Variable Star Search Using ROTSE3 Data

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Outline

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- ROTSE3
- Binary Stars
- Eclipsing Binary Stars
- Eclipsing Contact Binary Stars
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- Work in Progress
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Introduction

- ROTSE: Robotic Optical Transient Search Experiment
- Primary goal: observations in optical light of GRBs
- Observation and detection of optical transients on time scales of seconds to days
- Also used for variable star searches, identification of other transient events (AGNs, flare stars, X-ray binaries, SGRs)

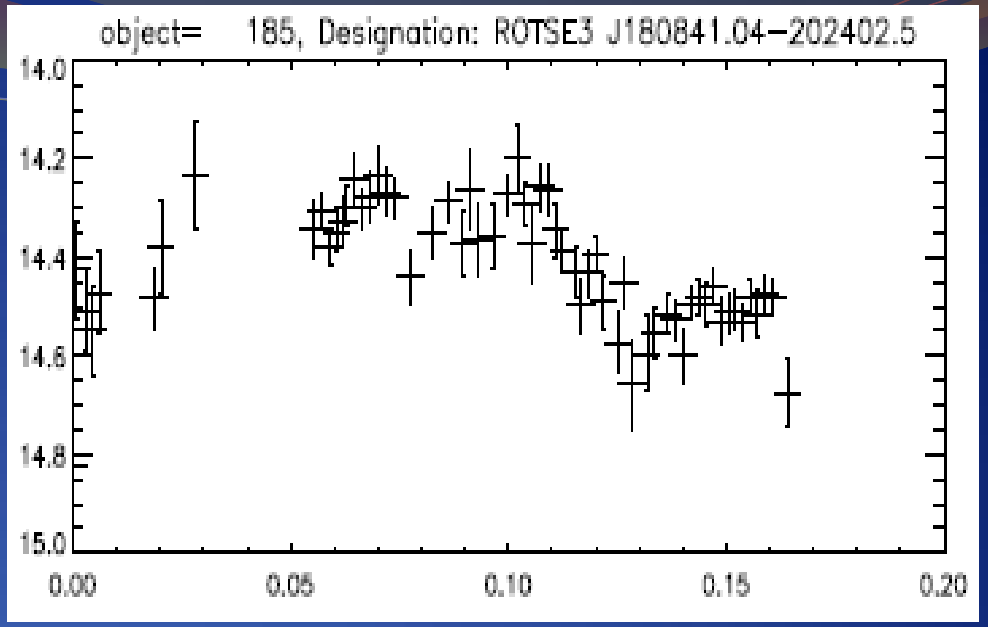
ROTSE Telescopes

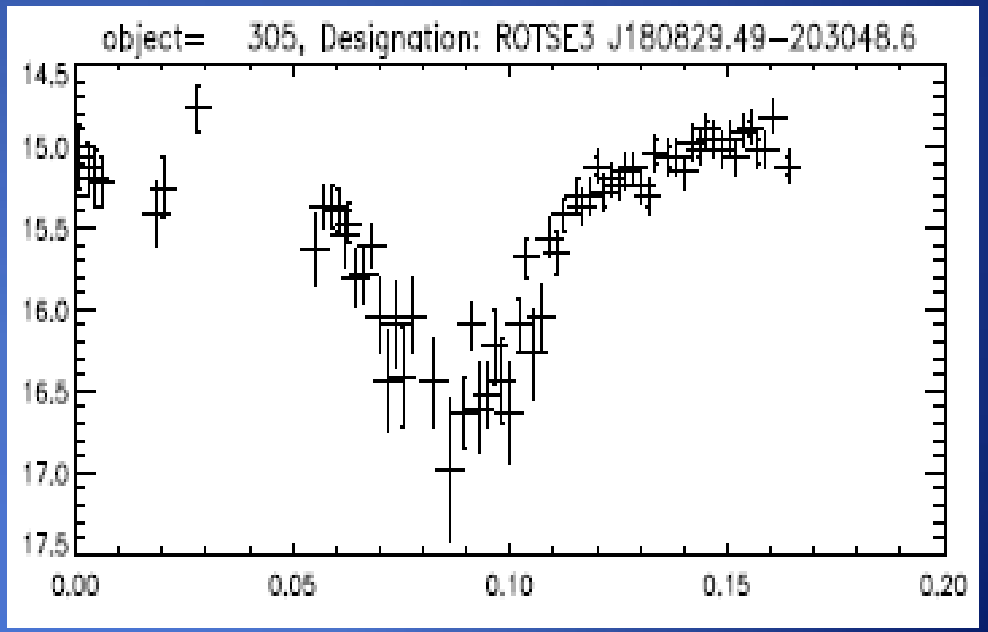
- **ROTSE1:**
  - Initiated in 1998
  - Four CCD cameras w/ telephoto lenses
  - FOV: 16°×16°
  - Limiting magnitude: 14-15
  - Observed 1st optical counterpart to GRB in progress on 01/23/99
  - Retired from active operation

