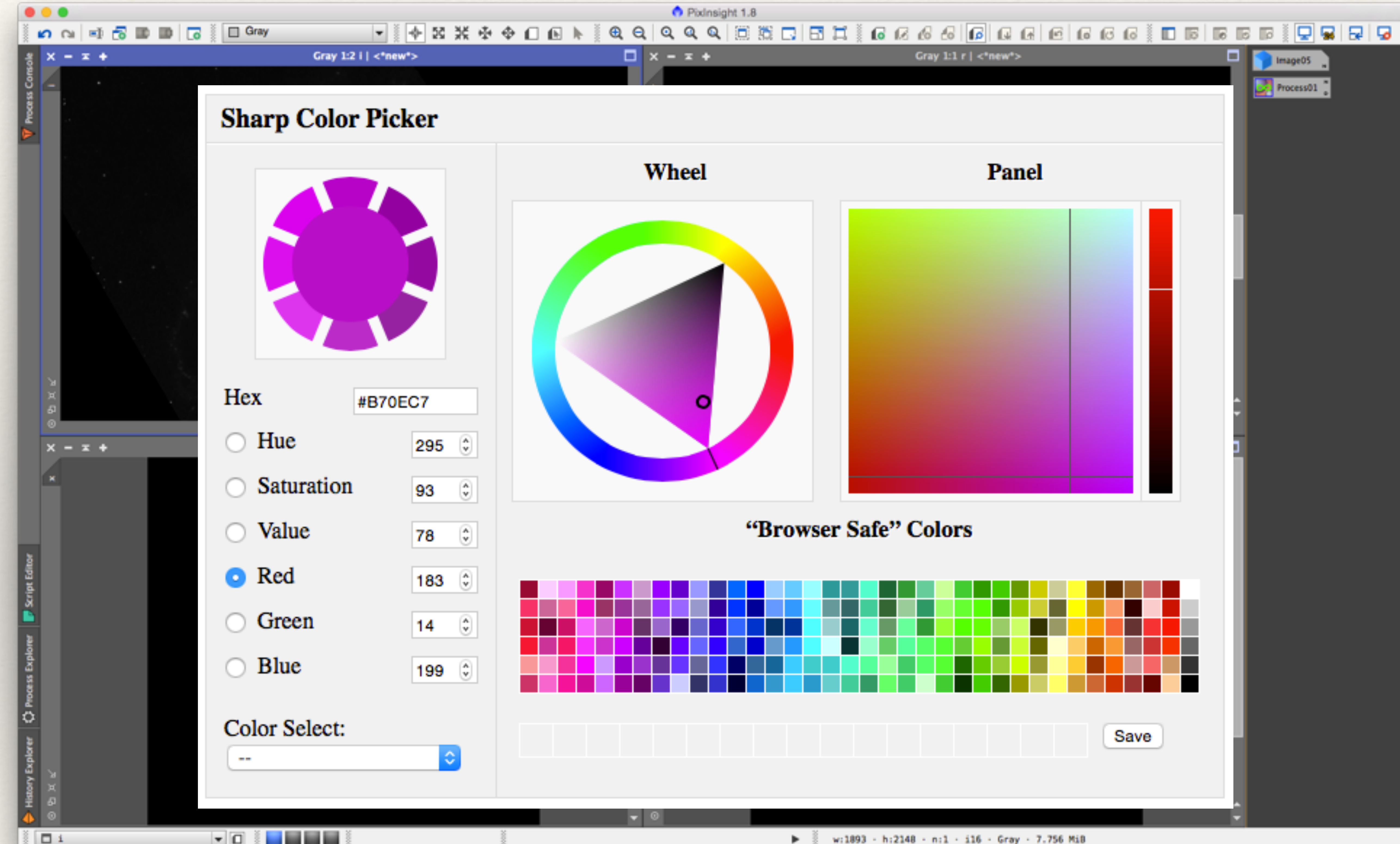

PixelMath
Expressions
R/K: g
G: g*0.5 + b*0.5
B: b
A:
Symbols:
Use a single RGB/K expression
Expression Editor
Destination
Generate output
Single threaded
Use 64-bit working images
Rescale result
Lower bound: 0.000000000000000
Upper bound: 1.000000000000000
Replace target image
Create new image
Image Id: <Auto>
Image width: <As target>
Image height: <As target>
Color space: RGB Color
Alpha channel
Sample format: <Same as target>

