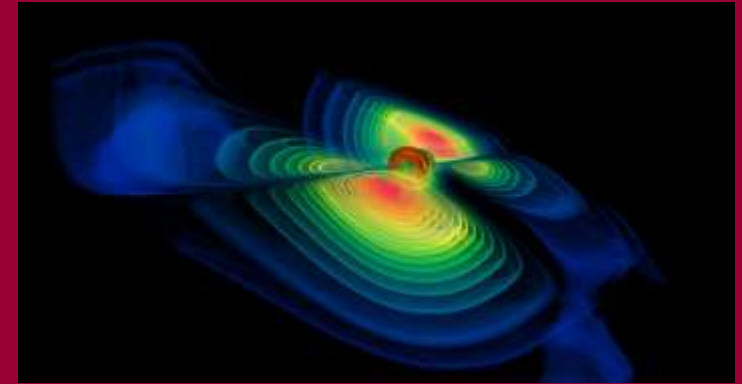


# Gravitational Waves, Asteroids and Occultation's

Culpeper Astronomy Club Meeting  
October 22, 2018



# Overview

- Introductions
- Gravitational Waves (Max Dubnowski)
- Asteroids and Occultation's (Mike Klosterman)
- Constellations: Aquarius, Pegasus, Pisces
- Observing Session

# Observing Sessions

- 30 September (MCO)
  - 30" Dob and 4.3" refractor
  - Jupiter, Saturn, and Mars
  - Some doubles (Polaris, Albireo, Almach)
  - Some DSO's (M13 and M22)
- 22 October (MCO)
  - Orionids Observing Session
  - Naked-eye and bino's
  - 30-40 meteors observed
  - Mostly sporadic meteors
  - Great skies after moon set

# *GRAVITATIONAL WAVE THEORY*

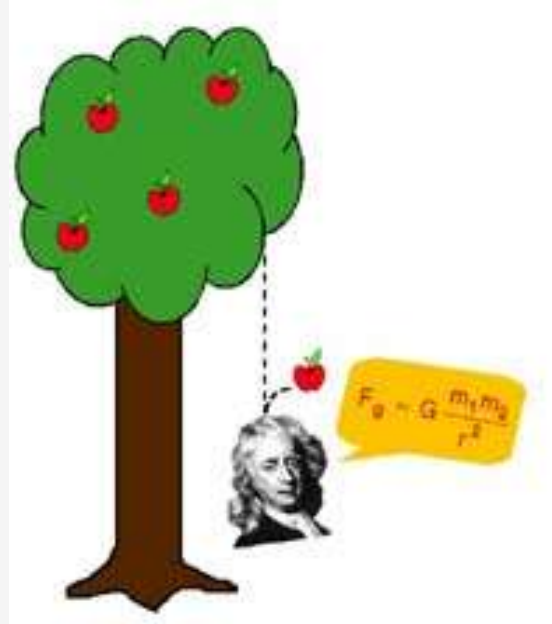
*Presented By Max Dubnowski*

# *Isaac Newton*

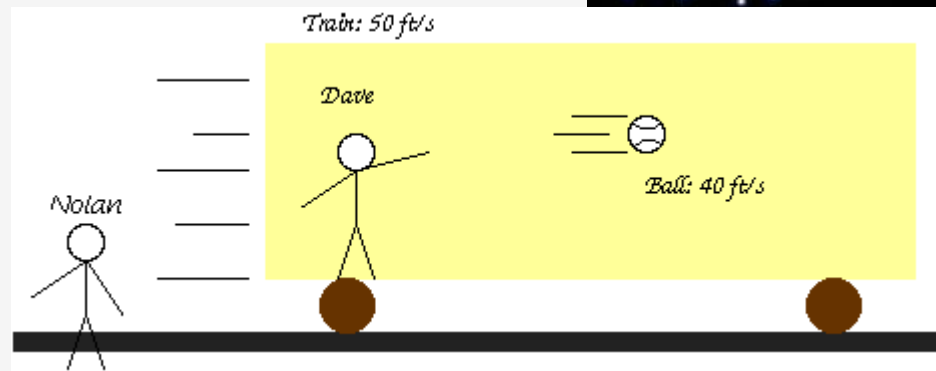
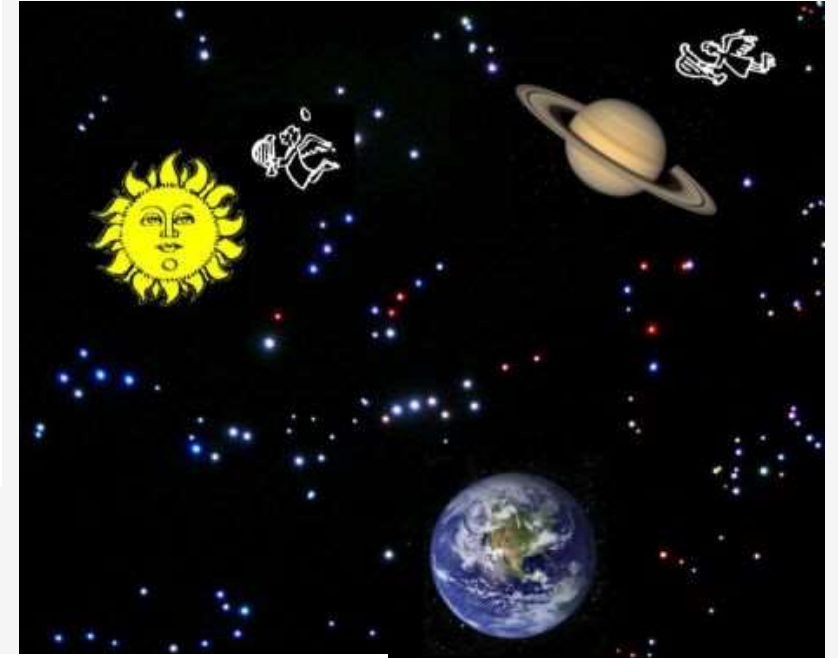
Inverse Square Law

