Transiting and Variable Objects: A Search Through Galaxy Evolution Explorer Observations

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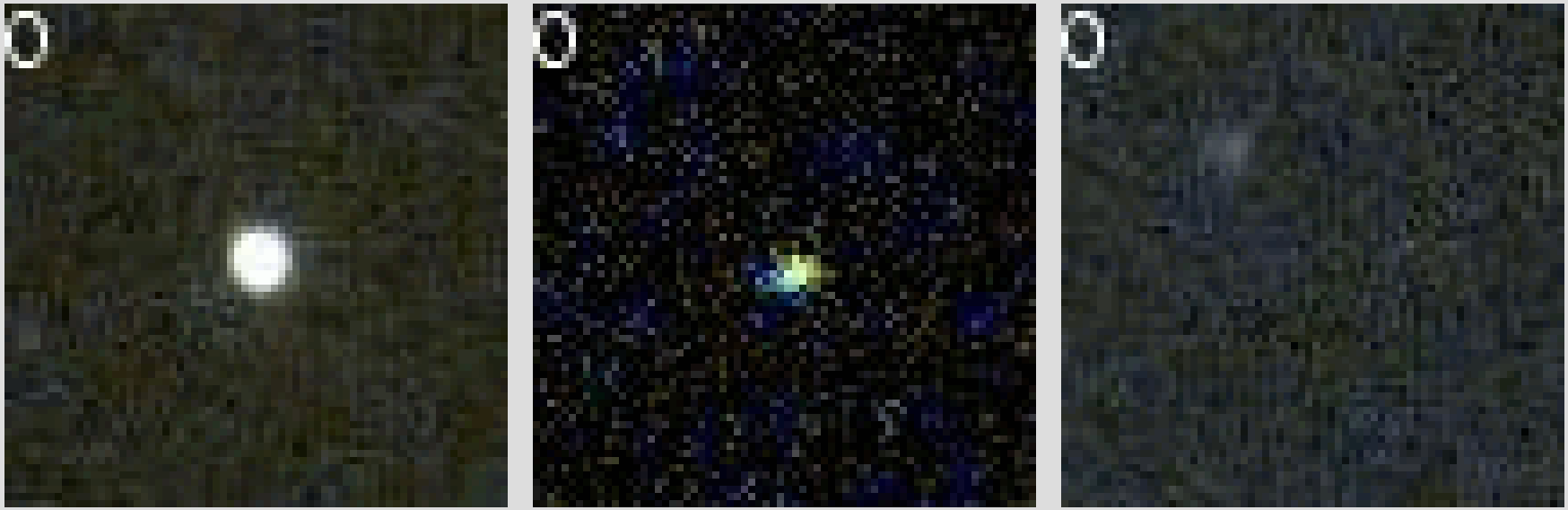


About GALEX

- All-sky ultraviolet sky survey satellite
- Two channels: Far (1260-1772Å) and Near (1537-2997Å) Ultraviolet
- All observations have timing information
- Maximum exposure time of about 1700s
- Multiple visits to gain additional exposure time

Variable Stars and Asteroids: Can they be seen?

- Can the GALEX project detect variable stars and asteroids?
- What do they look like in the ultraviolet?
- Are any of them new discoveries?
- On what timescales do the objects vary?

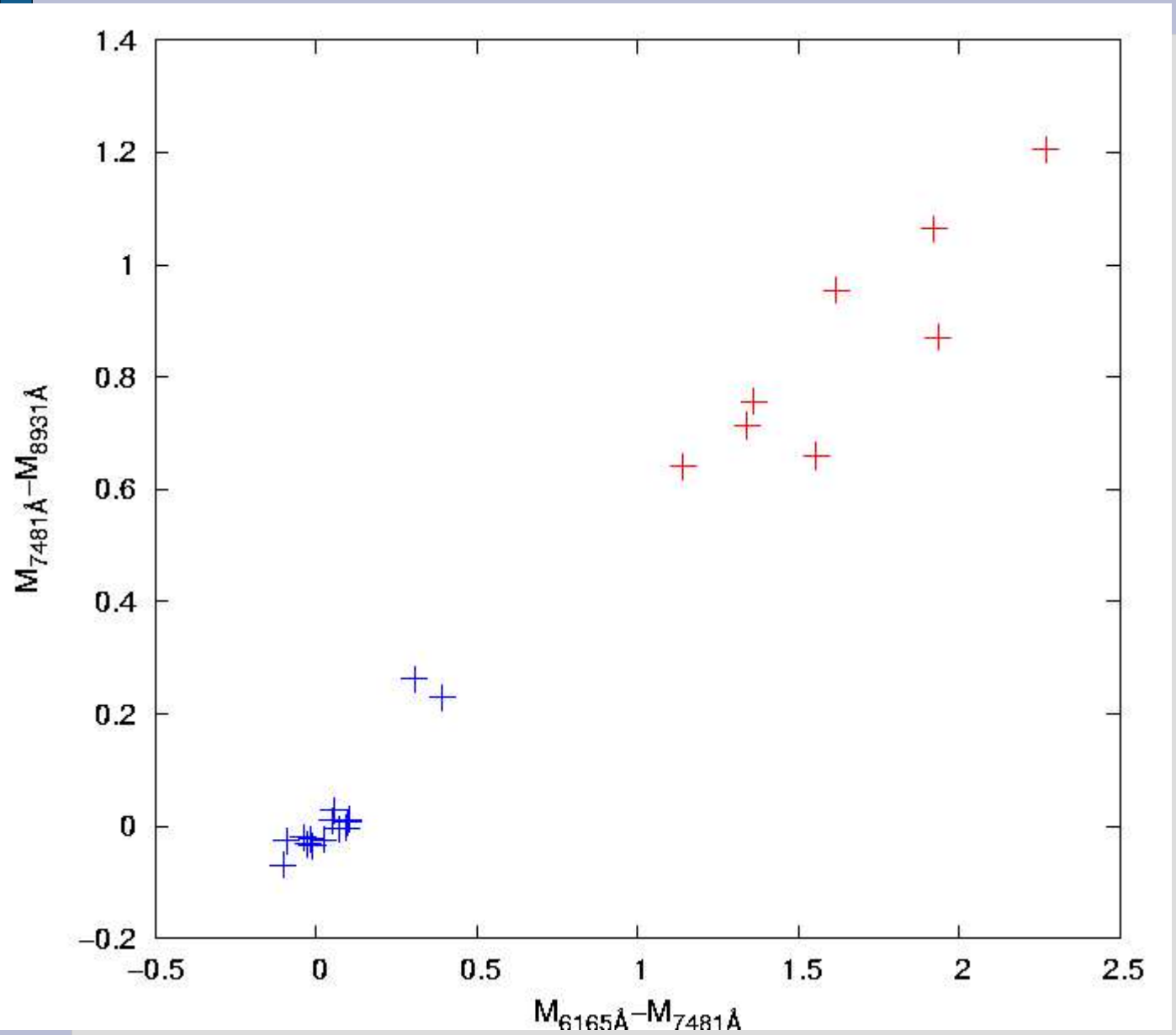
Variable stars and asteroids are found.