- **ROTSE3:**
  - Initiated in 2003
  - Four 0.45 m robotic reflecting telescopes
  - Managed, fully automated
  - Linux environment
  - Greater sensitivity than ROTSE1
  - f-ratio: 1.9
  - Limiting magnitude: 19-20
  - FOV: 1.85°×1.85°

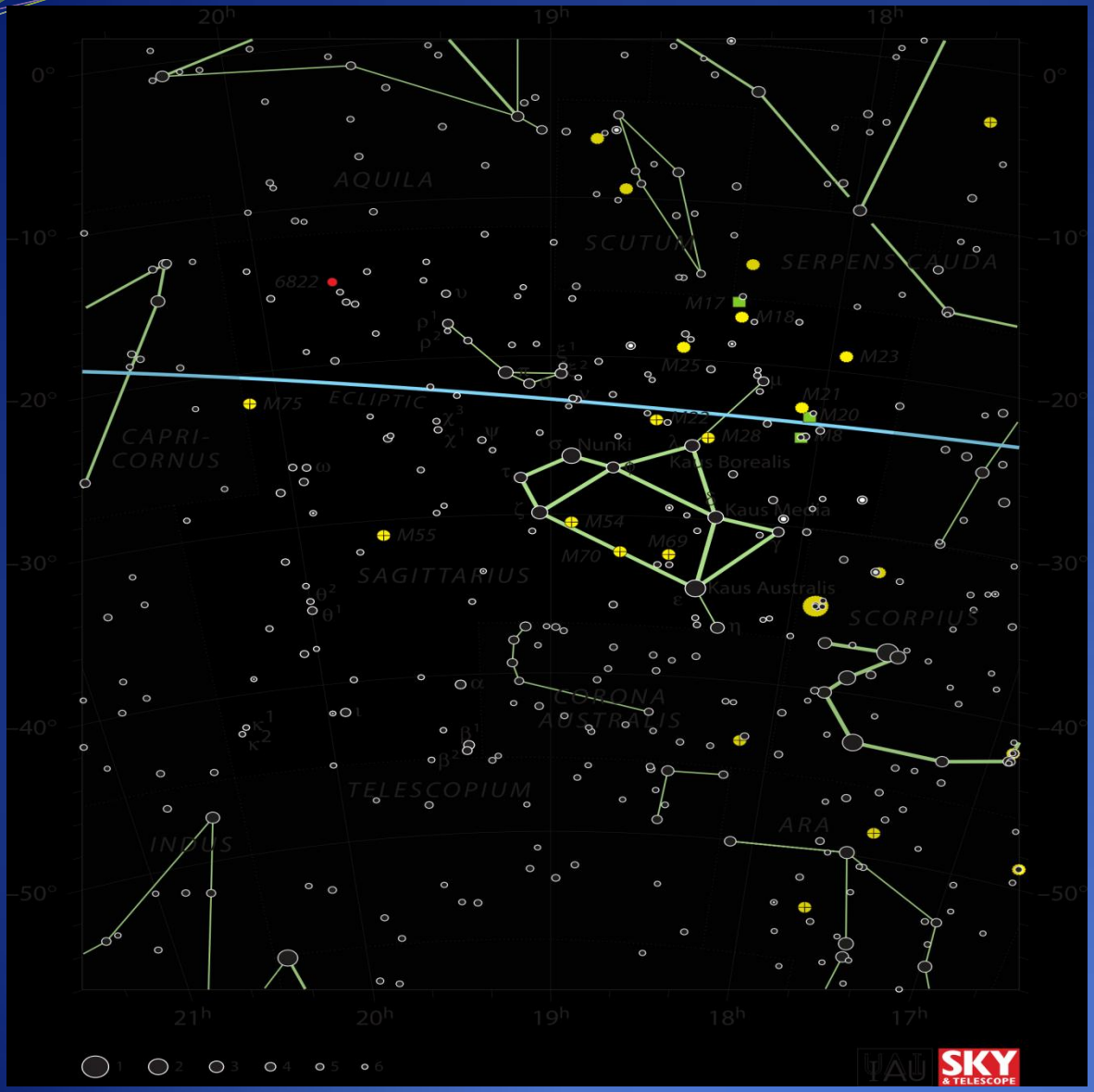
ROTSE3

- **DATA:**
  - ROTSE3 file GRB040408
  - 417 observations imaged over 4 hours
  - DEC: -20.40º, RA: 272.24º
  - Field located in Sagittarius (toward galactic center)
- **ANALYSIS:**
