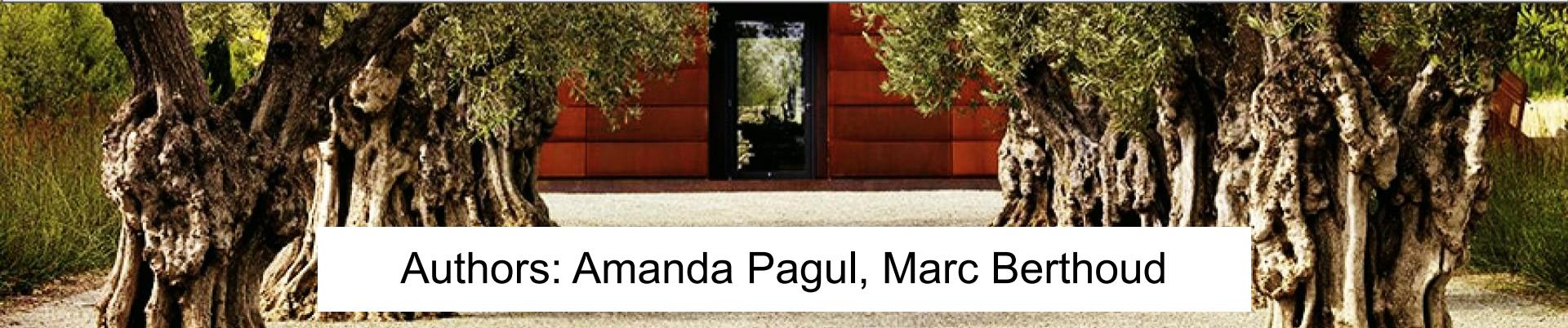




Stone Edge Observatory



Authors: Amanda Pagul, Marc Berthoud



M8 by Lindsay



M42 by Emil

Outline

- Observatory
- Telescope
- Observing
 - Itzamna Slack interface
 - Queue
- Data visualization and download
- Data reduction pipeline
- Additional computing and storage resources



About

- SEO: located on Stone Edge Farm vineyards and winery in Sonoma, CA.
- University of Chicago is operating the telescope making it available to students and researchers.
- SEO is used by astronomers and students worldwide.



- SEO science examples: asteroid lightcurves, supernovae and comet observations and high precision photometry.

Who's Who

- John McQuown: Owner of Stone Edge Farm
- Rich Kron: Faculty advisor
- Al Harper: Scientific advisor
- Richard Treffers: Telescope Engineer
- Amanda Pagul: Facility Astronomer
- Matt Nowinski: Observation software engineer and student advisor
- Marc Berthoud: Data software engineer and database curator.
- Rohan Gupta: System integrator
- Seth Knights: Software engineer
- Caleb Krueger: Observation specialist

Rich, Al, Amanda and Marc are available for support anytime.

Your gateway to SEO: UChicago server at

<https://stars.uchicago.edu>

More about the Stone Edge Observatory

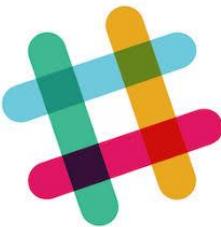
Some technical details:

- Ritchey-Chretien telescope with an aperture of 0.5m (20")
- Field of view is 26'x26' (4096 x 4096 pixels)
- Currently SDSS g', r', i', H-alpha, SII, OIII, and clear filters (will soon include SDSS u', z')
- Camera: **SBIG Aluma AC4040 CMOS**.
- Spare camera: **FLI Proline PL230** camera with an **e2v CCD 230-42 chip**



For general information, tutorials, and to request observing time, visit

<https://voices.uchicago.edu/stoneedgeobservatory.com/>



Itzamna on Slack

Itzamna: Mayan sky god

Itzamna: Web robot interacting with the SEO telescope. Takes commands on a Slack channel. Written by Matt Nowinski

To use Itzamna:

- Go to stars.uchicago.edu → Stone Edge → Slack
- Use your personal login or class account.

- Use the “itzamna” channel:
 - \help - to get command list
 - \clearsky - gives weather information
 - \lock - to lock the telescope so you can use it.
 - \crack - open the dome
 - \track on - start tracking
 - \find “object” - search the database
 - \pinpoint - point telescope to found object
 - \image “seconds” “bin” “filter” - take an image with given settings
 - \tostars - copies images to stars server
 - \squeeze - close the telescope dome
 - \unlock - release your lock on the telescope.
- Make sure the skies are clear, check at:
 - [NOAA Sonoma Weather](#)
 - Airport reports for [KAPC KDVO KO69](#)
 - **No Observing if** Humidity > 90%, chance of rain > 10% or sky cover > 25% at any of these

SEO Queue

Submit observations to be taken at an “ideal” time, accounting for object altitude, user-specified advanced options (lunar avoidance, max airmass, etc.), and user priority.