- 88 Variable Stars, 5 Asteroids
- Variable stars are found with a wide range of ultraviolet color. Several may be newly discovered.
- Asteroids are seen in only one band. They are are all known members of the main belt.
- Variability timescales range from 100 seconds to 13 hours.

Findings, Methods, and Problems

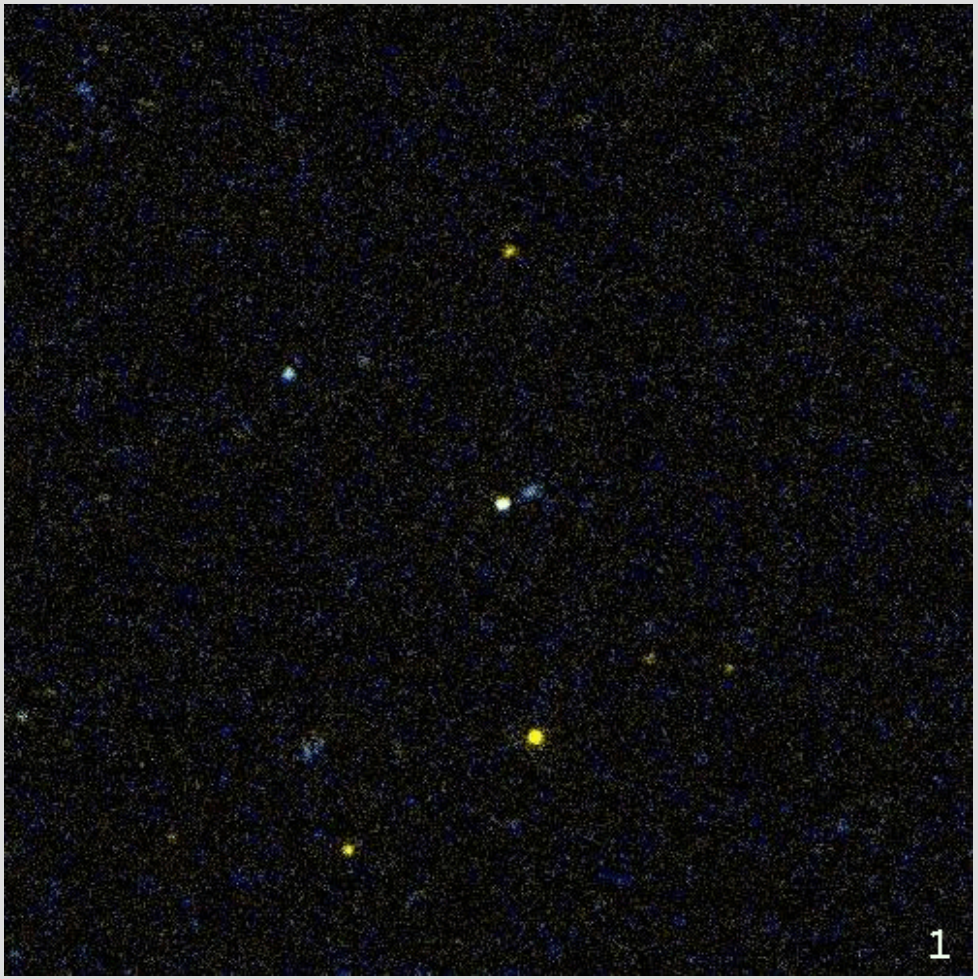
- Examples of the variable objects found
- Finding variable objects
- Analyzing variable objects
  - Database of measurements
- Problems Encountered
- Further Research

Optical Red Versus Blue



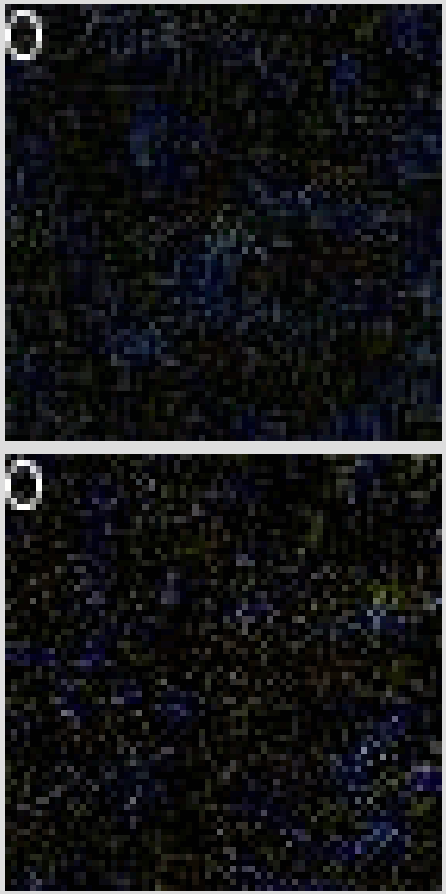
- Data from Sloan Digital Sky Survey on found stars
- Optical red stars seen flaring
- Optical blue stars are periodic