Galilean Relativity

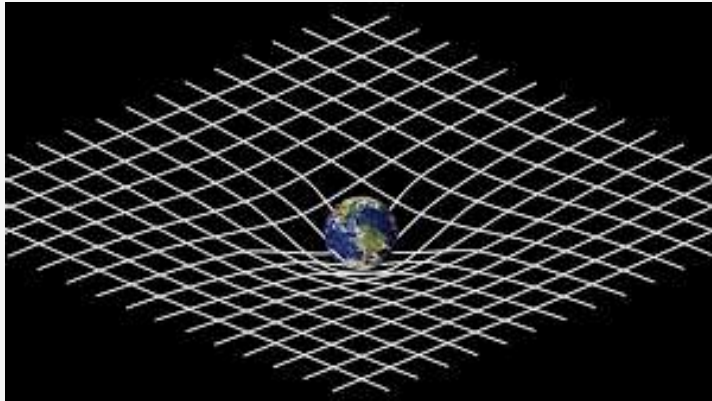
Angels flap their wings



# *How Gravity Works*



# *Albert Einstein*



$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = 8\pi GT_{\mu\nu}$$

## *Why Gravity Works*

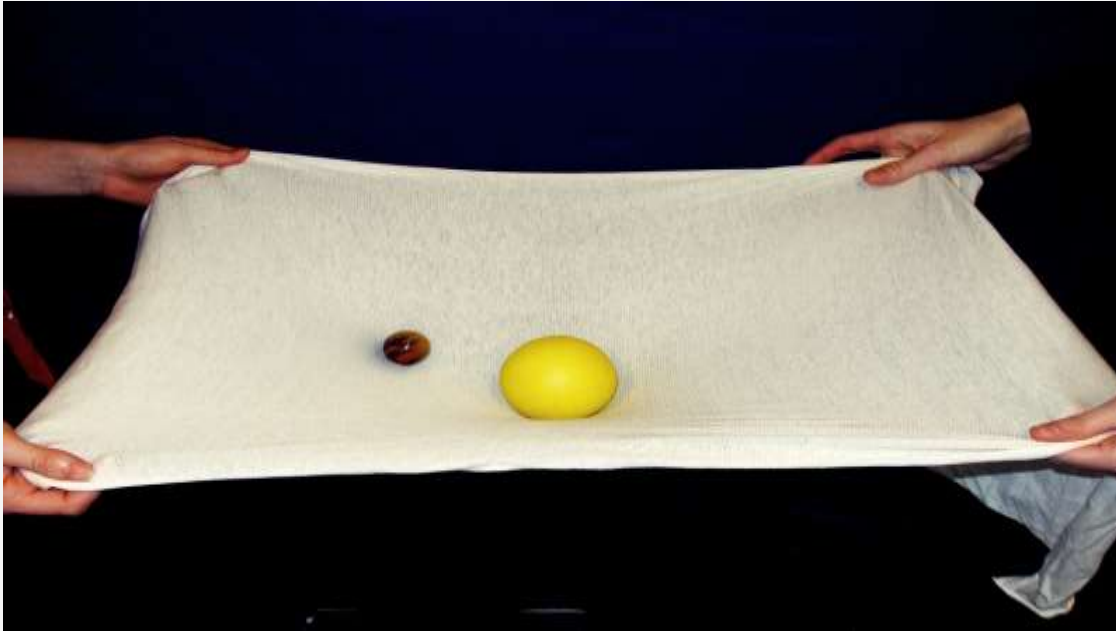
### *Special Relativity*

- Describes the idea of a single dynamic entity called space-time
- Massless particles cannot travel at any speed except the speed of light
- Massive particles cannot reach the speed of light

### *General Relativity*

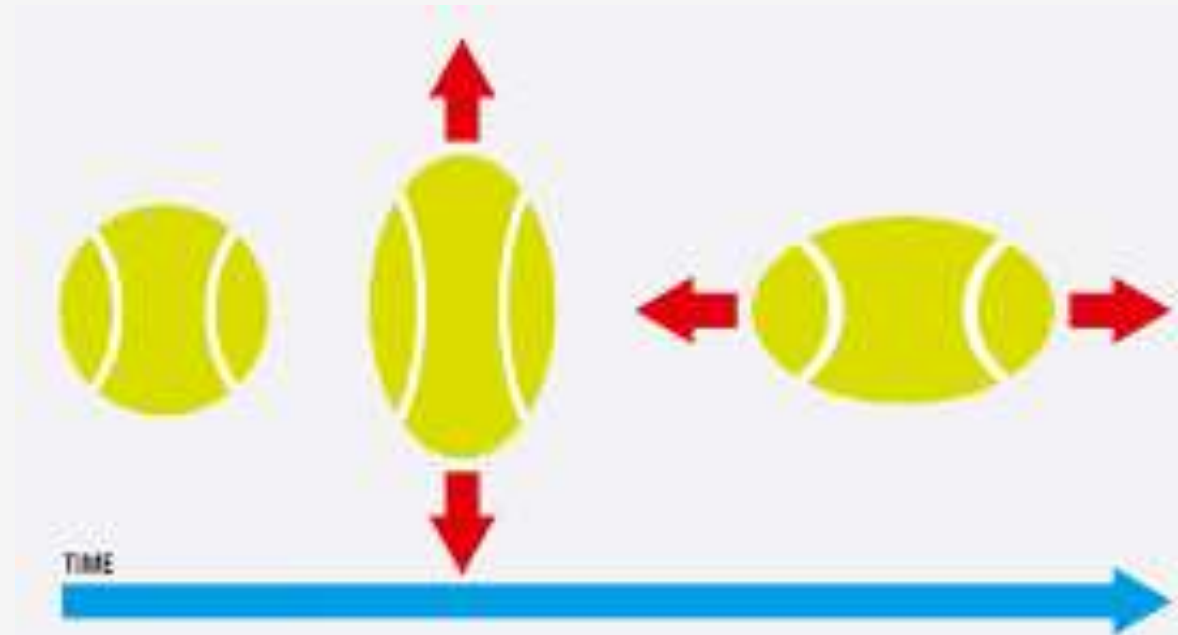
- Describes how energy warps space-time
- $R=GE$ ;  $R$ =Curvature of space-time,  $E$ =Energy,  $G$ =Gravitational constant

# *Picture This*



“Just as tossing a pebble into a pond generates outward spreading water ripples; a distant supernova explosion is like a cosmic pebble that’s tossed into a space-time pond.”  
-Brian Greene in *The Fabric of the Cosmos*

Interaction	Strength (relative to Strong)	Range/m
Gravitational	$10^{-38}$	~infinite
Strong	1	$10^{-15}$
Electromagnetic	$10^{-2}$	~infinite
Weak	$10^{-6}$	$10^{-18}$