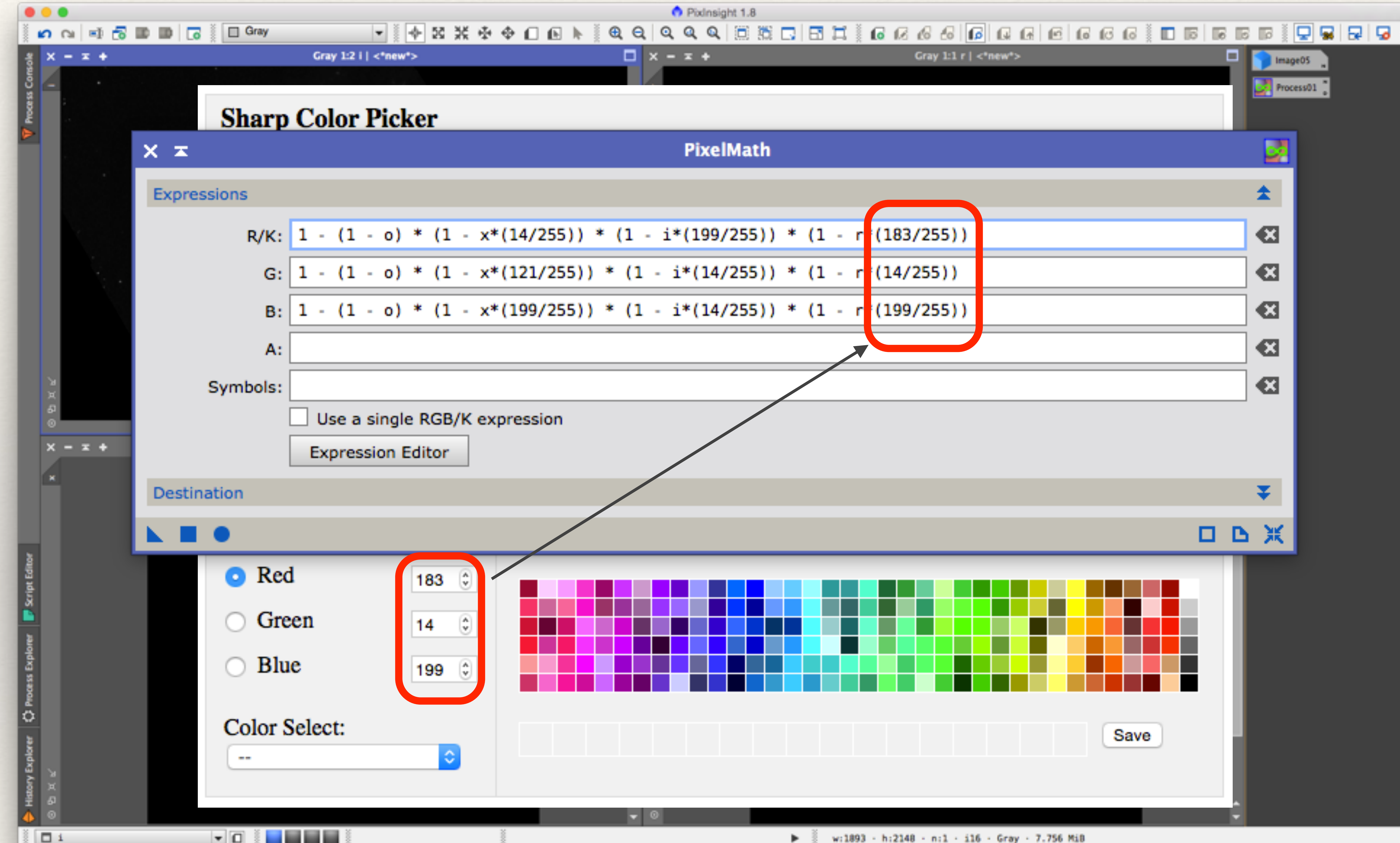

PixelMath
Expressions
R/K
Symbols
Destination
Lower bound
Upper bound
Image Id
Image width
Image height
Color space
Sample format
RGB 1:10 Image07 | <*new*>
Image07

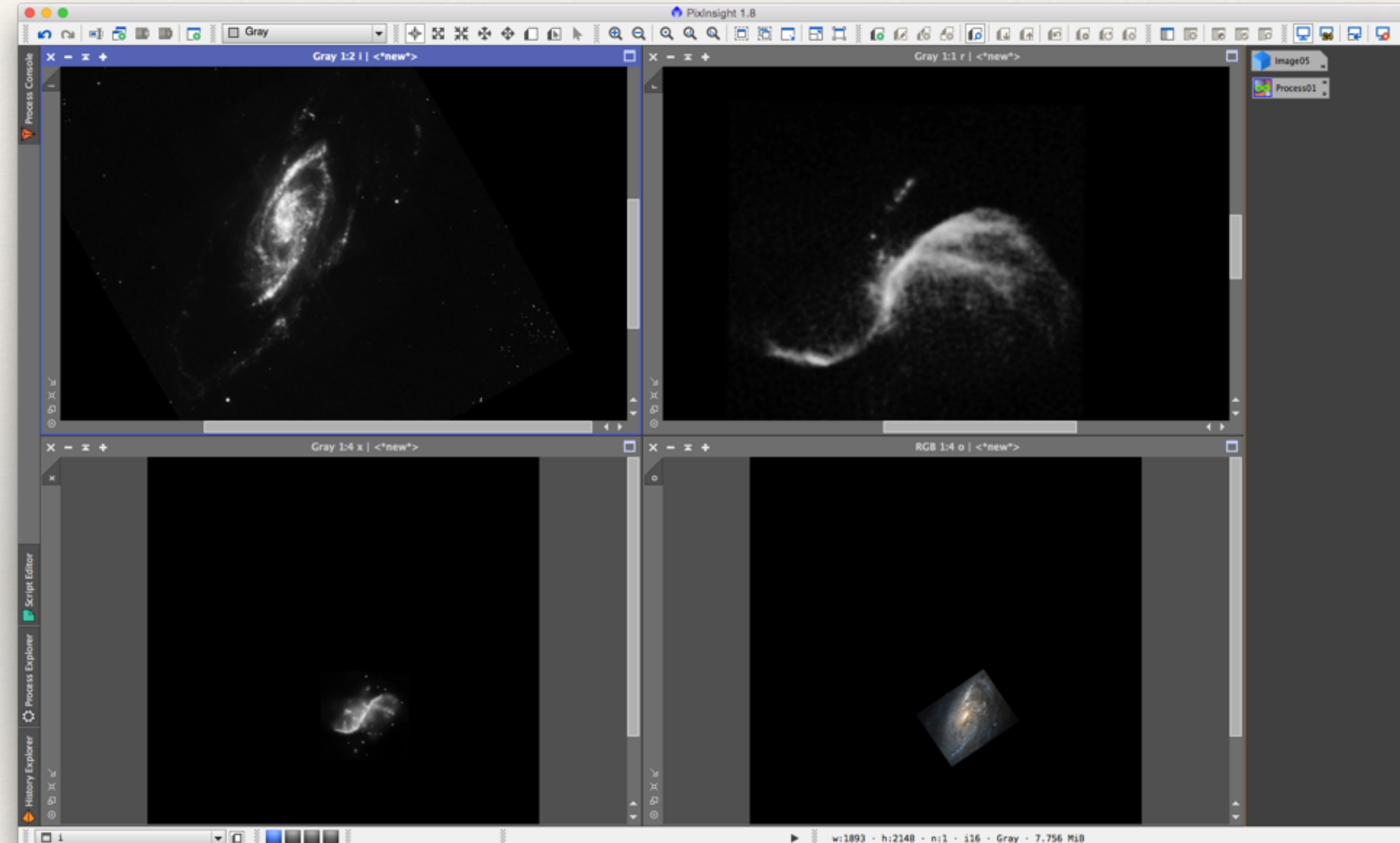

PixInsight 1.8
Gray
Gray 1:1 m106_sdss | m106_sdss.fits
RGB 1:9 m106_2color_optical | m106_2color_
Process02
Process Console
Script Editor
Process Explorer
History Explorer
m106_sdss
w:1801 · h:1800 · n:1 · f64 · Gray · 24.733 MiB