A Large Flare

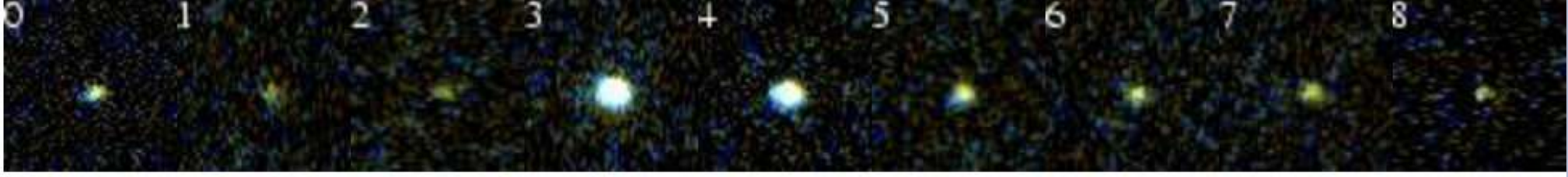


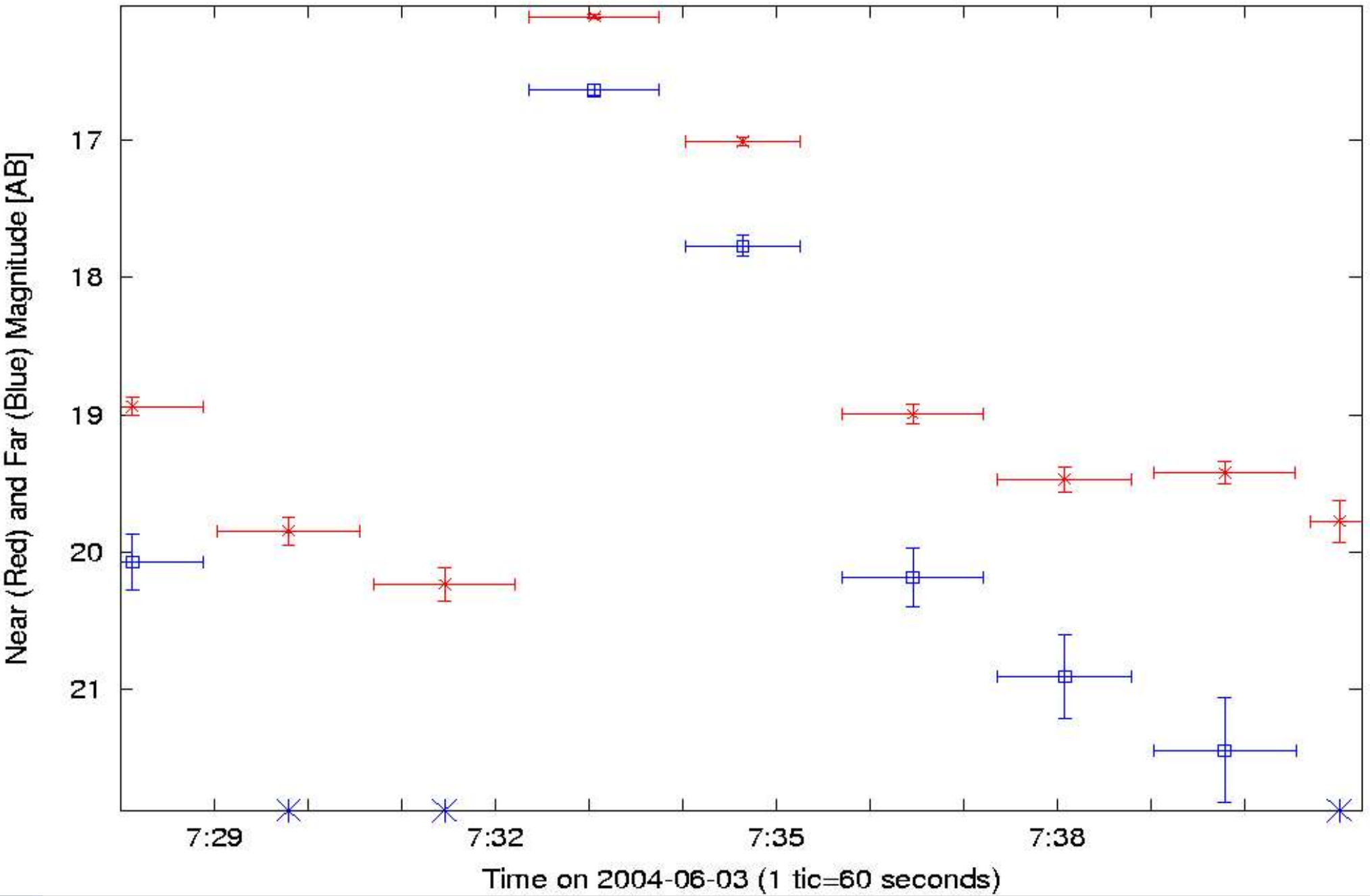
- Known variable GJ 3685A
- Largest ever observed ultraviolet flare
- 100s time intervals
- M-dwarf type binary system
- Optically red
- 176.919°, 0.256°