  - University of Michigan ROTSE IDL library, ported to SMU
  - Examine raw images, drop poor ones
  - Process & calibrate raw images
  - Generate light curves
  - Investigate time variation of optical light output for variable star candidates
  - Identify short period pulsating variable stars (δ Scuti), or other variable types (eclipsing binary, contact binary)





ROTSE3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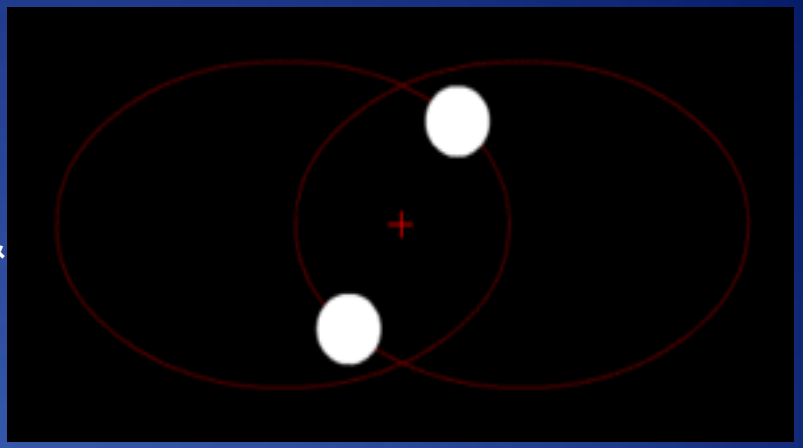
& TELESCOPE