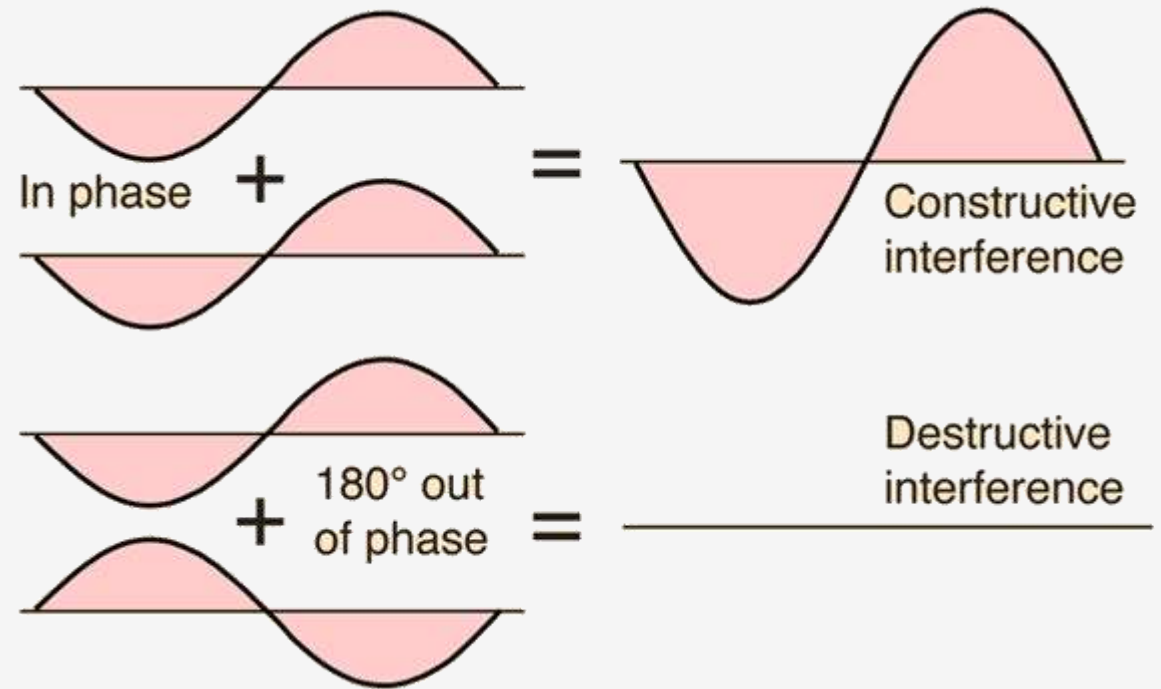


# *Joseph Weber and Birth of LIGO*

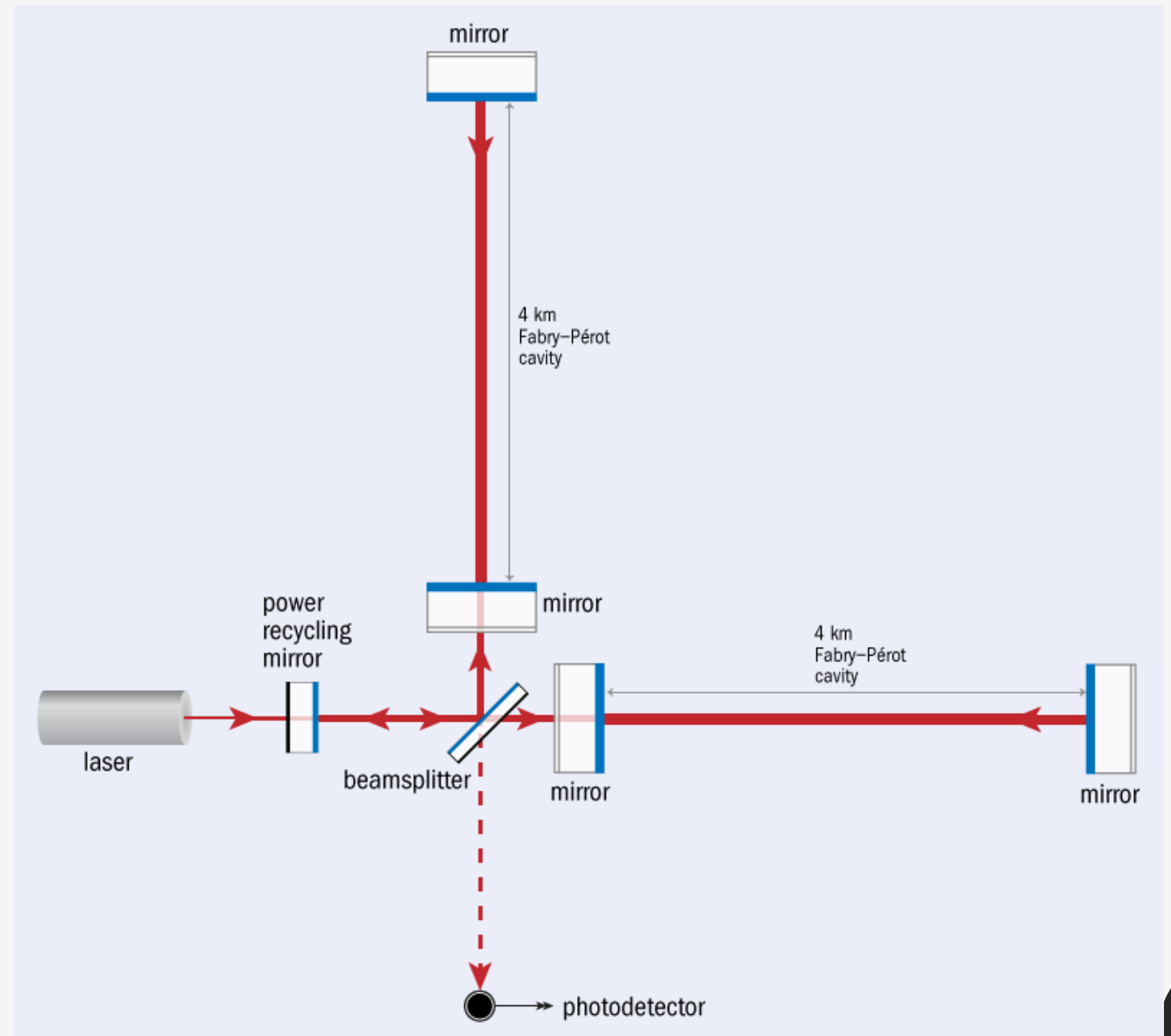
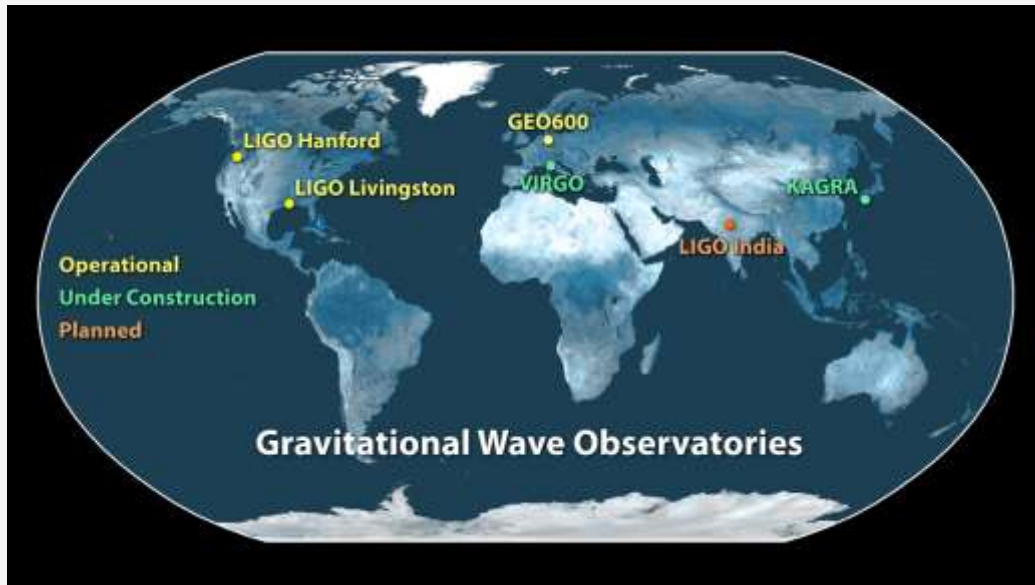