Mysterious UV Blue Dots

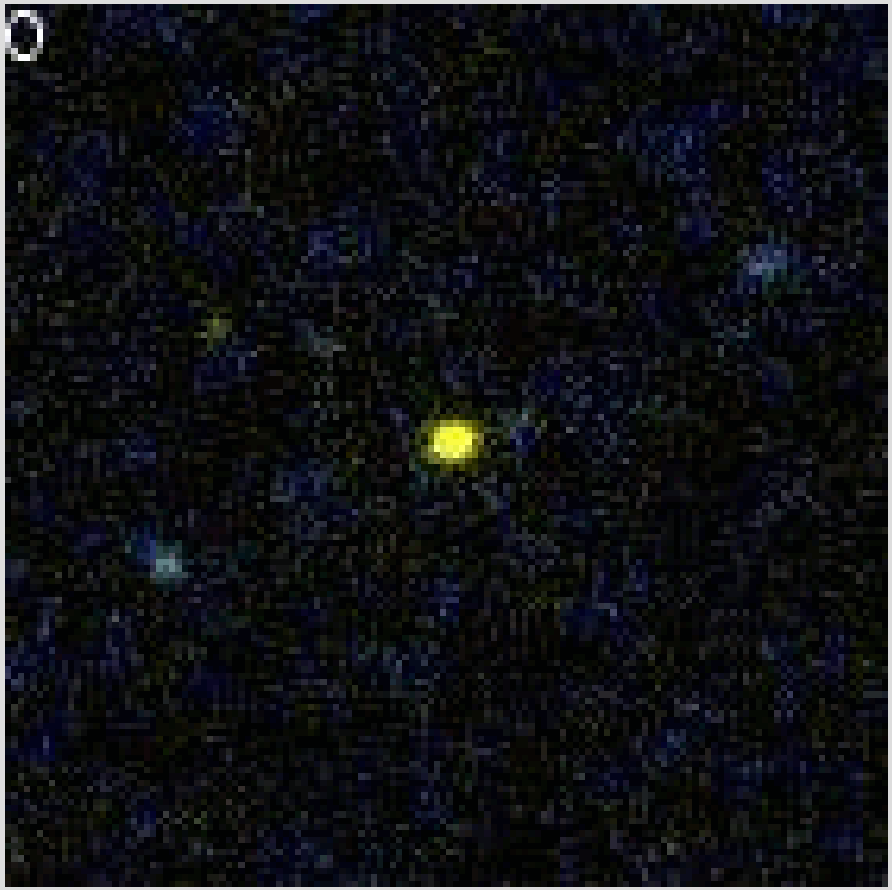


- Six sightings, all in different places
- Not in variable catalogs
- Existence confirmed by other surveys
- Optically red
- Similar to GJ 3685A.
- Theory: M-dwarf type stars flaring
- Good candidates for time slicing.


0
1
2
3
4
5
6
7
8

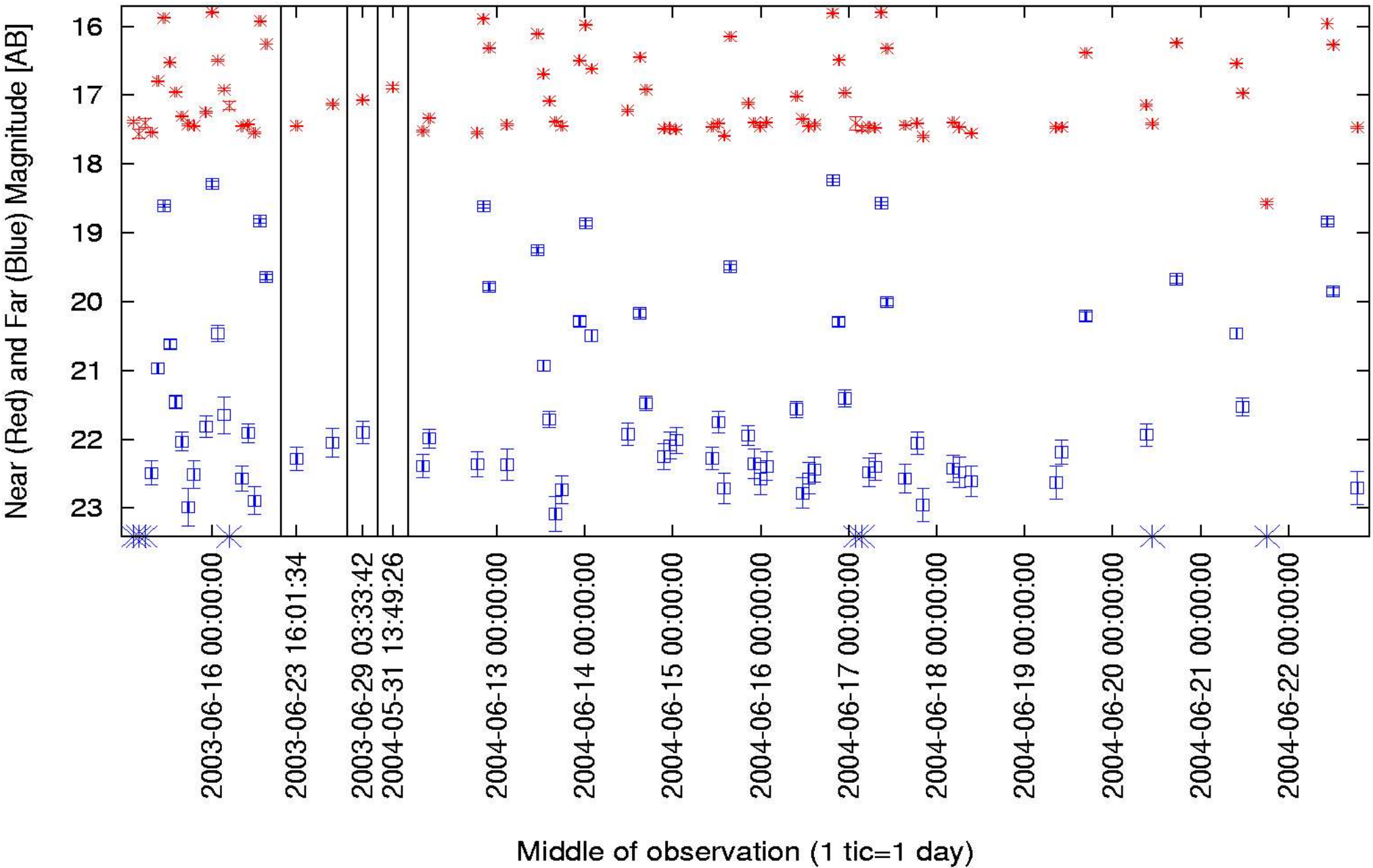

Near (Red) and Far (Blue) Magnitude [AB]
17
18
19
20
21
7:29
7:32
7:35
7:38
Time on 2004-06-03 (1 tic=60 seconds)