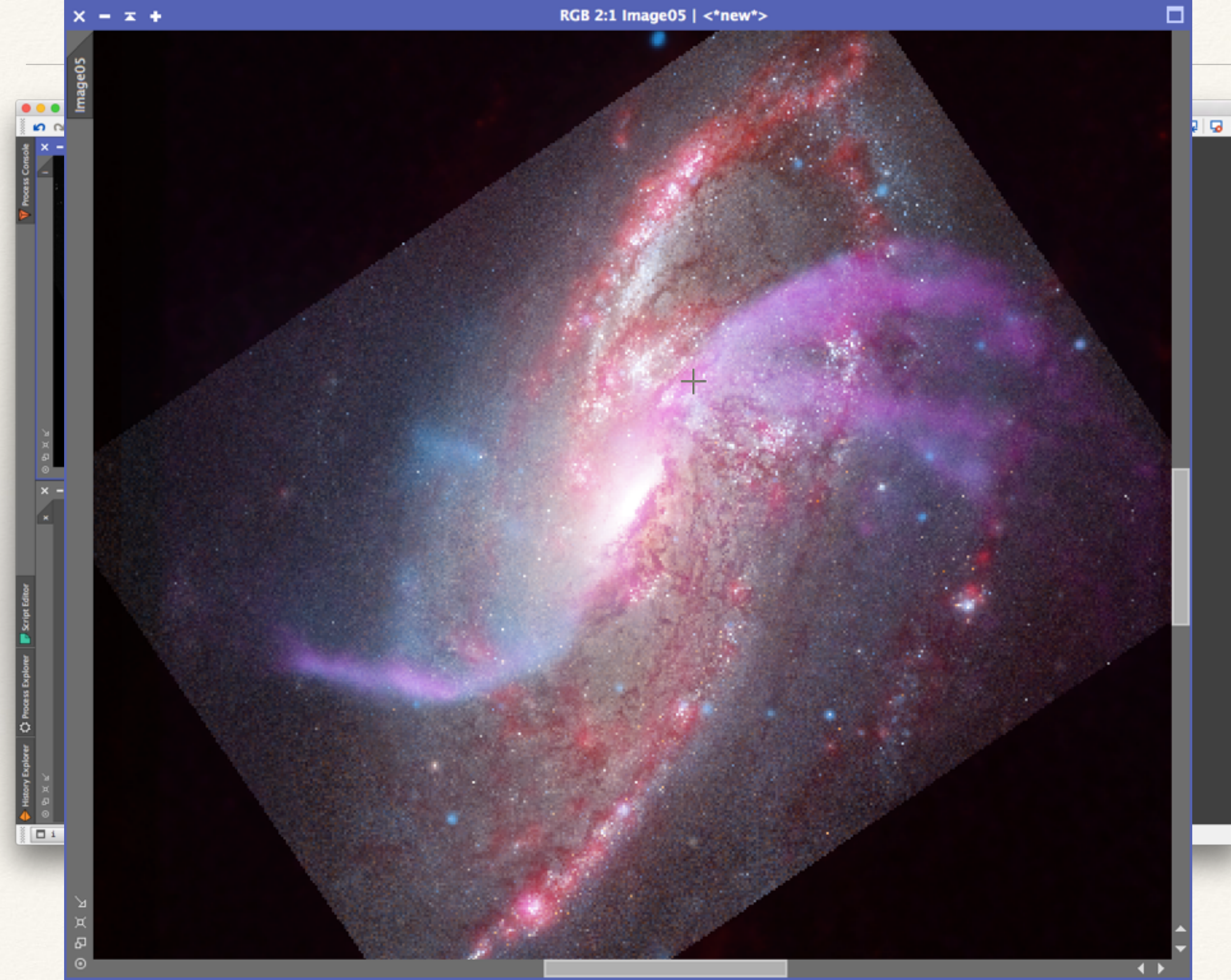

FITSHeader
m106_2color_optical
Name Value Comment
FOCALLEN 30697.25 Focal Length (mm)
XPIXSZ 7.400 Pixel size, X-axis (um)
YPIXSZ 7.400 Pixel size, Y-axis (um)
OBJCTRA '12 18 56.809' Image center R.A. (hms)
OBJCTDEC '+47 18 04.24' Image center declination (dms)
EQUINOX 2000 Equatorial equinox
CTYPE1 'RA---TAN' Axis1 projection: Gnomonic
CTYPE2 'DEC--TAN' Axis2 projection: Gnomonic
CRPIX1 3955.499957 Axis1 reference pixel
CRPIX2 3089.499892 Axis2 reference pixel
CRVAL1 184.736702706 Axis1 reference value
CRVAL2 47.3011778361 Axis2 reference value
CD1_1 -1.14830641026e-05 Scale matrix (1,1)
CD1_2 7.77761927926e-06 Scale matrix (1,2)
CD2_1 7.74511057465e-06 Scale matrix (2,1)
CD2_2 1.1366941512e-05 Scale matrix (2,2)
CDELT1 1.38822124639e-05 Axis1 scale
CDELT2 -1.37418284636e-05 Axis2 scale
CROTA1 145.809957012 Axis1 rotation angle (deg)
CROTA2 145.809957012 Axis2 rotation angle (deg)
POLYNDEG 1 Polynomial degree
Name:
Value:
Comment:
HIERARCH Convention
1/21
Add
Replace
Remove


PixInsight 1.8
Gray
Gray 1:2 i | <*new*>
Gray 1:1 r | <*new*>
Gray 1:4 x | <*new*>
RGB 1:4 o | <*new*>
Image05
Process01
Process Console
Script Editor
Process Explorer
History Explorer
w:1893 · h:2148 · n:1 · i16 · Gray · 7.756 MiB