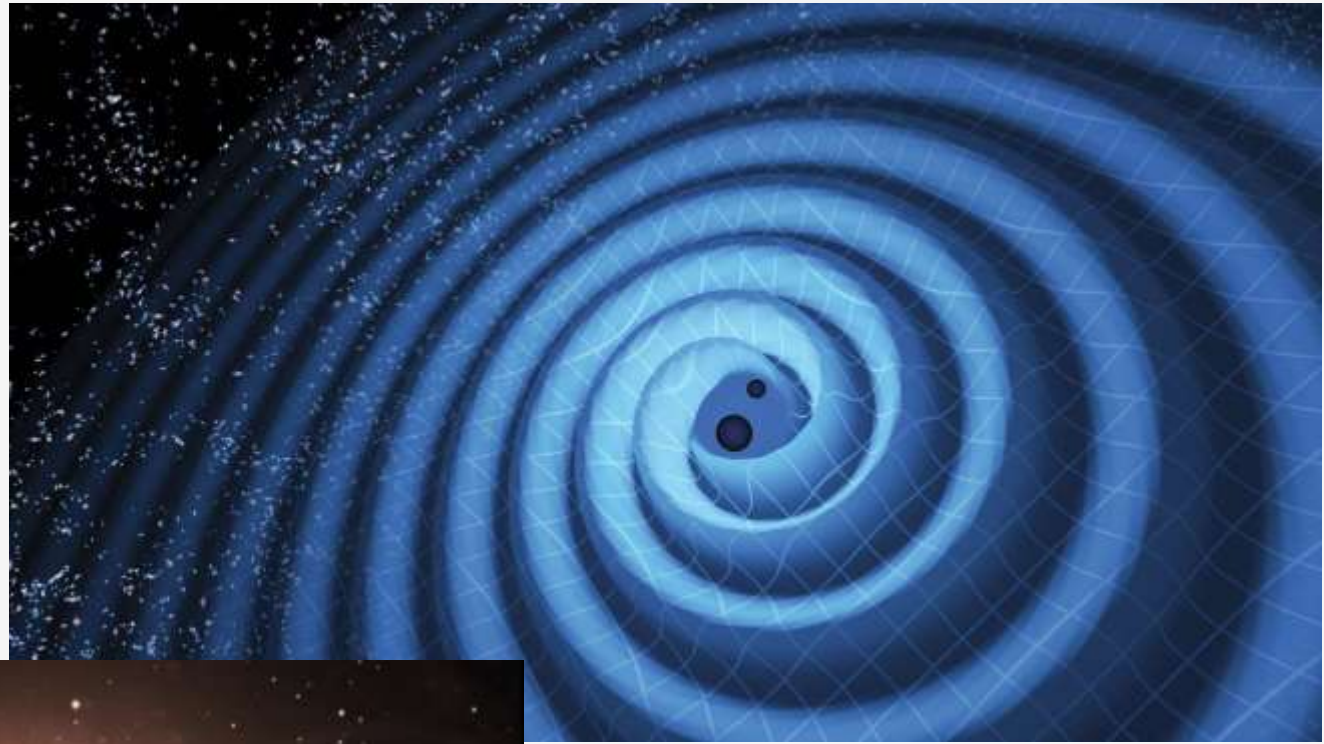
# *Interference*



# *LIGO and VIRGO*



*Used to Study  
Black Holes  
and Massive  
Supernova*







# Asteroids & Asteroid Occultations

Mike Klosterman

# Overview

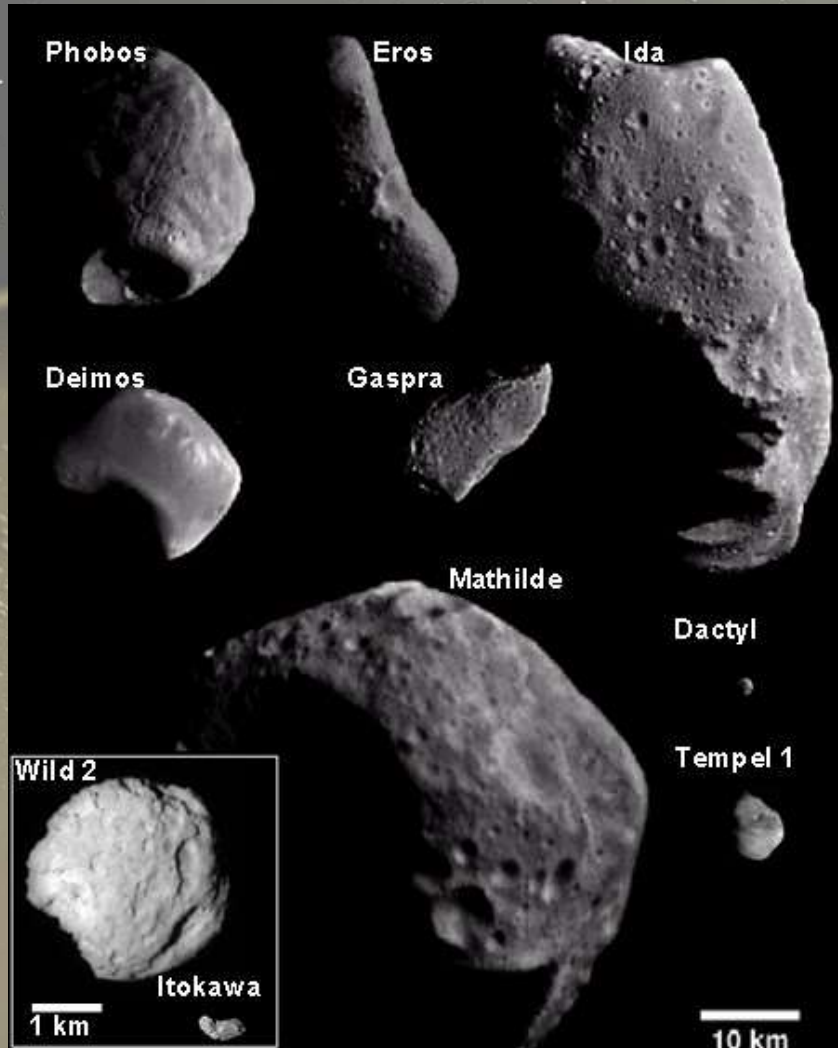
- What are Asteroids?
- Different Types/Sizes/Composition
- Where are they?
- Occultations
  - What is it?
  - How do you do it?
  - Why?
- Equipment and Stories