Periodic Variables

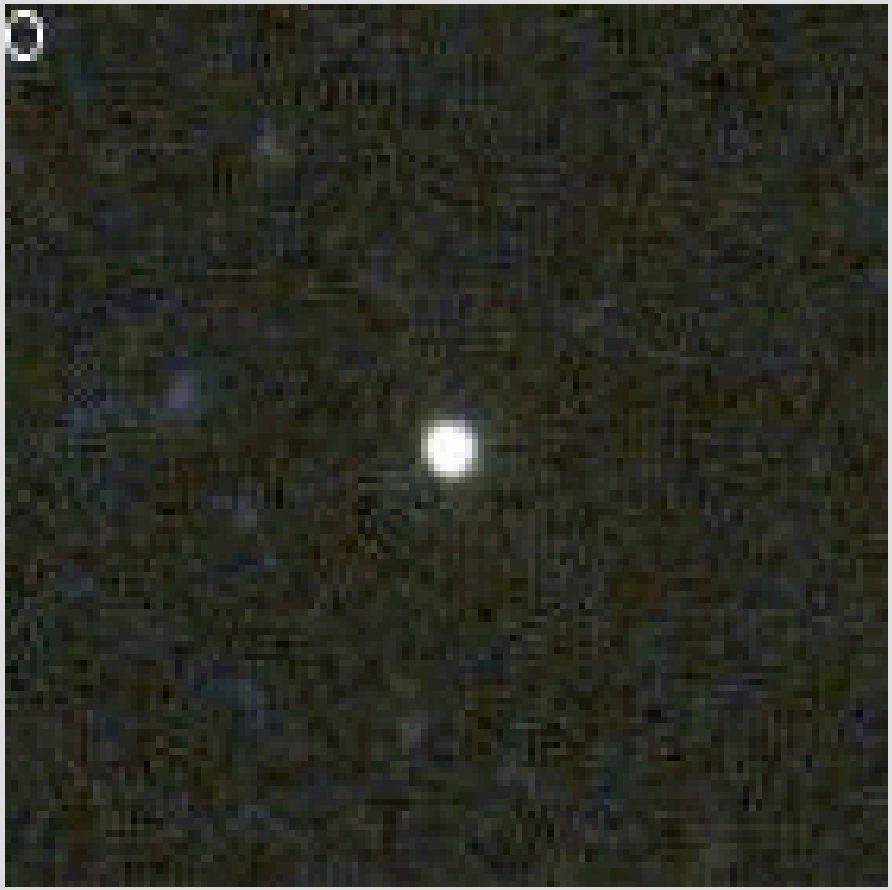


- Known RR-Lyrae variable
- Frames with low background like 1, 15, and 60 are short exposures.
- Named ROTSE1 J143753.84+345924.8

Periodic Variables Over Time

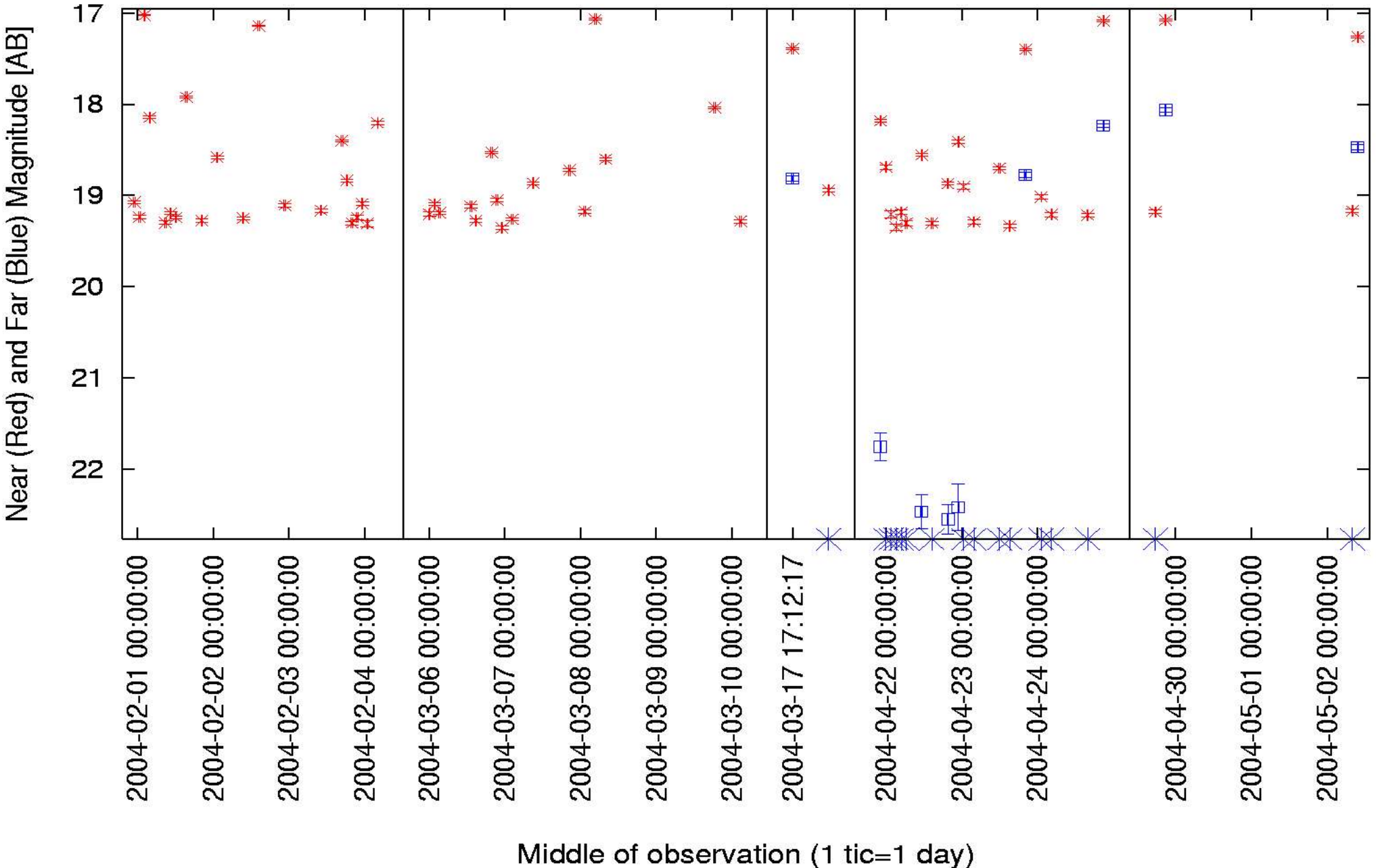


New Periodic Discovery?