Sagittarius

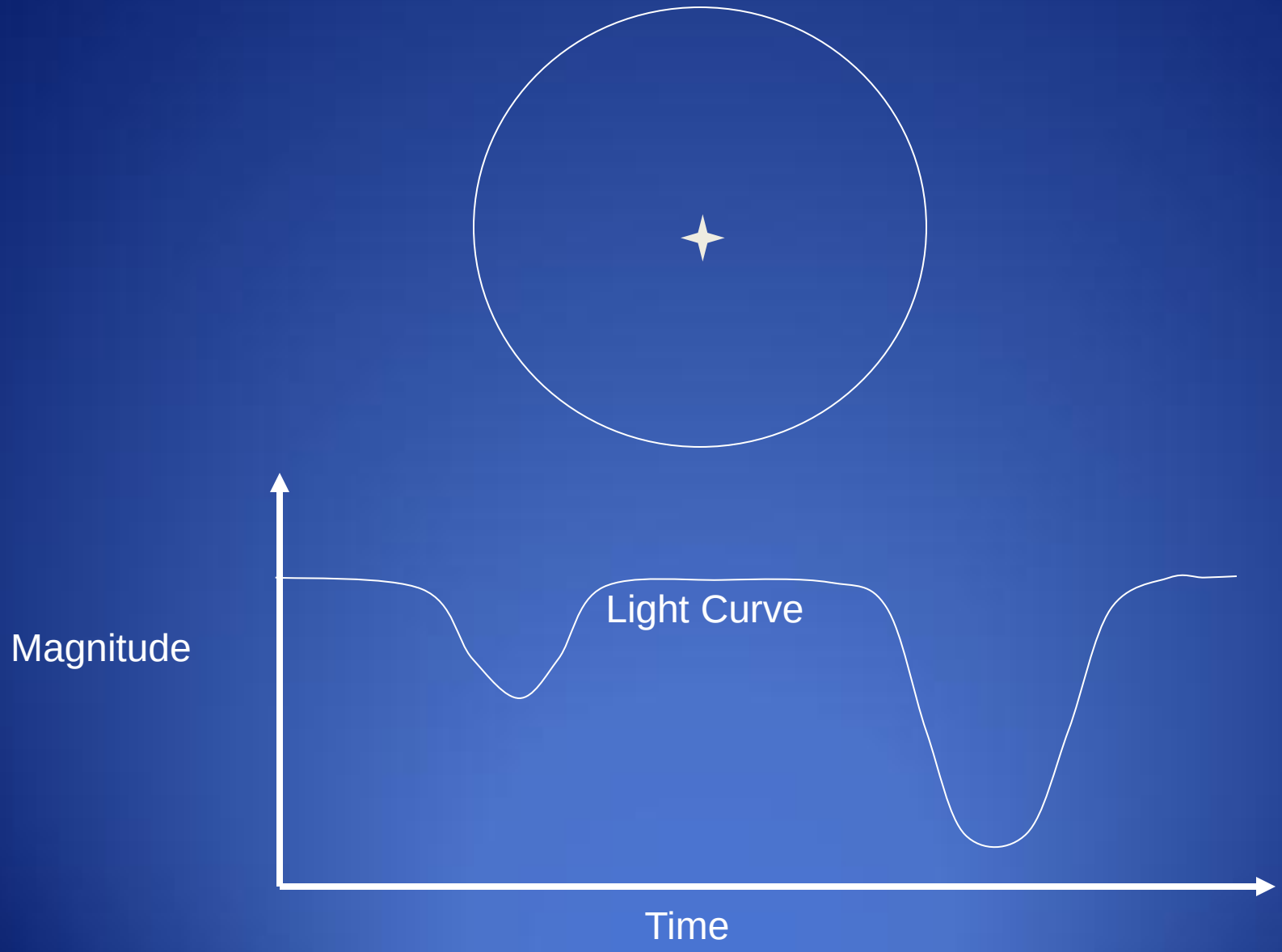
Binary Stars

- Best method available to determine the mass of a distant star:
  - Orbit around their common center of mass; mass of individual stars can be determined using Kepler's laws & Newton's law of universal gravitation
  - Establishes relationship between a star's temperature, radius, & mass; allows for the determination of the mass of non-binaries
- Large proportion of stars exist in binary systems (estimated 1/3 of stars in Milky Way)
  - Binaries important to our understanding of the processes by which stars form
  - Period and masses of the binary reveal amount of angular momentum in the system
  - Provide important clues about the conditions under which the stars were formed