# Asteroids- What are they?

- A Diverse Group of Small Celestial Bodies in Solar System that Orbit our Sun
- “Asteroid”- Greek Meaning “star-like”
- AKA Minor Planet, some countries call it “Planetoid”
- Asteroids generally Rocky while Comets are icy/dusty (“Dirty Snowball”)

# Typical Asteroids



- NEOs
  - Atens
  - Apollos
  - Amors
- Main Belt
  - Some are planetary moons
- Trojans
- Centaurs
- Trans Neptunian Objects (TNOs)

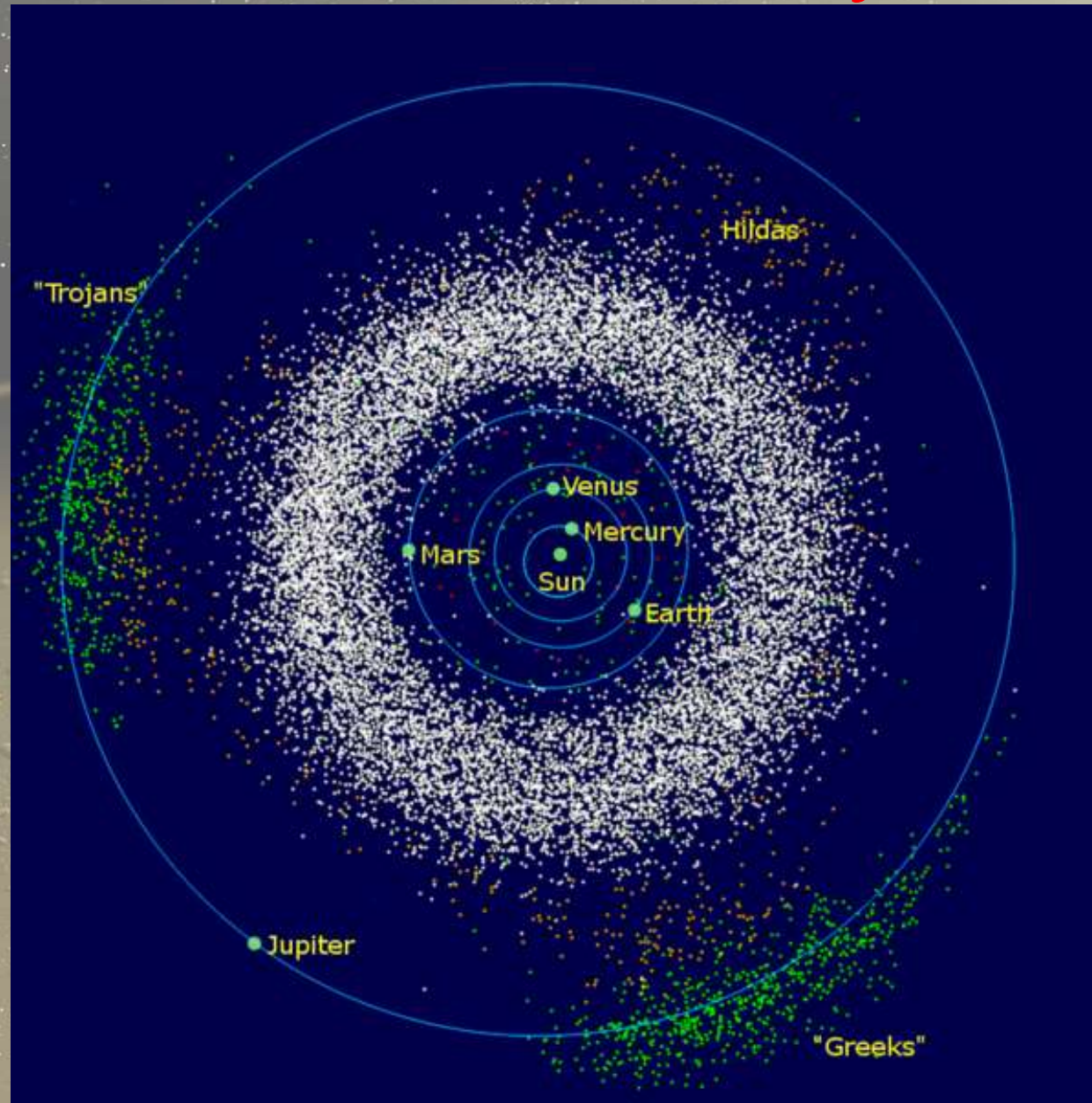


# Asteroids Composition



- C-type asteroids - carbonaceous, 75% of known asteroids
- S-type asteroids - silicaceous, 17% of known asteroids
- M-type asteroids - metallic, 8% of known asteroids