Queue upgraded this summer.

New features we are working on:

- Exposure time suggestions
- User-specified session
- User-specified observing program
- Upgrade UI

Access here:

queue.stoneedgeobservatory.com/home

The screenshot shows the SEO Queue interface. At the top, there's a navigation bar with links for HOME, PROGRAMS, SESSIONS, OBSERVATIONS (with a dropdown arrow), MESSAGES, and ADMIN. Below the navigation is a dark background with a star field. On the left, under 'TELESCOPE STATUS', there's a large icon of a telescope with a grid pattern, labeled 'Slit: open'. Below it are icons for clouds (Clouds: -0.70) and rain (Rain: 0). To the right, under 'PROFILE SNAPSHOT', is a section titled 'Edit Profile' with fields for NAME (Amanda Pagul), AFFILIATION, and PENDING: 5. It lists four targets with their details:

Target	Exposure Time (s)	Exposure Count	Filters	Binning
HIP 3829	60	1	g',i'	2
m1	180	5	g',r'	2
m13	20	1		2
ngc147	60	100	r'	2

Below this is a section titled 'COMPLETED: 5' with another table:

Target	Exposure Time (s)	Exposure Count	Filters	Binning
04:15:21.50 -07:39:22.3	30	1	g',r',i'	2
44 Bootis	10	1	g',r',i'	2
61 Cygni	10	1	g',r',i'	2

Ask Brent / Marc / Amanda for an account to observe!

If you'd like to help develop additional features, contact berthoud@astro.uchicago.edu

stars.uchicago.edu

- Education → Class Wiki
- Stone Edge → Queue, SEO
Main page
- FITS Data → Fits View, Folders



Education

Stone Edge

Yerkes

FITS Data

Internal



Image uploaded to our [blog](#), taken by a Yerkes, Stone Edge, or SKYNET telescope.

Learn more about this page, visit the

[Guide to the Stars Server](#)

Getting SEO Images

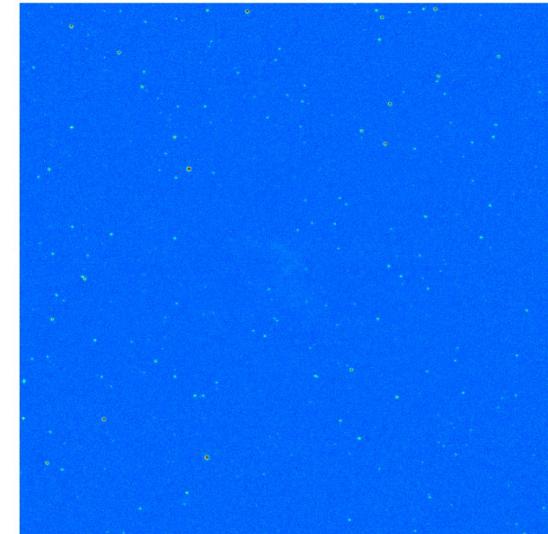
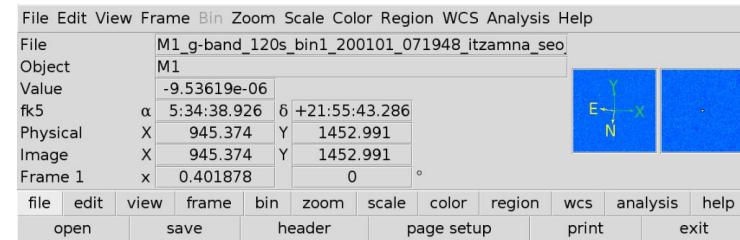
Use Data Viewer on STARS to view and analyze data and to download images.

- Several viewers on stars:
 - stars.uchicago.edu/fitsview24 for 2022 data
 - stars.uchicago.edu/queue for queue and class support data
- Several views:
 - List view: allows you to select observations
 - Data view: to look at and analyze data.
 - Pipeline log: current log of reduction pipeline
- Details on data access on the class wiki at github.com/bradfordbenson/ASTR21200_2024/wiki/Stone-Edge-Observatory

The screenshot shows the HAWC Data Viewer interface. At the top, there's a logo for the SOFIA Science Division and the text "HAWC - High Altitude Observatory". Below the logo is a navigation bar with links: "Select Function", "AOR List", "Data Viewer", "Pipeline Log", "Open New Tab", and "Help / Manual". A large red box highlights the "Function Navigation" link. The main area is divided into three sections: "Selection", "Info", and "Image Tools". The "Selection" section contains dropdown menus for "Filter", "AOR", "File", and "Pipe Step", along with a "Display" dropdown set to "PRIMARY IMAGE" and a "Download Selected FITS File" button. The "Info" section displays observational parameters: Object: Bird, Band: 1, Pupil: 37, Date: 2023-12-27, Time: 17:38:51.321, Observatory: lab, Obs RA: 4900.0, and Obs Dec: 4800.0. The "Image Tools" section includes controls for "Mouse X / Y", "Zoom" (set to 3x), "Value" (3.2111074), "Scale" (MinMax), and "Color" (Grey). A red box highlights the "Image Tools" section. In the bottom right corner, there's a small window titled "Zoom Display" with a red border, also containing the text "Image Display".