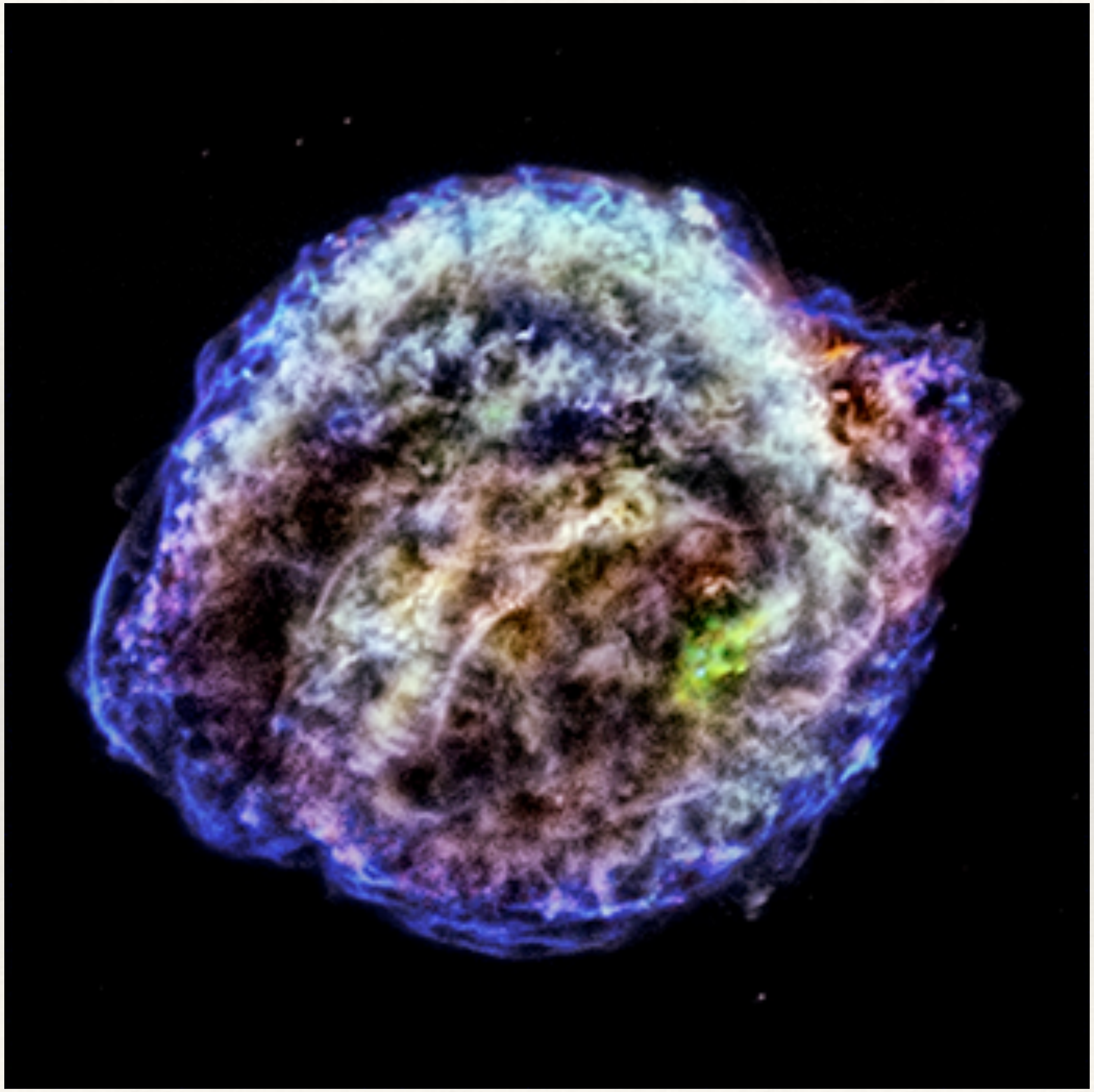

PixInsight 1.8
Sharp Color Picker
Wheel
Panel
Hex
#B70EC7
Hue
295
Saturation
93
Value
78
Red
183
Green
14
Blue
199
"Browser Safe" Colors
Color Select:
Save
w:1893 · h:2148 · n:1 · i16 · Gray · 7.756 MiB


Sharp Color Picker
PixelMath
Expressions
R/K: 1 - (1 - o) * (1 - x*(14/255)) * (1 - i*(199/255)) * (1 - r
(183/255))
G: 1 - (1 - o) * (1 - x*(121/255)) * (1 - i*(14/255)) * (1 - r
(14/255))
B: 1 - (1 - o) * (1 - x*(199/255)) * (1 - i*(14/255)) * (1 - r
(199/255))
A:
Symbols:
Use a single RGB/K expression
Expression Editor
Destination
Red
183
Green
14
Blue
199
Color Select:
--
Save