# Where are they?

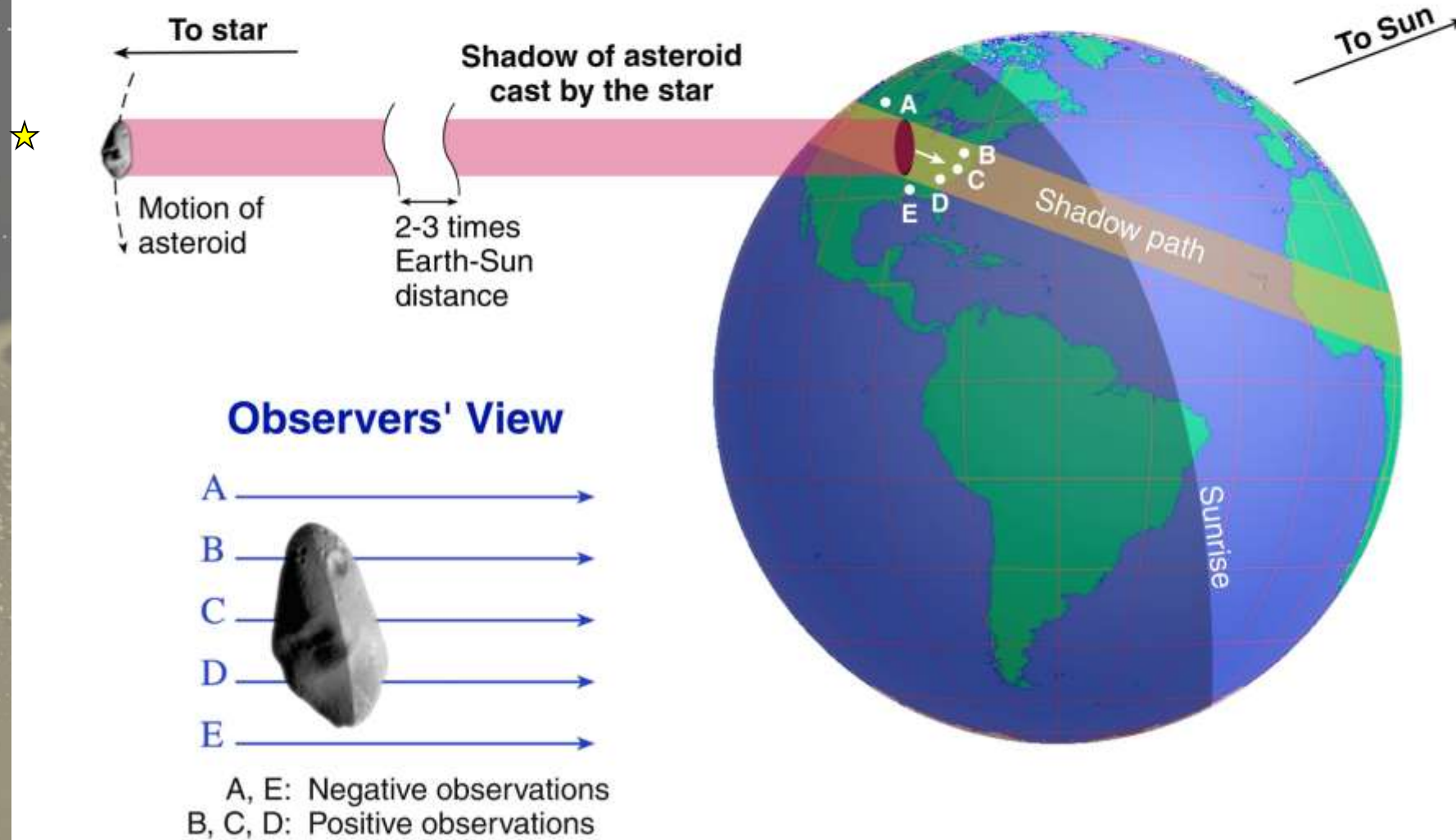




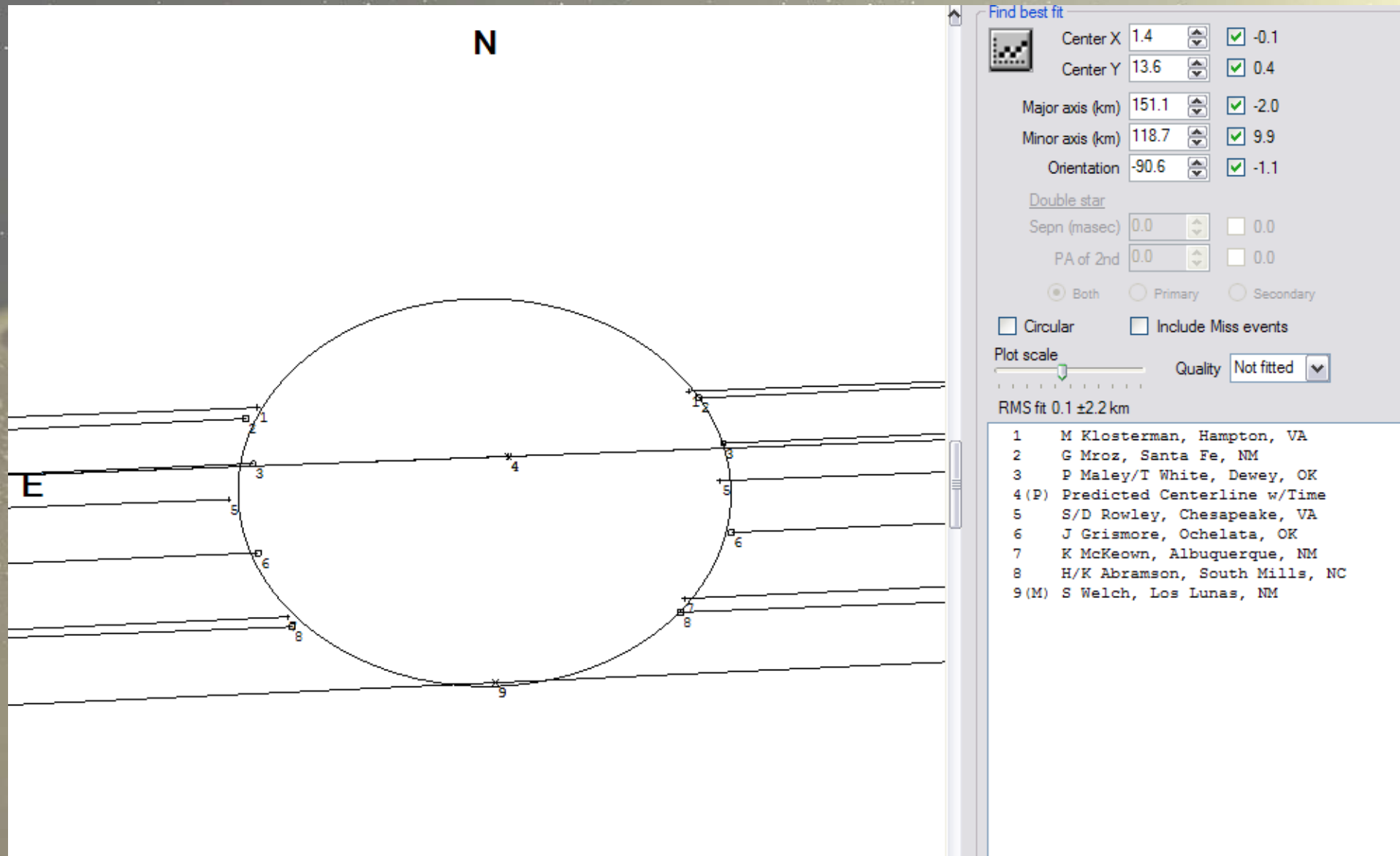
# Asteroid Occultations

- Indirect Measurement
  - Shape
  - Size
  - Satellites of Asteroid
- Using Accurate Timing, Position, and Recording
  - Disappearance and Reappearance
- More Observers = Better Results