http://en.wikipedia.org/wiki/File:Orbit5.gif

Eclipsing Binary Stars

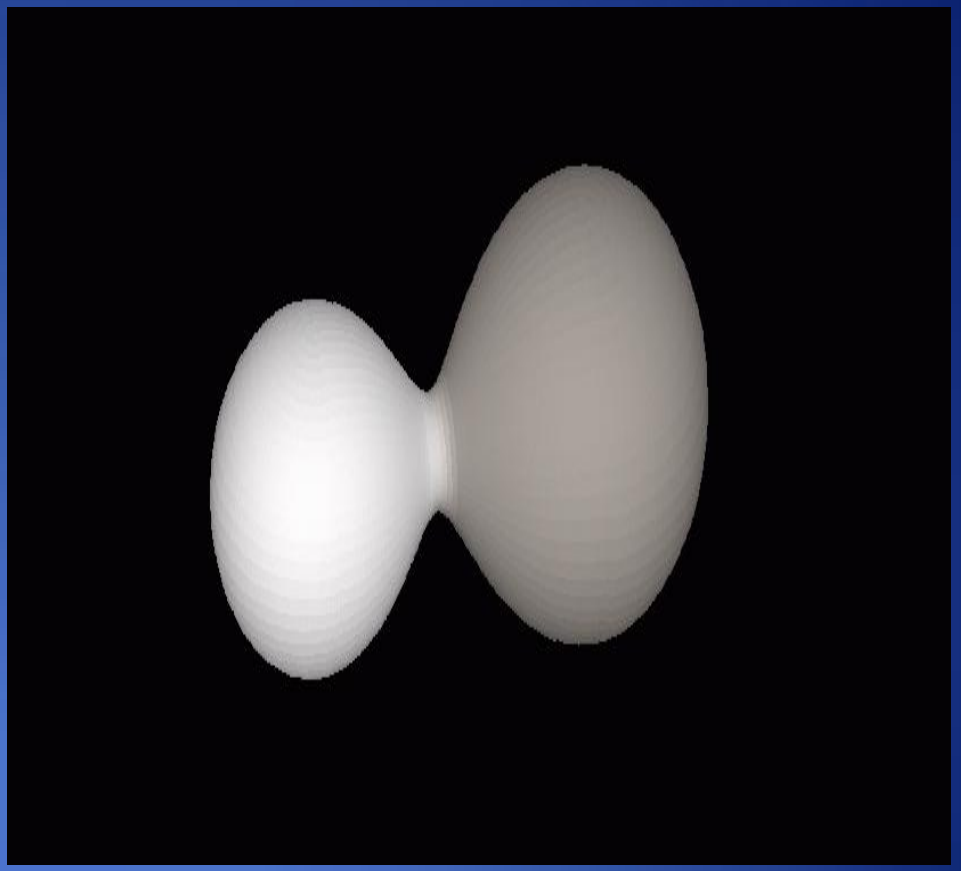


http://en.wikipedia.org/wiki/File:Eclipsing_binary_star_animation_3.gif

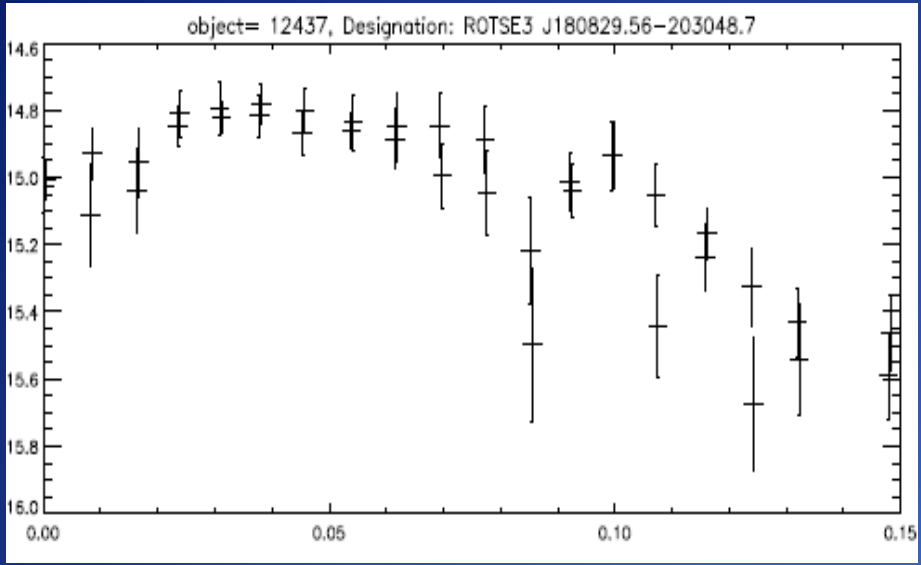
Eclipsing Contact Binary Stars

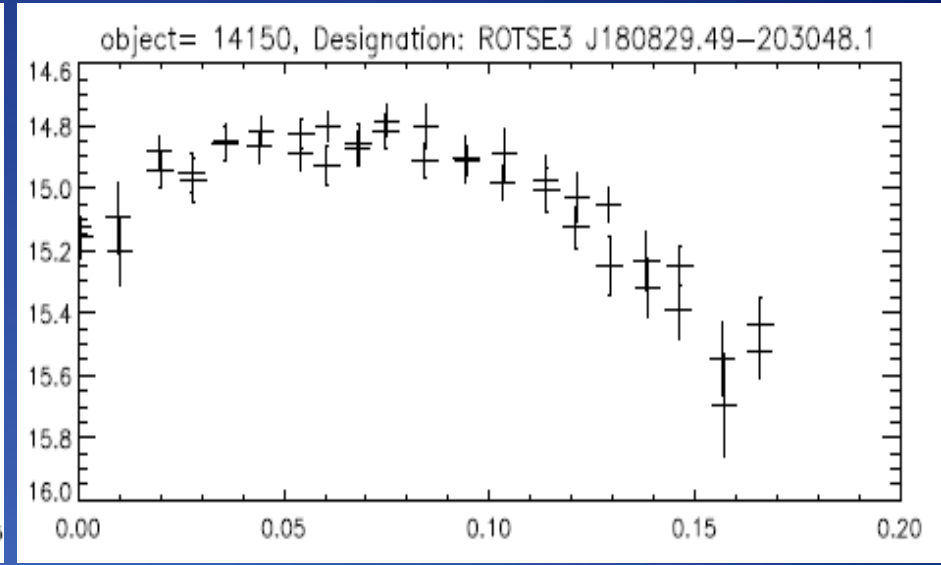
(W Ursae Majoris variables)

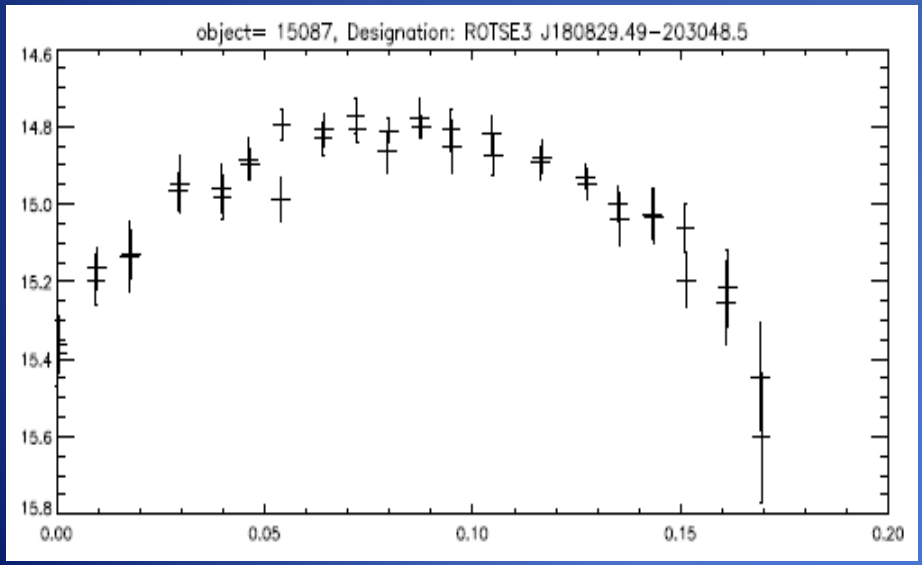
- Almost all known contact binary systems are eclipsing binaries
- **Contact binary**:
  - Component stars are so close that they are in contact with each other
  - Roche lobes filled: region of space around a star in a binary system within which orbiting material is gravitationally bound to that star
  - Uppermost part of the stellar atmospheres forms a common envelope that surrounds both stars & shared by both
  - As the friction of the envelope brakes the orbital motion, stars may eventually merge