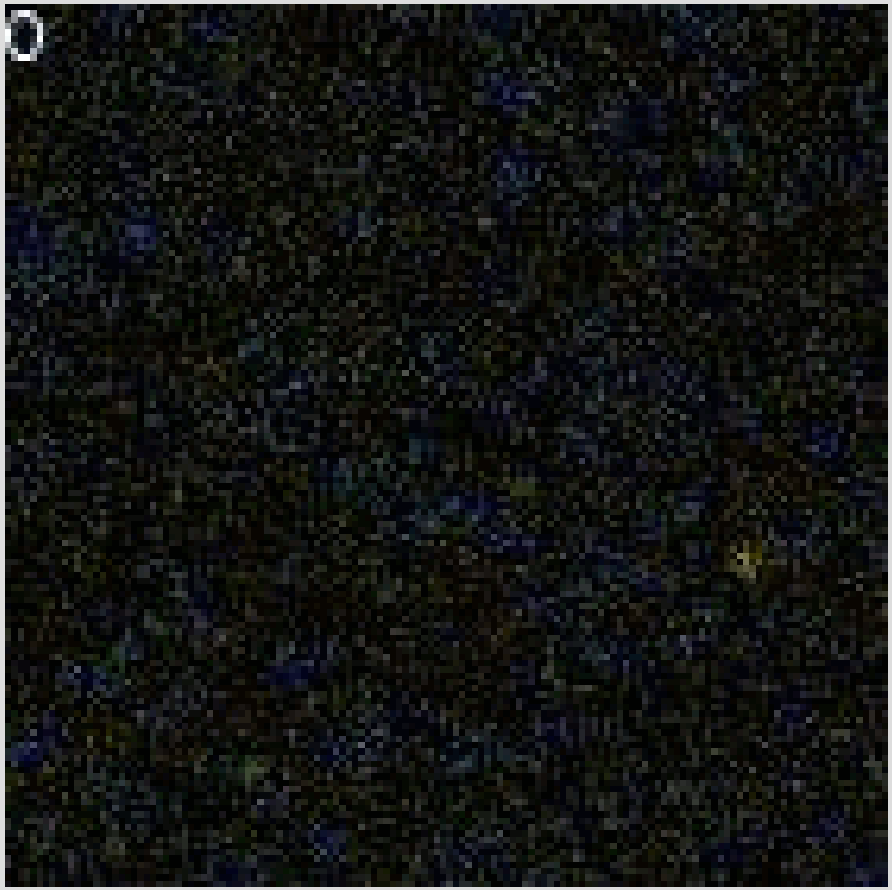


- Not in SIMBAD catalogs
- Acts quite similar to the previous RR-Lyrae star
- Blue in optical
- 164.093°, 57.089°