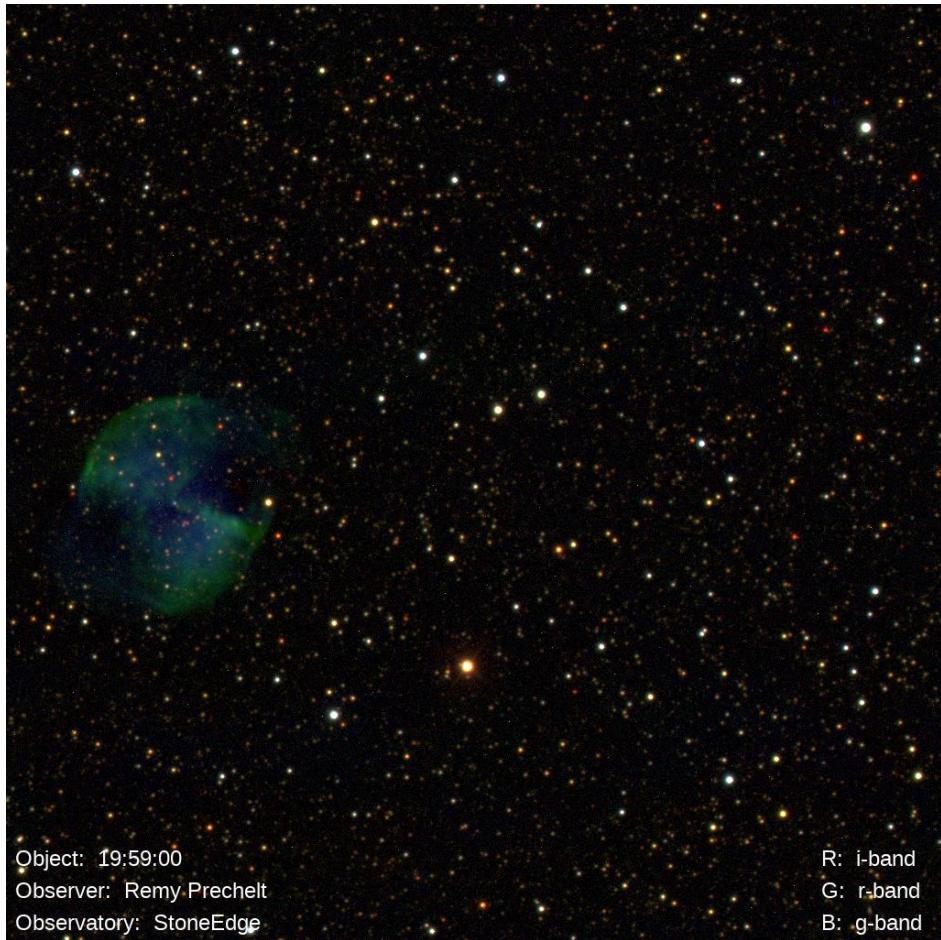
DS9 — Image Analysis and making RGBs

- The pipeline often fails out before reaching completion, for a variety of reasons
- You can still make color images even when this happens though, using a tool called DS9
 - It can be found at <http://ds9.si.edu/site/Home.html> with versions for Mac, Windows, and Linux
- Also great for making quick color images while operating Itzamna
 - Also capable of more sophisticated scientific operations and measurements
 - Instructions for creating a color image can be found at <http://ds9.si.edu/doc/user/rgb/index.html>