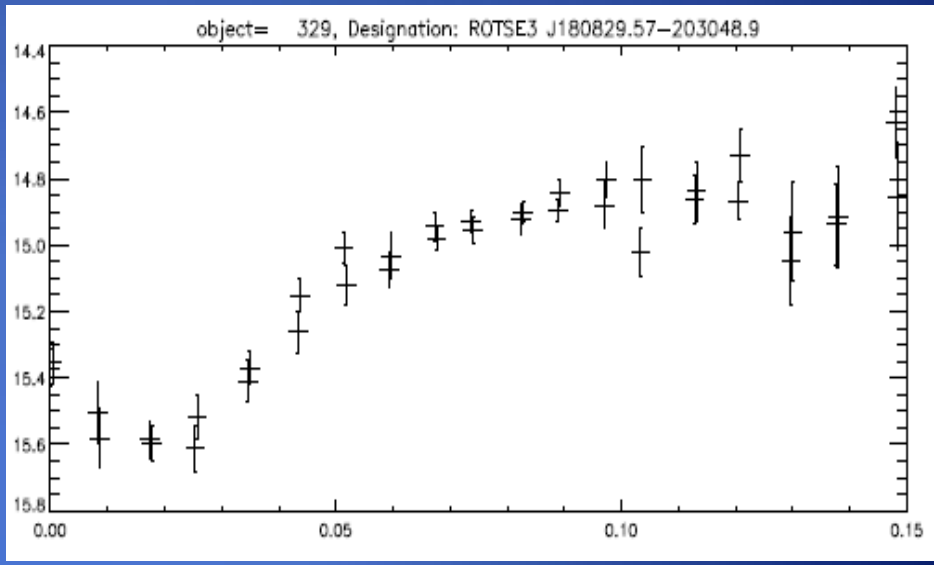


Candidate Contact Binary Star









Work in Progress

- Confirm variable identification
- Physics:
  - Period
  - Mass
  - Luminosity
  - Spectral class
  - Model properties using simulation software
- If variable star is previously unidentified -- submit to AAVSO for verification (maintains International Variable Star Index)

References

www.aavso.org

http://xxx.lanl.gov/archive/astro-ph

http://www.physics.smu.edu/kehoe/astro/papers/

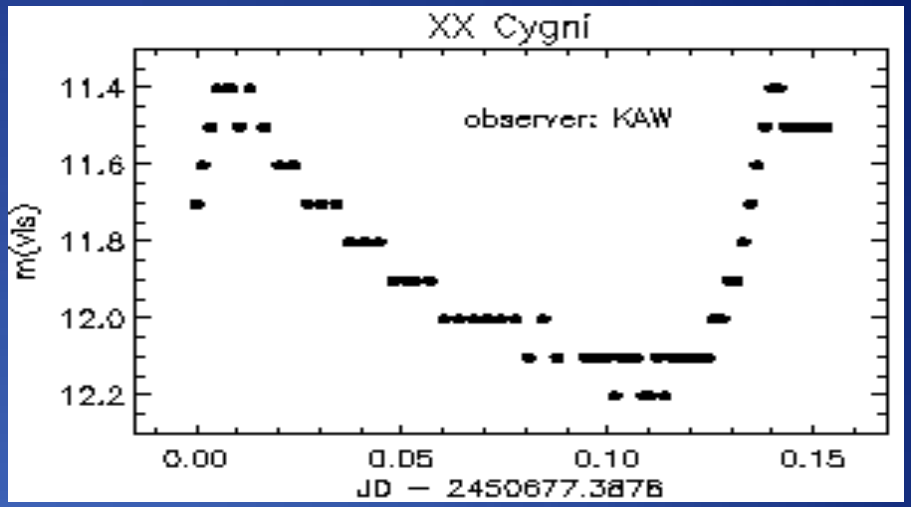
http://www.midnightkite.com/binstar.html