New Periodic Over Time

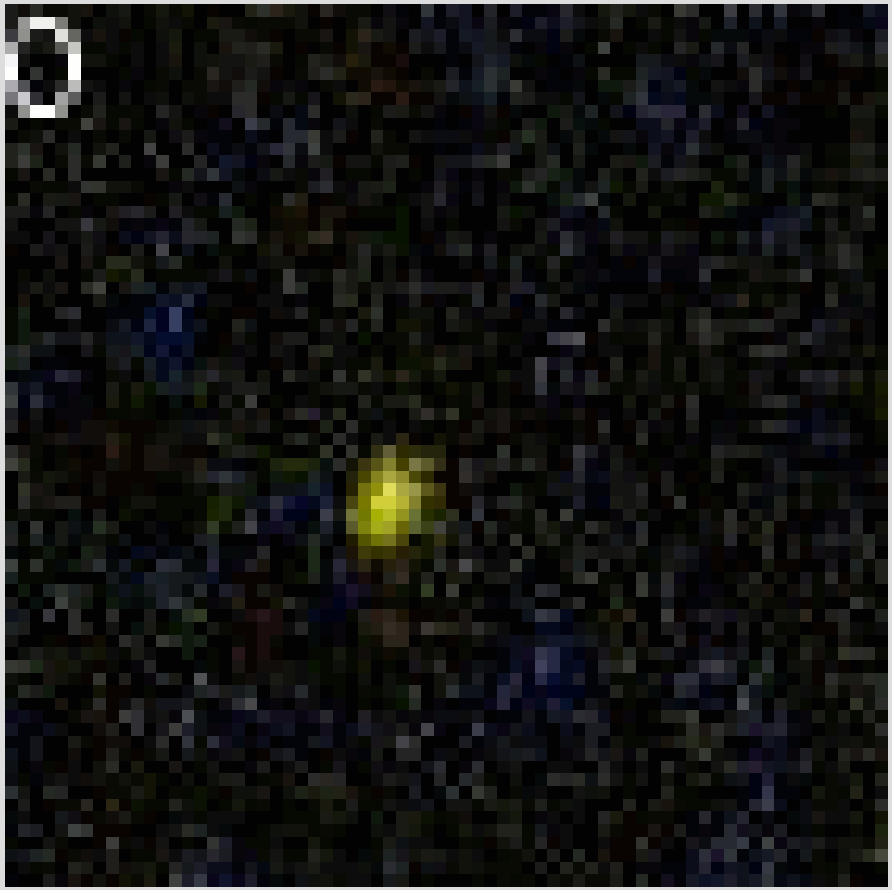


Five Asteroids: Endymion, Johanna, Kallisto, Phaedra, and Stereoskopia



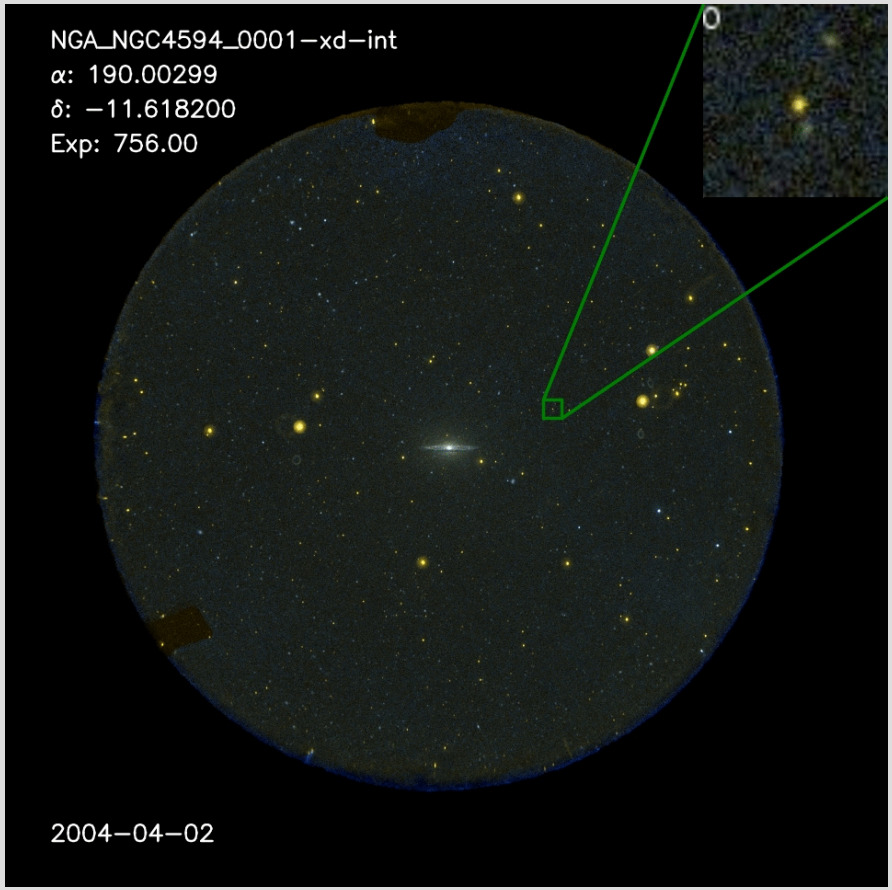
- All Found by streak in only one observation
- Kallisto's streak is shown at left.
- Minor Planet Center used to identify them
- All are in the main belt.

Slicing an Asteroid



- 200s between frames.
- Moved 0.0138 arcsec/s.
- Small changes in magnitude
- Kallisto observed 03/29/2004 13:30 GMT
- 164.62°, -0.65°

Finding Variable Objects



- Identify overlapping observations
- Blink images
- Disregard reflections and edge effects
- Note for analysis

Analyzing Variable Stars: Measurements

Exposed[s]	Time	FUV	NUV
756	2004-04-02 6:07	None Detected	19.41
1173	2004-04-02 7:46	17.93	17.09

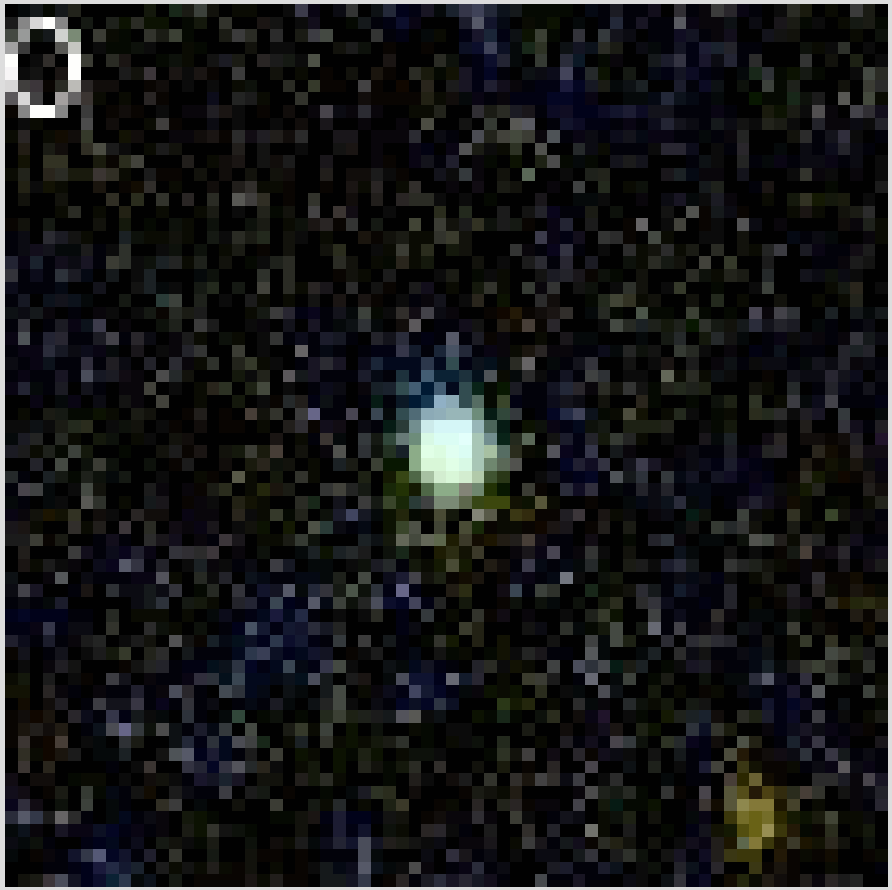
FUV and NUV values are Magnitudes in AB.