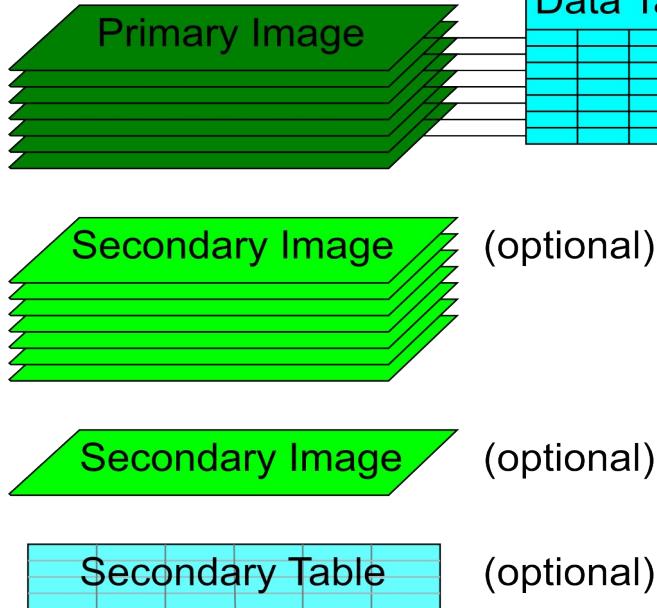
Data Reduction Pipeline

- Automates several processes which, for large data sets, can be time consuming to run on personal machines (or difficult to set up)
 - At a minimum, files are Bias/Dark/Flat corrected and hot pixels are removed
 - Process will typically work for images with many background stars. Otherwise color images will need to be created manually
 - Assuming all steps work, a color image preview will be generated
- Runs daily on the STARS to reduce queue and Itzamna data
- Generally good for creating images using g/r/i (broad-band) filters automatically, but not for other (narrow-band) filters like H-alpha, OIII, SII



Flexible Image Transport System (FITS)

FITS Data Format



Primary Header

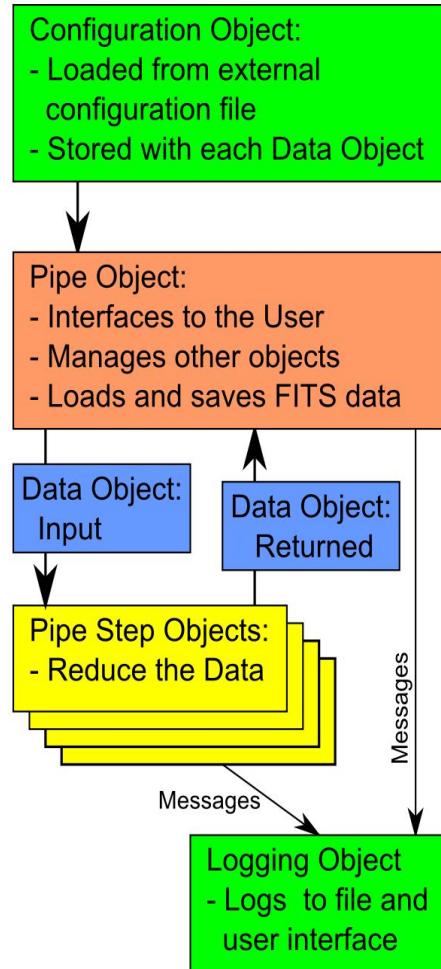
Data Table (optional)

Main data format used by astronomers.

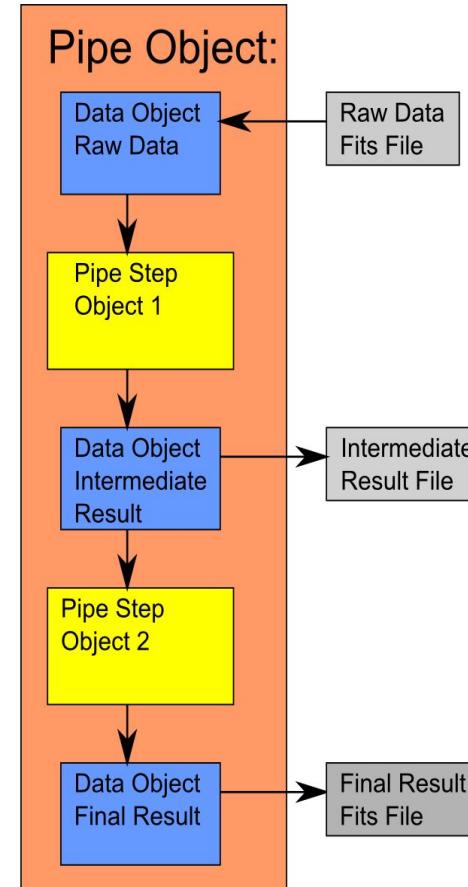
- Each image contains HDU(s) - header data unit
- Primary Header: Information about File and (optional) first data set
- Secondary Headers:
 - Tables
 - Additional Images (Error image, Bad Pixel Mask . . .)
- Images can have 2, 3 or more dimensions, same for table columns.

DarePype Structure

Pipeline Object Architecture:



Data Processing Sequence:



DarePype Configuration

- Each pipeline needs a configuration file (it will not run without it)
 - Config files has different sections: [general], [data] one for each mode, one for each step
- Pipe MODE says how the data is reduced.
 - You can use modes to have different ways to run the pipeline or do reduce different types of data.
- Make your own config file
- Config file Toolkit
 - Header overwrite
 - Hierarchical / delta config files
 - Modes can have extra parameters for steps

```
# General Section: configuration of the pipeline
[general]
    # list of packages to look for pipe step modules (order matters)
    steppacks = stonesteps, darepype.drp
    # list of steps for unknown instrument mode
    stepslist = load, StepRGB

    # Data Section: information on data objects and file names
    [data]
        dataobjects = DataFits, DataText #, DataCsv

    ### Pipelines Section: configuration for individual pipeline modes
    # Stoneedge Mode Configuration
    [mode_stoneedge]
    # List of keyword=values required in file header to select this pipeline mode
        # Format is: Keyword=Value|Keyword=Value|Keyword=Value
        datakeys = "OBSERVAT=StoneEdge"
        # list of steps
        stepslist = load, StepAddKeys, StepBiasDarkFlat, save, StepHotpix, StepRGB

    ### Pipe Step Section
    # BiasDarkFlat step configuration
    [biasdarkflat]
        # filename that overrules the fit keys
        biasfile = /data/images/StoneEdge/0.5meter/2018/*/bias/bias*.fits
        darkfile = /data/images/StoneEdge/0.5meter/2018/*/*dark/dark*.fits
        flatfile = /data/images/StoneEdge/0.5meter/2018/*/*flat/flat*.fits
        daterange = 0.5
        # list of keys that need to match bias and data file
        #fitkeys = 'list','of','FIT Keywords','for Bias/Dark/Flat' # StoneEdge
        biasfitkeys = XBIN, DATE-OBS
        darkfitkeys = XBIN, DATE-OBS, EXPTIME
        flatfitkeys = XBIN, FILTER, DATE-OBS
        # list of input file datasets to flatten
        # - Expects None or a list of image HDU
        #datalist = R array, T array

    # RGB step configuration
    [makergb]
        # percentile value for minumum scaling (in decimal form)
        minpercent = 0.5
```

SEO Pipeline CCD

- The Pipeline runs automatically on all queue data and the data taken by Itzamna.
- You can look at the reduced data on the stars server at stars.uchicago.edu
 - Look at “Fits Data” □ “SEO Queue” for the queue data
 - Look at “Fits Data” □ “SEO 2022” for itzanma data
 - Look at “Fits Data” □ “Data Folders” to have listing of raw files.
- The pipeline usually is able to fully reduce good r/g/i/clear data but not narrow-band (H-alpha, OIII, SII) or bad data.
 - At a minimum BDF/HDR corrected and hot pixel removed files are produced.
 - Calibration process will usually work well for images clear and bright foreground stars.
- Pipe Steps and Files:
 - Raw File: from telescope
 - StepAddKeys: Adds missing header information
 - StepBiasDarkFlat: Does BDF correction
 - StepHotpix: Removes bad pixels
 - HPX File: is BDF and hotpix corrected
 - StepAstrometry: Uses a star catalog to find precise RA/Dec coordinates
 - WCS File: Has updated coordinates
 - StepFluxCalSex: Uses sextractor to extract sources and calibrate the image using guide star catalog
 - FCAL File: Flux calibrated (also make fit plot .png)
 - StepRGB: makes JPEG rgb image
 - .JPG File: a JPEG image preview

Running the Pipeline in Colab / Jupyter Notebook

- Run through the the jupyter notebook under SEO UChicago/PipeLine/SEO_PipeColabV6.0.ipynb at https://drive.google.com/drive/folders/1O4HBbrZMIDb1I7XCH5ewJ8AVubsyh6rr?usp=share_link
- You can select which images to download. They should be RAW images of the same object taken with different filters.
- This folder also contains colab notebooks to
 - Coadd images: Coadd_DemoColabV2.1
 - Make an RGB image with the pipeline: MakeRGB_withPipeline
 - Run webastrometry: WebAstrometry_Colab_V2.1

PipeRuns

- `DarePypeRun.py` is a support tool to help reduce data using `darepype` packages.
- Needs a `PipeRun.txt` file which specifies all run parameters

Example Piperun File:

```
# Daily Reduction PipeRun file
# This is a COMMENT
pythonpath = /data/scripts/pipeline/source
pipeconf = /data/scripts/pipeline/config/pipeconf_SEO.txt
/datascripts/pipeline/config/dconf_stars.txt
pipemode = postbdf
loglevel = DEBUG
logfile = /data/scripts/pipeline/PipeLineLog.txt
inputfiles = /data/images/StoneEdge/0.5meter/2022/2022-01-12/reduced/*_HDR.fits
outputfolder = /data/images/StoneEdge/0.5meter/2022/2022-01-12/reduced
```

PipeRuns (continued)