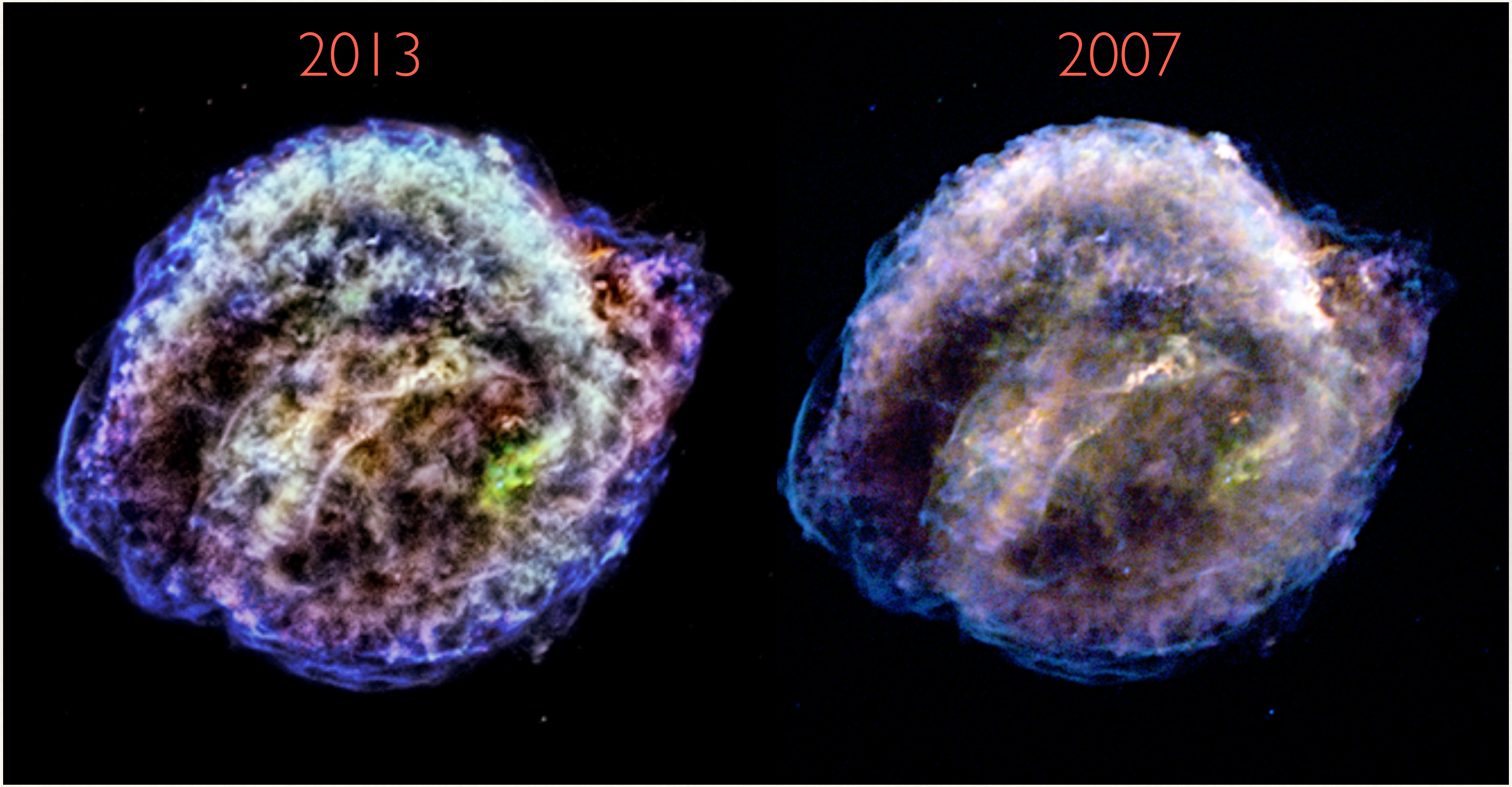

PixInsight 1.8
Gray
Gray 1:2 i | <*new*>
Gray 1:1 r | <*new*>
Gray 1:4 x | <*new*>
RGB 1:4 o | <*new*>
Image05
Process01
Process Console
Script Editor
Process Explorer
History Explorer
w:1893 · h:2148 · n:1 · i16 · Gray · 7.756 MiB


RGB 2:1 Image05 | <*new*>
Image05
Process Console
Script Editor
Process Explorer
History Explorer