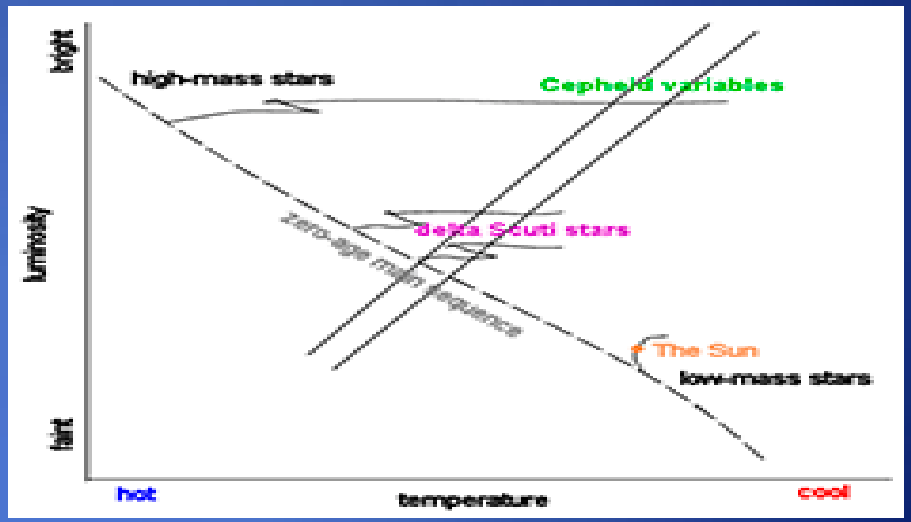
www.rotse.net

http://www.univie.ac.at/tops/

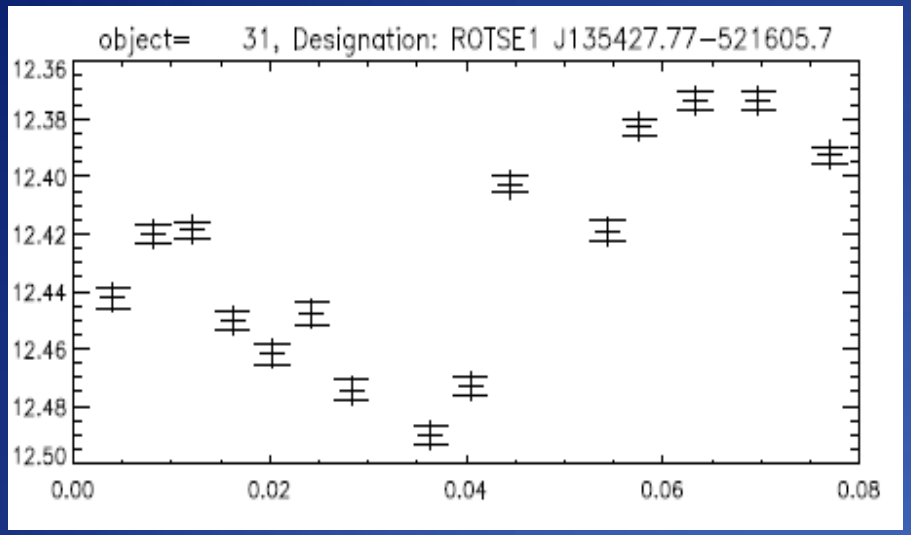
Delta Scuti Variable Stars

- Low amplitude pulsating variables
- Some have amplitudes of about one magnitude & regular light curves
  - Radial pulsations
  - One dominant pulsation mode
- Others have complex light curves & multiple periods with smaller light variations
  - Radial & non-radial pulsations
  - May have multiple modes of oscillation
- Reside near instability strip of HR diagram
- Importance:
  - Asteroseismology: pulsations used to study interior structure
  - Standard candles (higher amplitude)





ROTSE 1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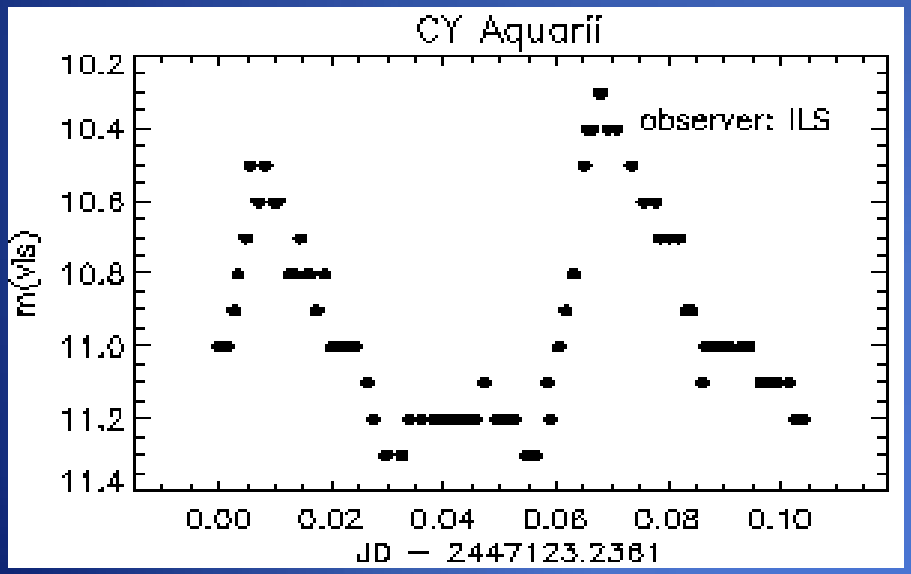
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