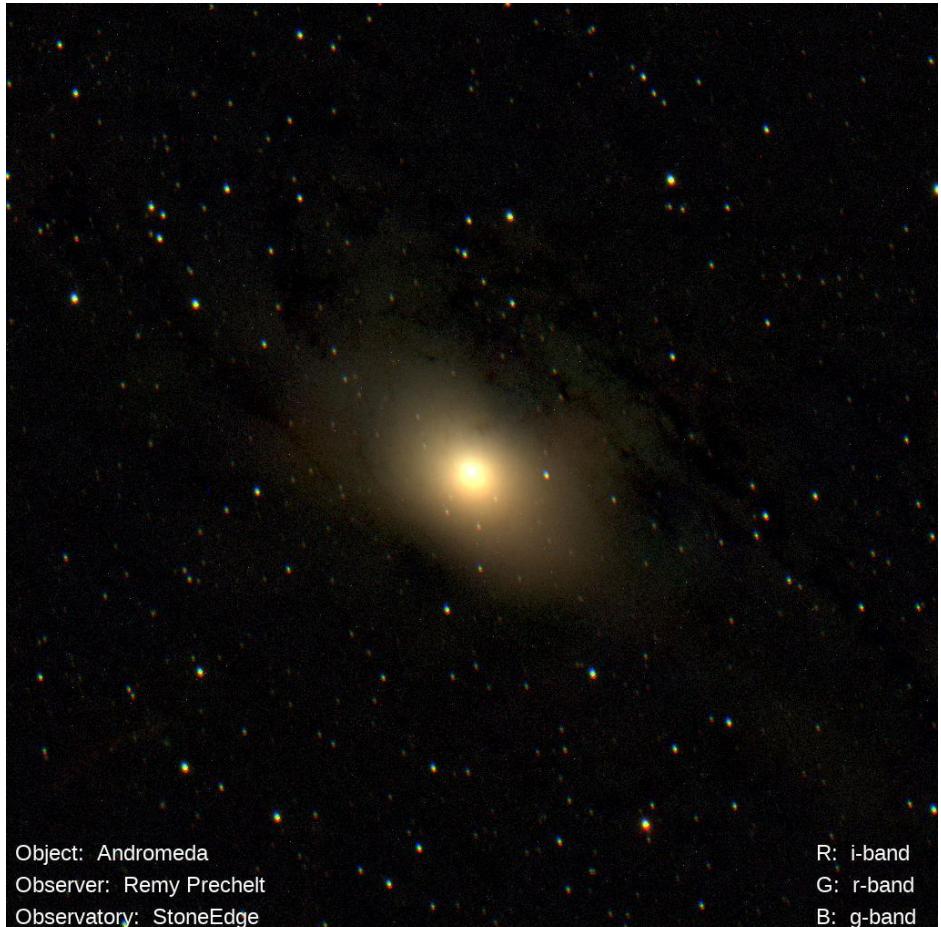
- To run a darepyperun download and edit user_piperun.txt and user_dconf.txt files from
stars.uchicago.edu/images/Tmp/Users/berthoud
- Edit those files to point to your installation of the SEO pipeline and the RAW data you want to be reduced.
- Run piperun with the following command in the command line

```
darepyperun.py /path/to/your_piperun.txt
```

 - You might have to set PATH or list full path for darepyperun
- That's all Folks!

Installing the Pipeline

- Requires python (version 3.6 or later)
 - Also requires the following python packages
 - numpy
 - astropy
 - logging
 - darepype
 - drizzle (for creating mosaics)
 - ccdproc (for BDF corrections)
- Git repo is located at
github.com/yerkesobservatory/pipeline
- More documentation and instructions for running the pipeline locally can be found on the projects page at
sites.google.com/a/starsatyerkes.net/yerkesprojects/projects/image-pipeline/pipe-development