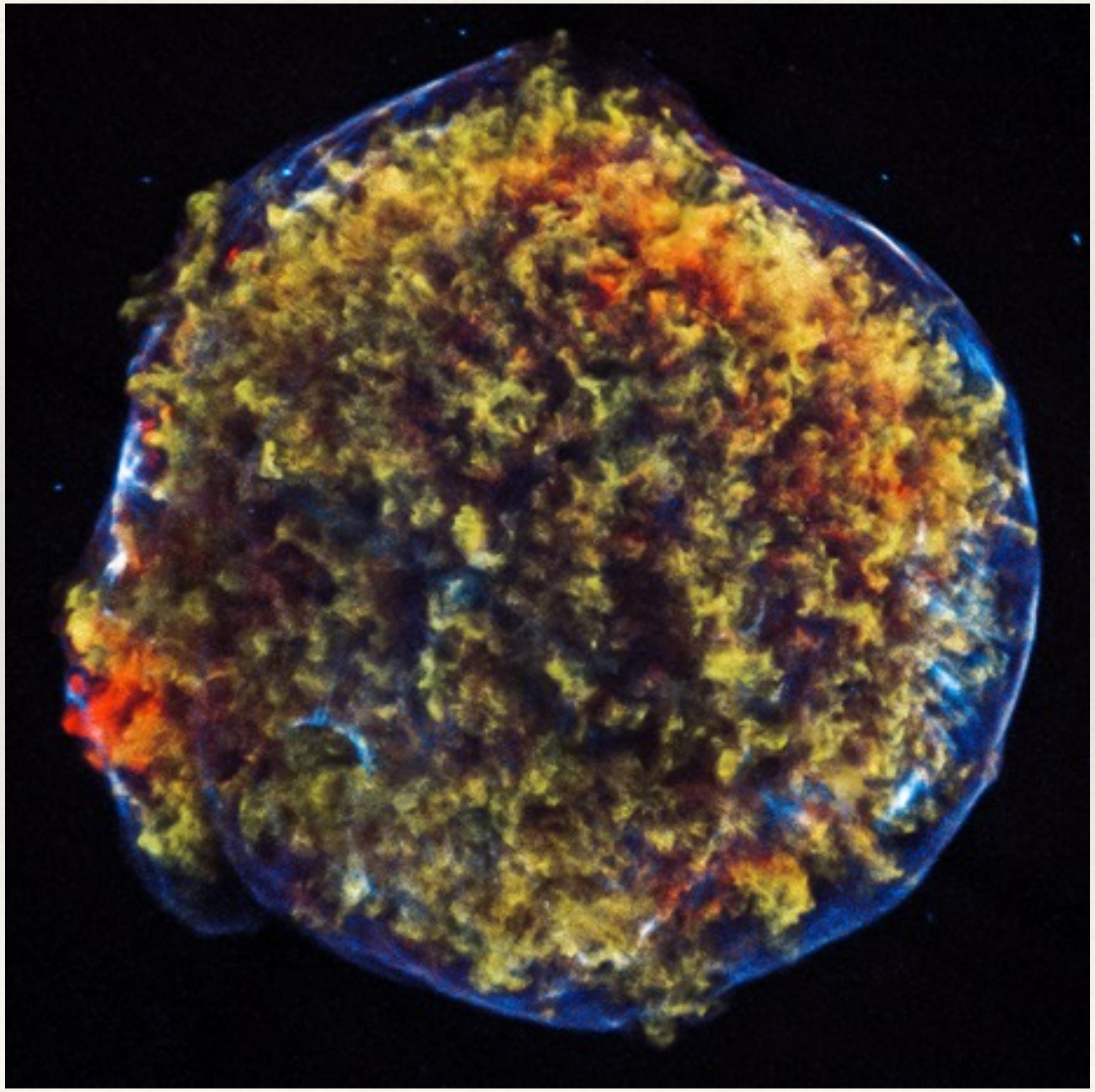
Kepler's SNR



Kepler's SNR

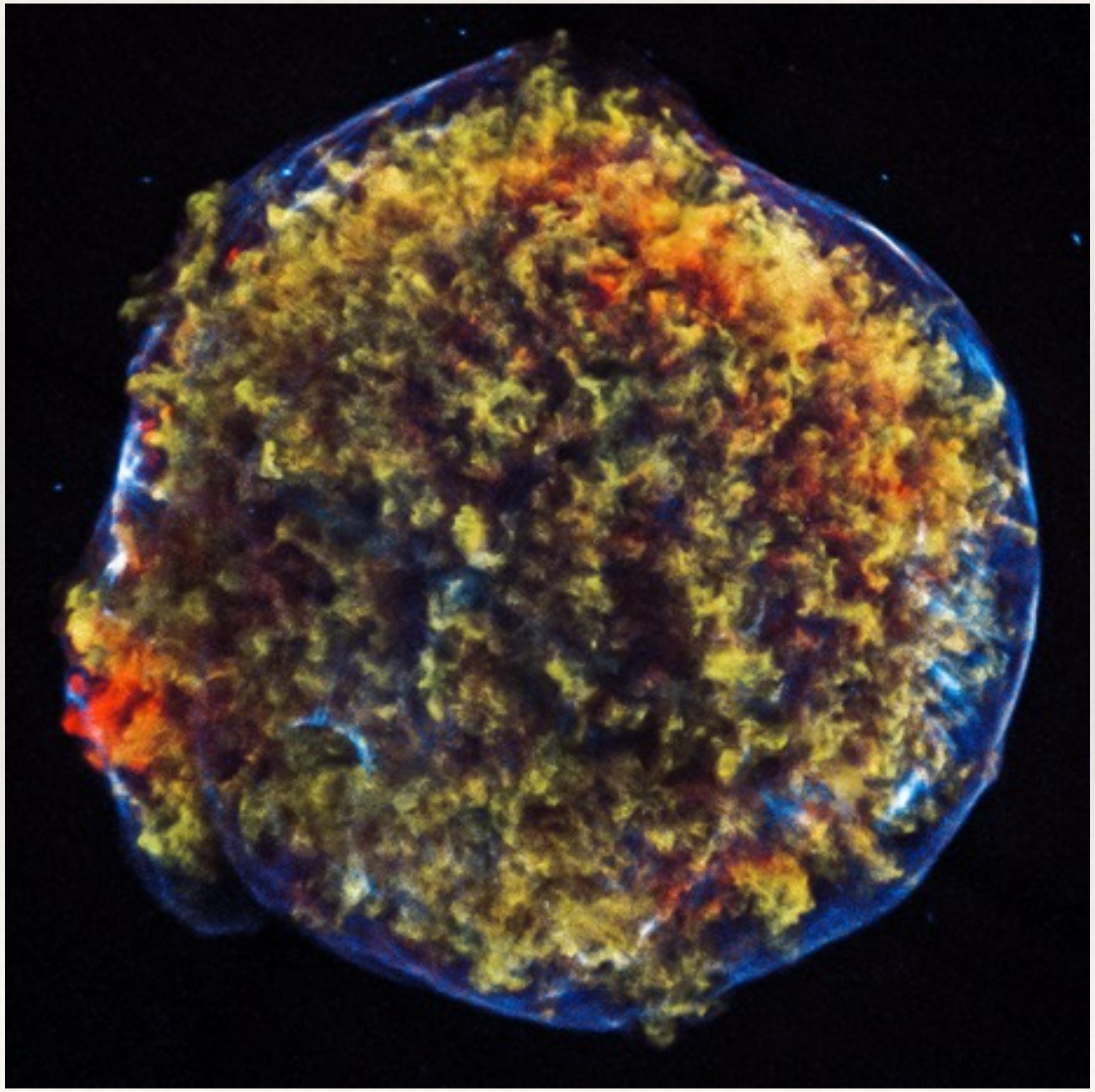


Tycho’s SNR

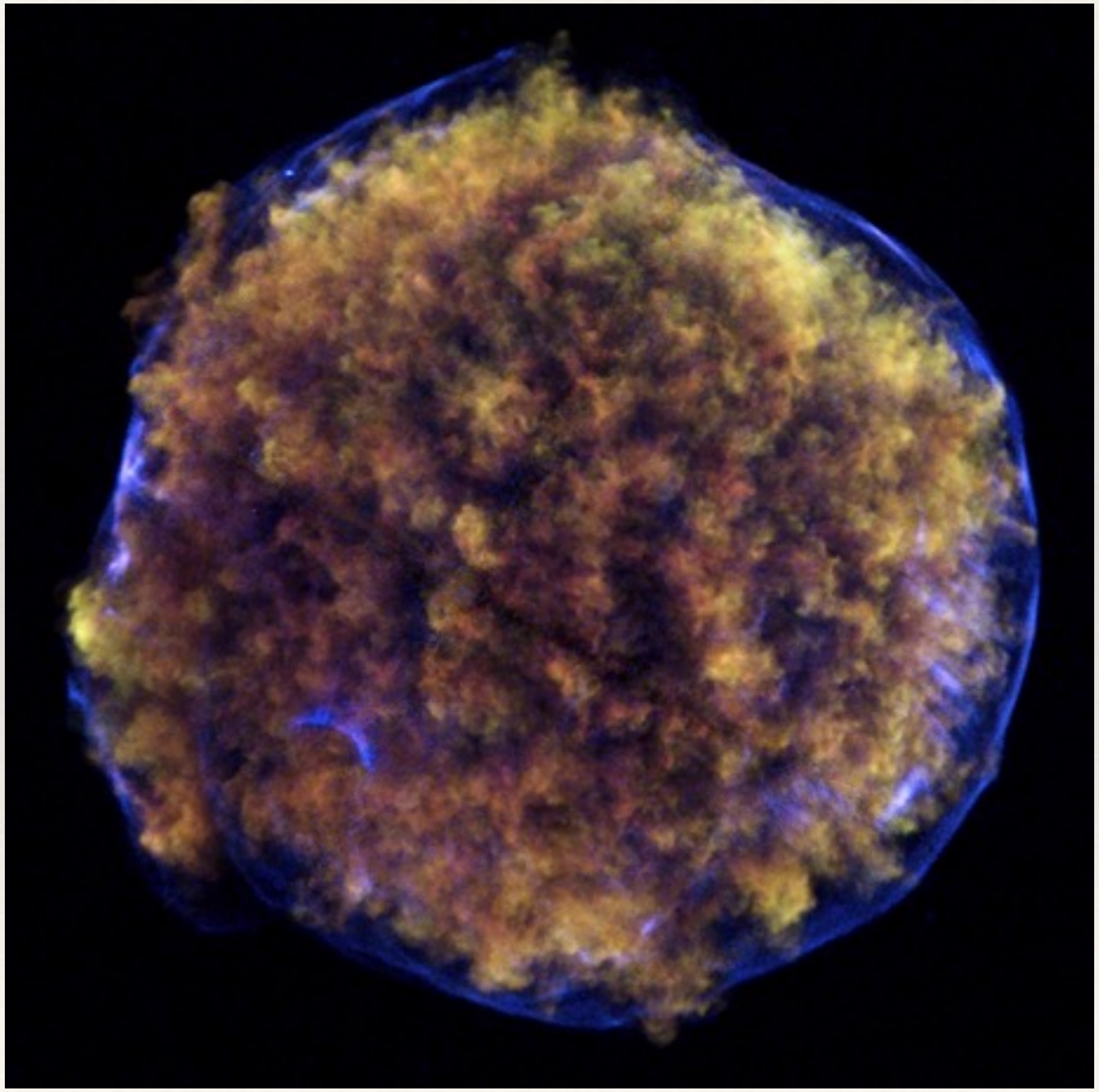


Tycho's SNR

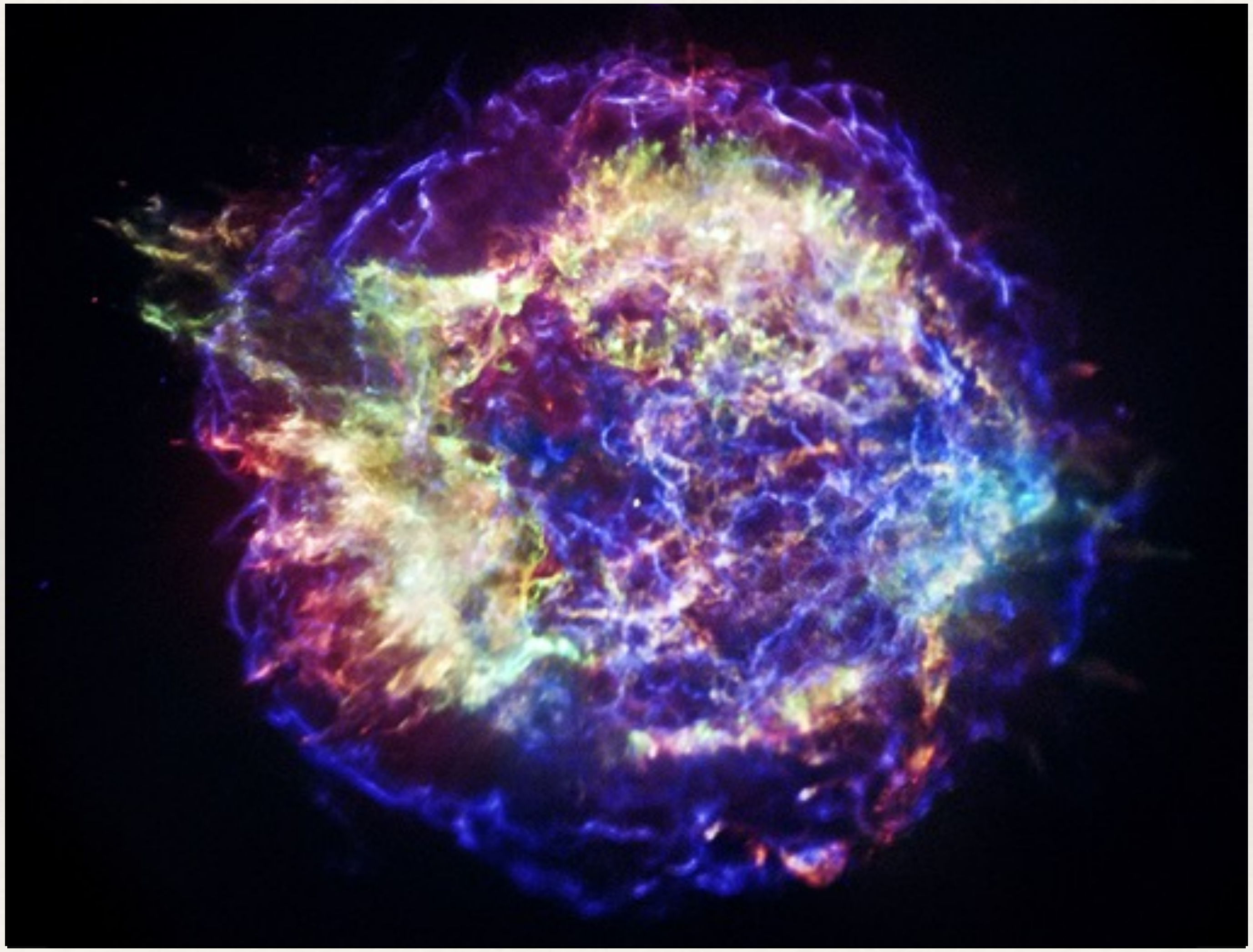
2014



2011

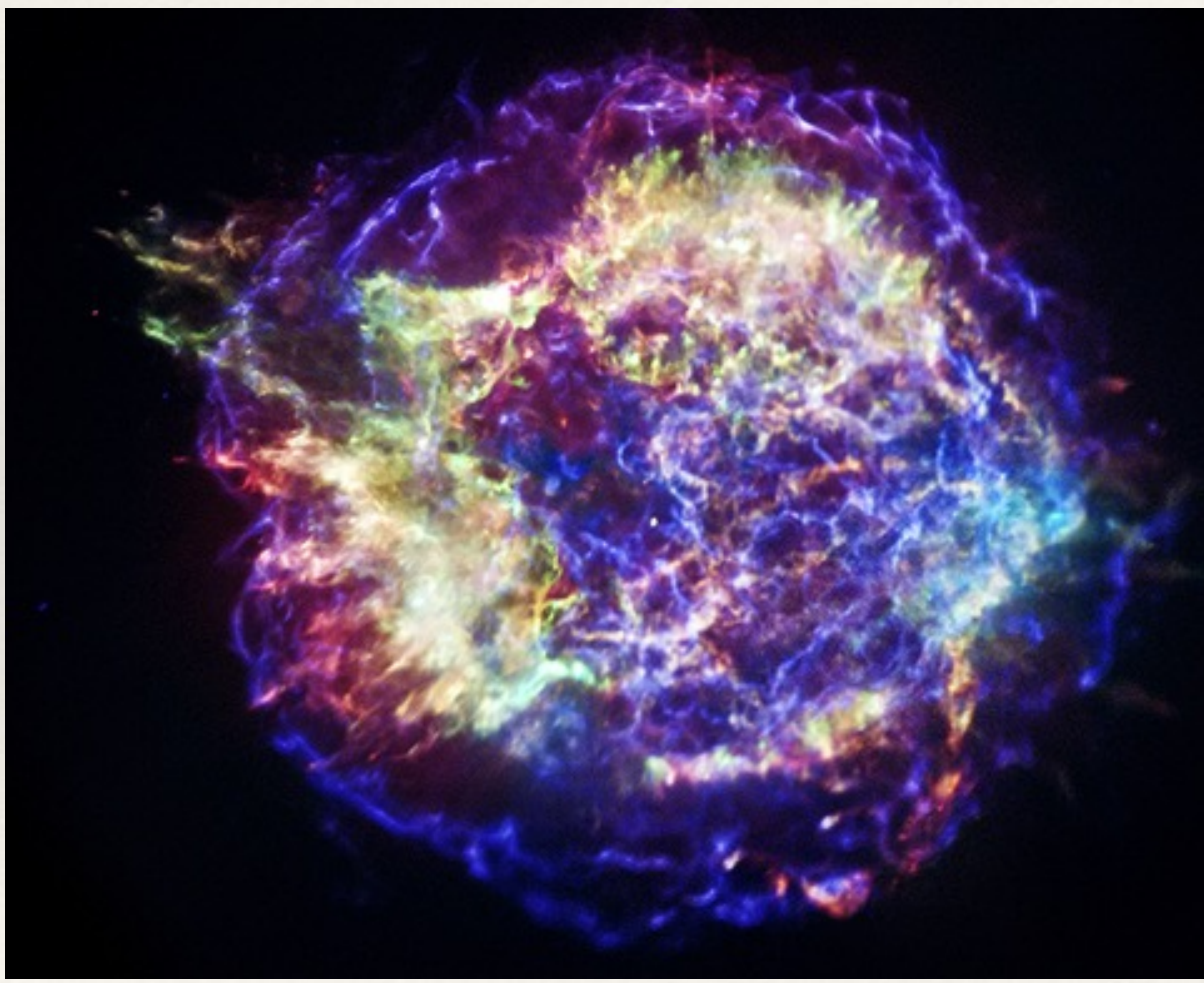