- Created 30 million row, 297 column database of GALEX measurements
- Call up all measurements and images of an object in seconds
- Confirm visual inspection with quantitative data
- Further research: Use database to find variables

Outside Databases

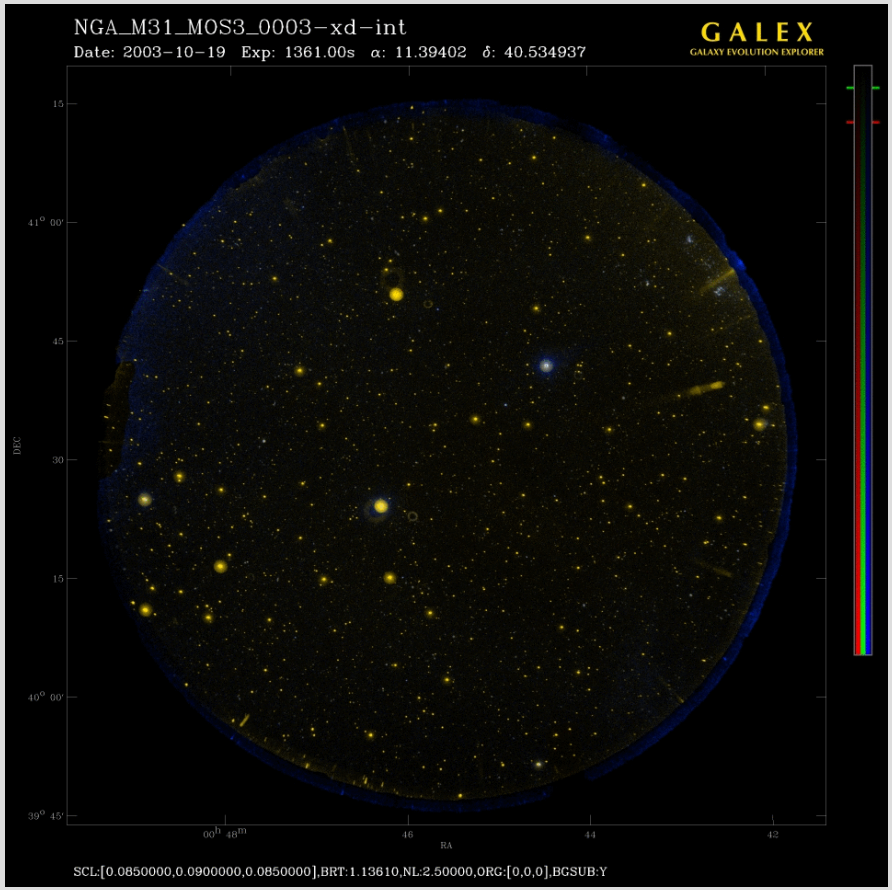
- Sloan Digital Sky Survey (SDSS): Magnitudes in other wavelengths
- SIMBAD collection of catalogs to determine known variables
- Digital Sky Survey, Multimission Archive at Space Telescope: Verify UV blue dots
- Minor Planet Center Checker to determine if asteroids are known and to identify them

Problems Encountered: Hotspots



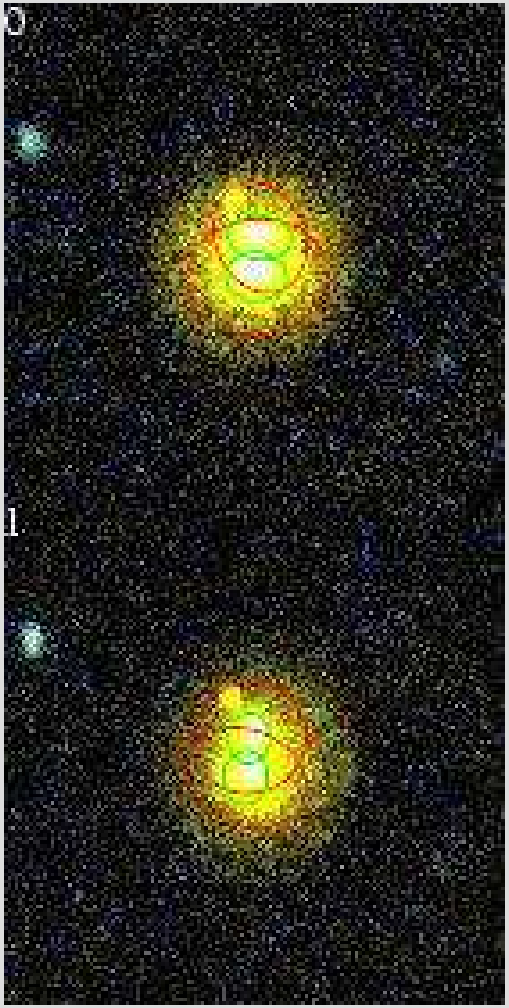
- Parts of the detector malfunction
- Sometimes stars are obscured
- Happens in short exposures
- Usually easily recognized by eye

Problems Encountered: Alignment



- Images aligned by tracking guide stars
- The tracker can fail or track the wrong star.
- Sudden movement can cause two copies of each source.

Problems Encountered: Source Blending



- At left is a binary star system possibly containing a variable star.
- Green and red ellipses indicate FUV and NUV detections, respectively
- Difficult to measure NUV magnitudes of variable
- 227.958°, 61.859°

Further Research

- Using database
  - Look for variability in an automated fashion
  - Match with other surveys
- Investigate further the found sources
  - Study flares (particularly M-dwarfs)
    - Short time scales
    - Frequency
  - Distance measurements using RR Lyrae stars
  - Spectroscopy of variable sources
  - Rotation periods of asteroids

Summary

- Database of GALEX measurements
- GALEX can find variable objects
- Asteroids can be observed but must be bright
- Variability in stars can be flaring or periodicity
- Many variable stars are possible new discoveries