Object: Andromeda

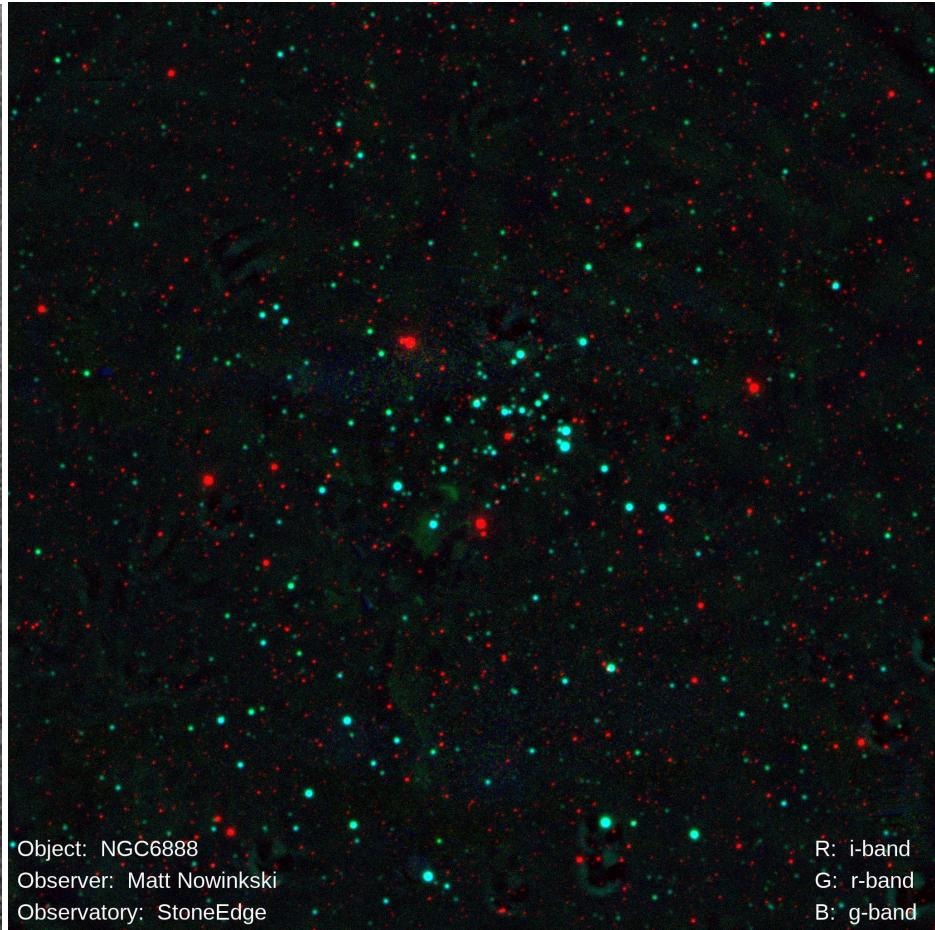
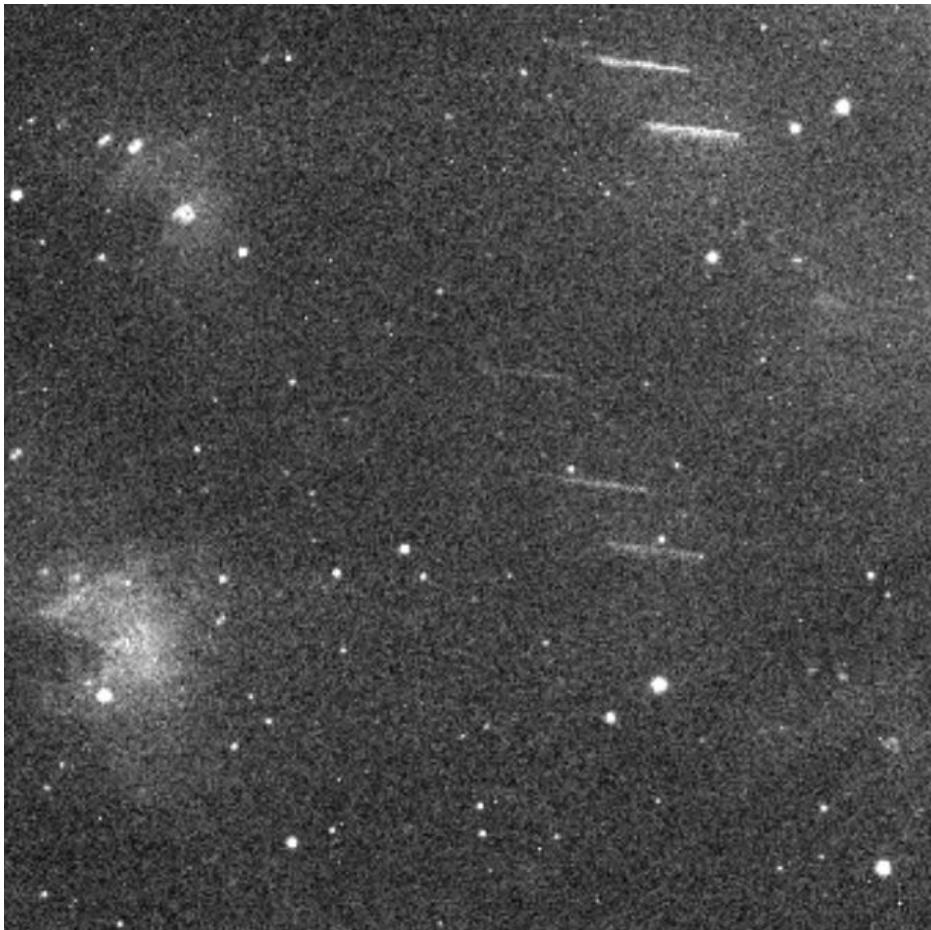
Observer: Remy Prechelt

Observatory: StoneEdge

R: i-band

G: r-band

B: g-band



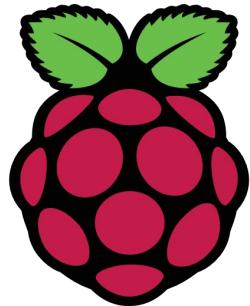
StarDrive & StarBase

StarDrive



- 24TB NAS with Raid 5
- Archives all past SEO data
- Temporary user folder (up to 1TB)
- Can also support other projects.