Cas A

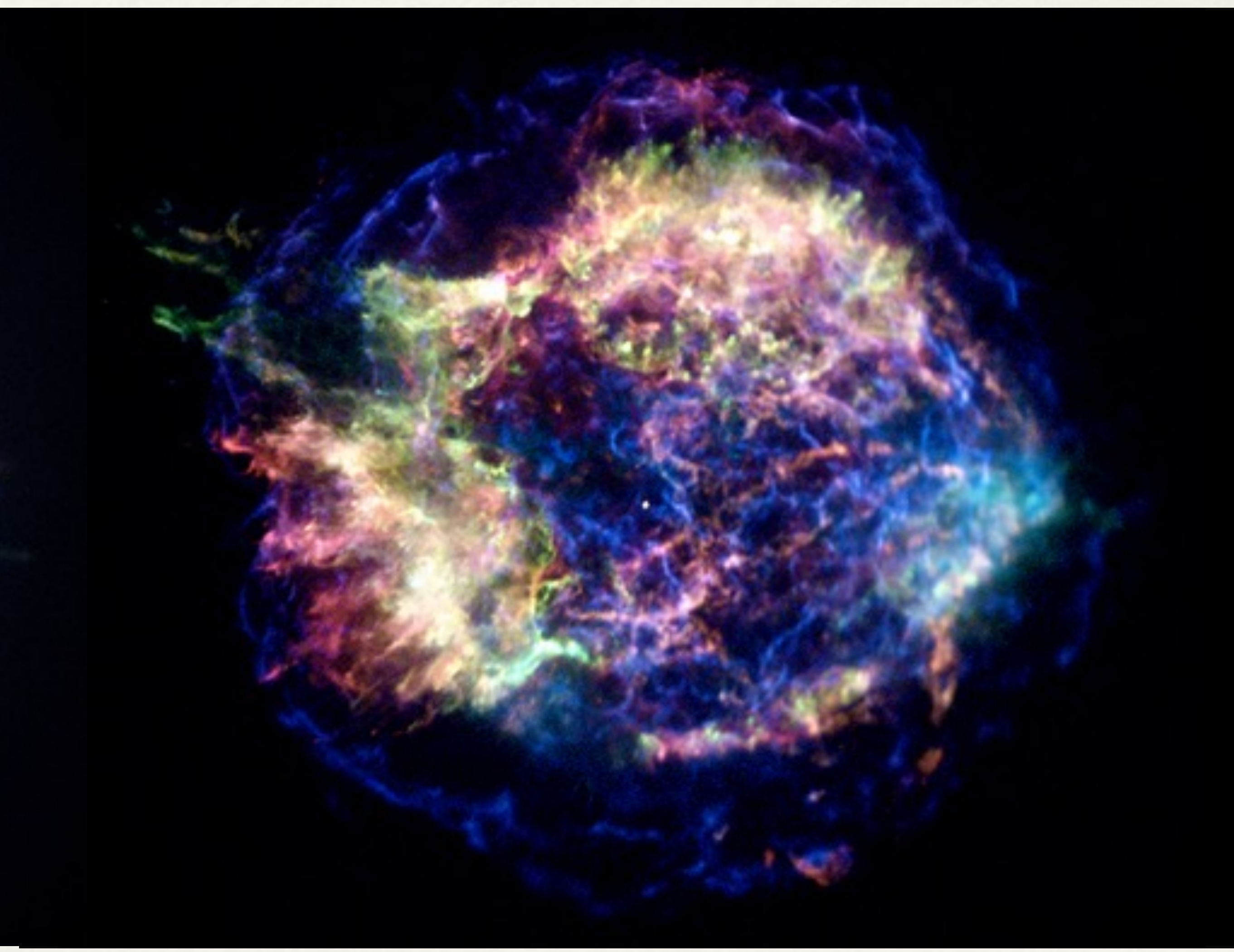


Cas A

2013



2011



Moving Beyond "Pretty Pictures"

JS9
Image processing via javascript in the browser
http://js9.si.edu

Project Goals:
Automated image registration via WCS
Photoshop-like implementation of layers
Image smoothing
Dynamic range processing (wavlets?)

Ultimate Goal:
Preserve original source data and track compositional changes (WCS)
Provide ability to revisit source data if/when interesting features
are discovered in the image creation process


Thank you!