Starbase

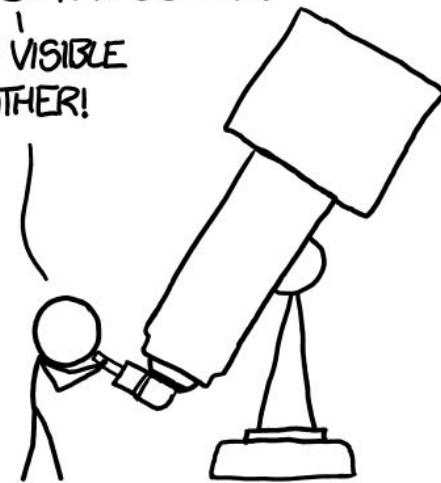


- Raspberry Pi 4 8GB with 1TB SSD
- Mounted access to StarDrive
- Pipeline installed (incl. astrometry.net)
- Temporary or permanent student accounts possible.

Additional Comments

- Amanda, Al and Marc are usually on Slack and willing to help!
- The SEO community is awesome and will help out if you ask a question and they happen to be on Slack (e.g. Emil)
- Please reach out if you would like to observe, do a mini SEO project, or help in the development--any level of engagement is welcome! :)
- The software can always be improved, suggestions, bug reports and help is appreciated.

I'VE DISCOVERED AN EARTH-SIZED
PLANET IN A STAR'S HABITABLE ZONE!
IT EVEN HAS OCEANS!
AND VISIBLE
WEATHER!



TO MESS WITH AN ASTRONOMER, PUT A
MIRROR IN THE PATH OF THEIR TELESCOPE.



Horsehead Nebula
Lorenzo et al. 2022

Spare Slides / Notes

SEO Raw Images for HDR mode (CMOS camera)

- The CMOS Camera has HDR (high dynamic range) mode and takes two images for each exposure.
 - One Low gain image - to get the flux of bright stars
 - Image stored in secondary header
 - One High gain image - to get the flux of dim stars and objects. This over-saturates bright stars.
 - Image stored in primary header
- The camera can still be operated single image mode.
 - In that case first HDU has the image.

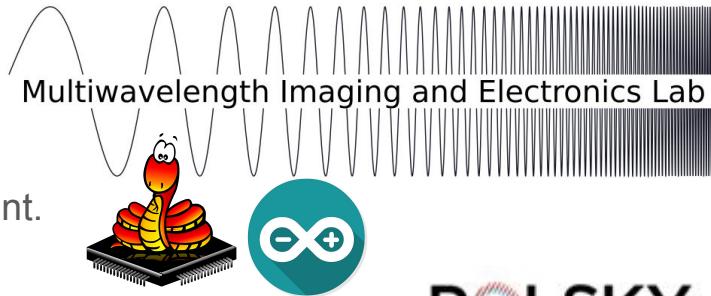
SEO Pipeline HDR

- The Pipeline runs automatically on all queue data and the data taken by Itzamna / ixchel.
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 - Look at “Fits Data” → “SEO 2022” for itzamna data
 - Look at “Fits Data” → “Data Folders” to have listing of raw files.
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 - At a minimum BDF/HDR corrected and hot pixel removed files are produced.
 - Calibration process will usually work well for images clear and bright foreground stars.
- Pipe Steps and Files:
 - Raw File: from telescope
 - StepAddKeys: Adds missing header information
 - StepHdr: Used instead of StepBiasDarkFlat to reduce and combine high dynamic range (HDR.fits) data
 - StepHotpix: Removes bad pixels
 - HPX File: is BDF and hotpix corrected
 - StepSrcExtPy: Extracts point sources
 - SEP File: has table of extracted sources
 - StepAstrometry: Uses a star catalog to find precise RA/Dec coordinates
 - WCS File: Has updated coordinates
 - StepFluxCal: Uses extracted sources to calibrate the image using guide star catalog
 - FCAL File: Flux calibrated (also make fit plot .png)
 - StepRGB: makes JPEG rgb image
 - .JPG File: a nice JPEG

UChicago Makerspaces

You can learn to build your own projects and experiments on campus. There are several student labs available for you.

- MIELab: ERC 524
 - Sensing electronics: Radio to UV
 - IoT and embedded computers
 - In-situ and remote sensing equipment.
 - Data acquisition and automation
- POLSKY center Fab Lab: School of Business
 - Mechanical building, electronics polsky.uchicago.edu/fab-lab
- Mechanical Design + Fabrication Lab: PRC 307
 - 3D printers, CAD workstations, engineering support voices.uchicago.edu/mechanicallab
- Hack Arts Lab (HAL): MADD center, Crerar Library
 - 3D printers, laser cutters arts.uchicago.edu/hack-arts-lab-hal
 - MADD center also has Weston Game Lab





Marc's Notes

- Nothing now