# Geometry of an Asteroid Occultation

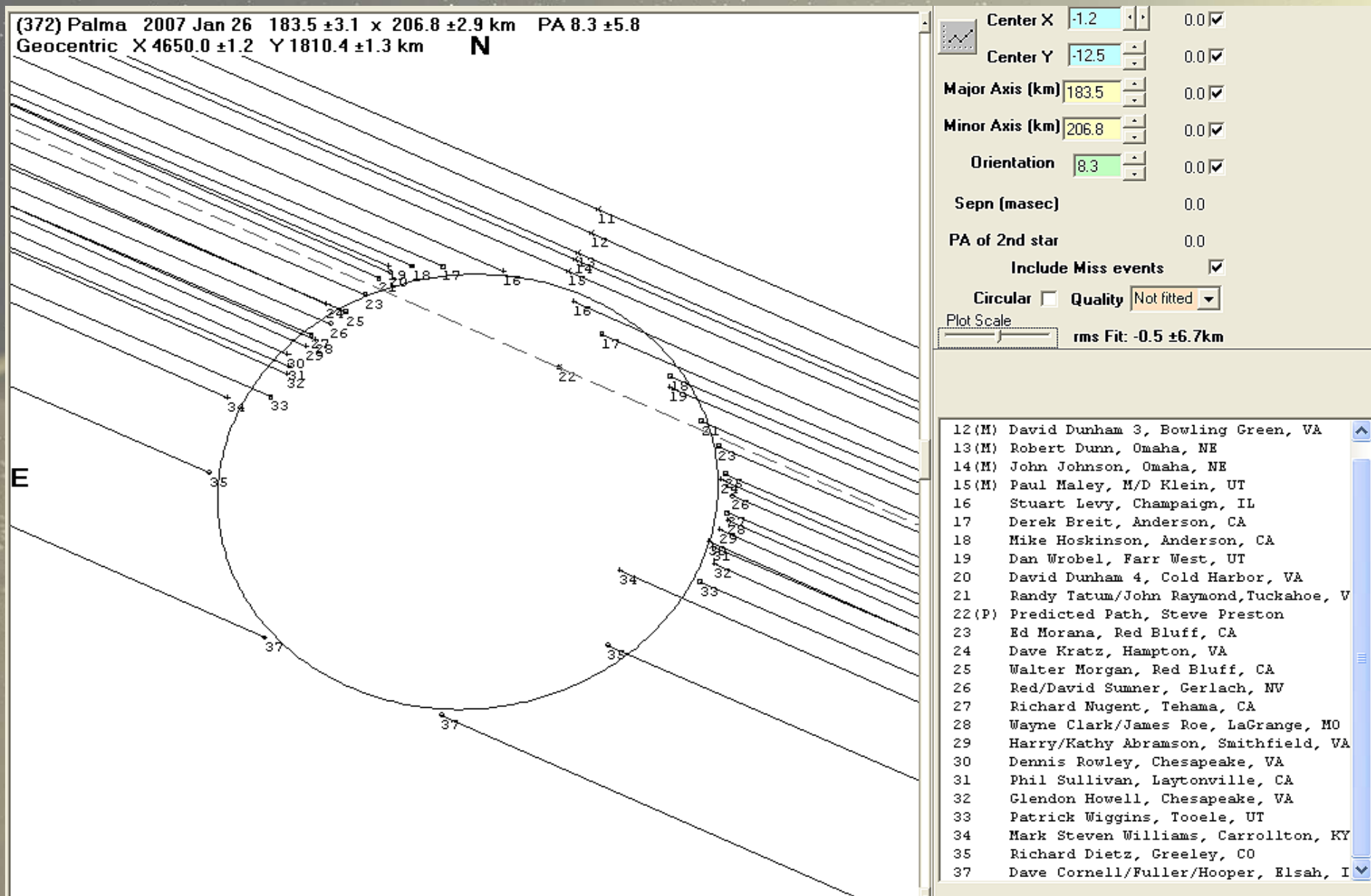


# 187 Lamberta 20 Dec 07



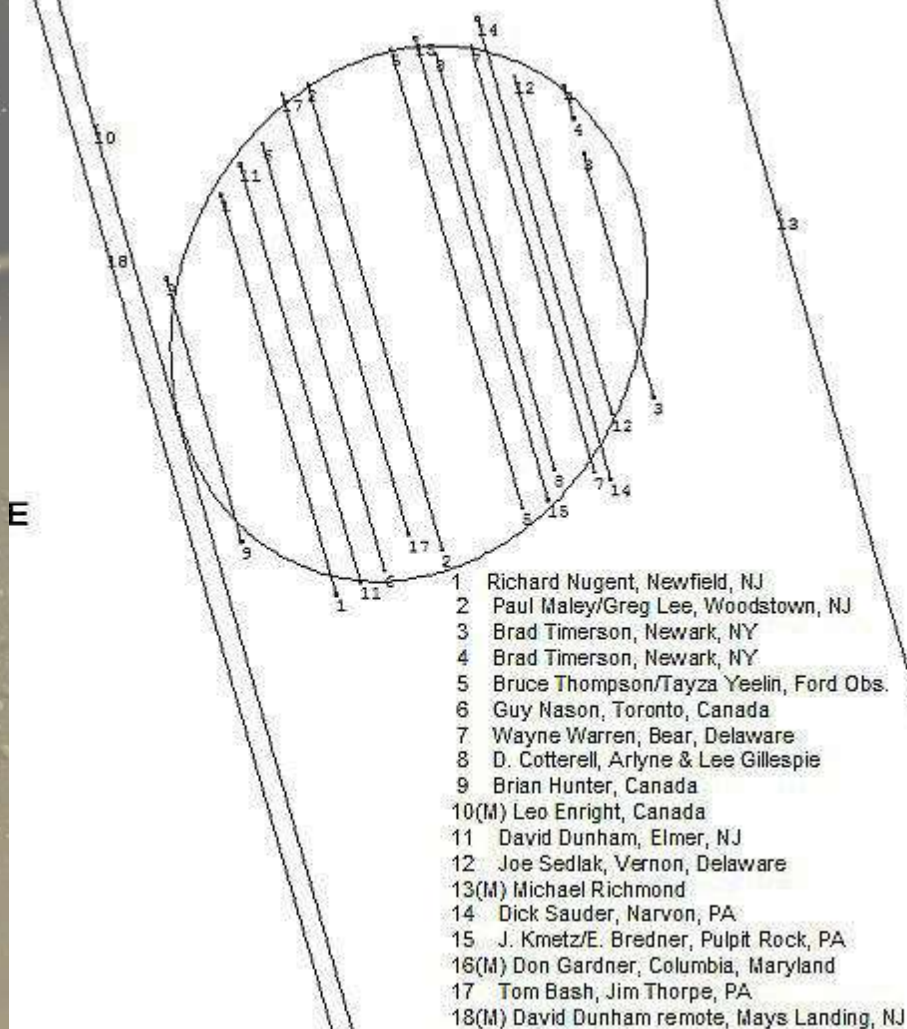


# 372 Palma 26 Jan 07



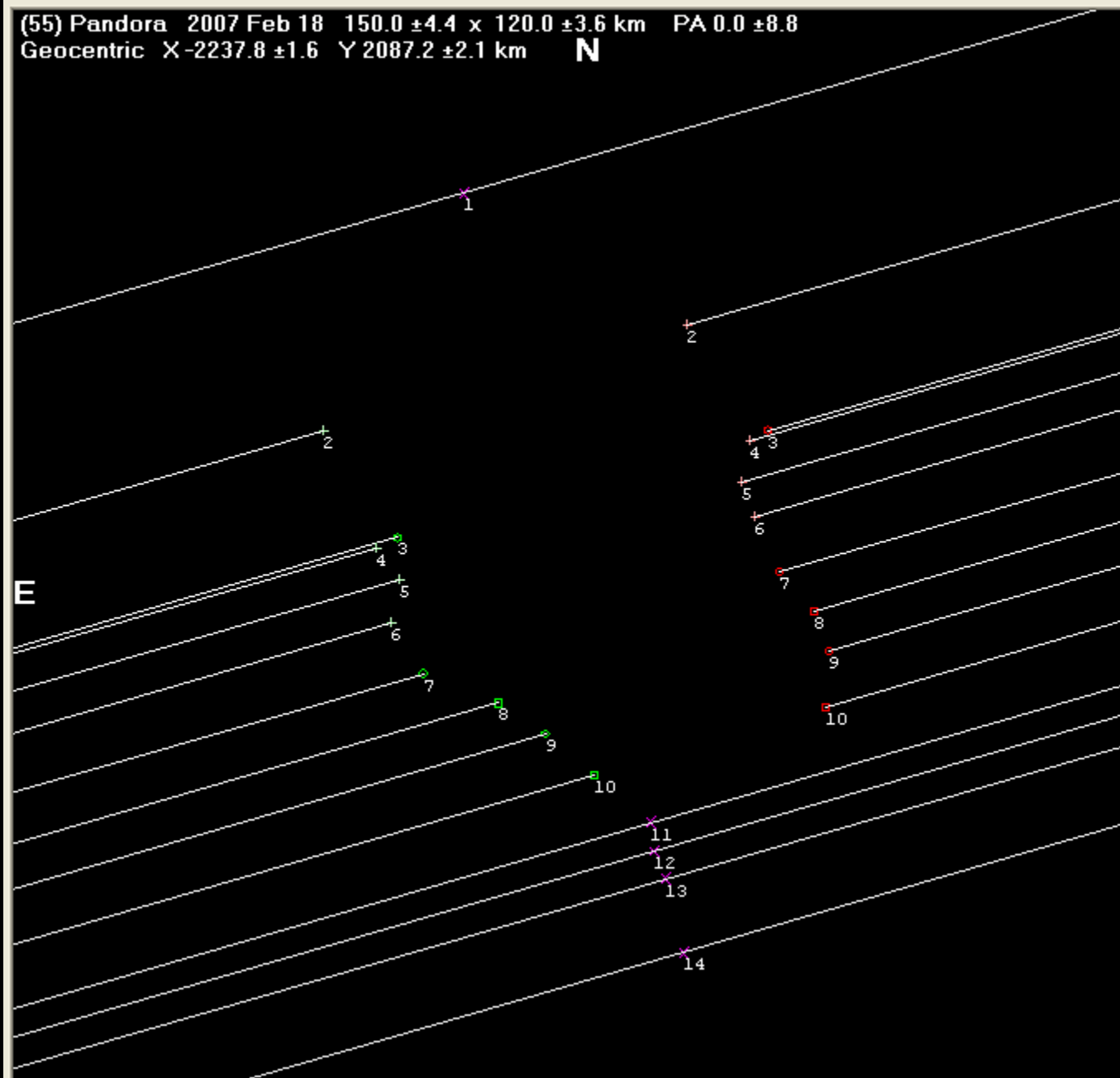
# 25 Phocaea 3 Oct 06

(25) Phocaea 2006 Oct 3  $85.5 \pm 0.9 \times 72.0 \pm 1.0$  km PA  $-23.8 \pm 3.9$   
Geocentric X  $-3313.6 \pm 0.4$  Y  $2604.6 \pm 0.4$  km **N**





(55) Pandora 2007 Feb 18  $150.0 \pm 4.4 \times 120.0 \pm 3.6$  km PA  $0.0 \pm 8.8$   
Geocentric X  $-2237.8 \pm 1.6$  Y  $2087.2 \pm 2.1$  km **N**



# Why Occultations?

- Discovery
- Research Contribution
- Fun!
- More Information Avail:

<http://lunar-occultations.com/iota/iotandx.htm>

<http://www.occultations.org/>

<http://iota.jhuapl.edu>

<http://www.eclipsetours.com/occultationa>

<http://asteroidoccultation.com>



# Equipment & Event Description





# Asteroid Occultation Video Capture

# Why Use Video Capture?

- ⊕ Minimize chances of missing the event
- ⊕ Highest possible timing accuracy
- ⊕ Allows backup options in case of equipment problems
- ⊕ Able to set up multiple remote stations
- ⊕ Chance to play with cool electronic stuff

# Una Occultation (and “new Double Star”)– 24 Jan 2011

<https://www.youtube.com/watch?v=c8hsUFhyrQI>





# Typical Low-Light Video Images



Canon Low-Light  
Camcorder  
2.0 Lux



Special Night Vision  
Video Camera  
0.01 Lux





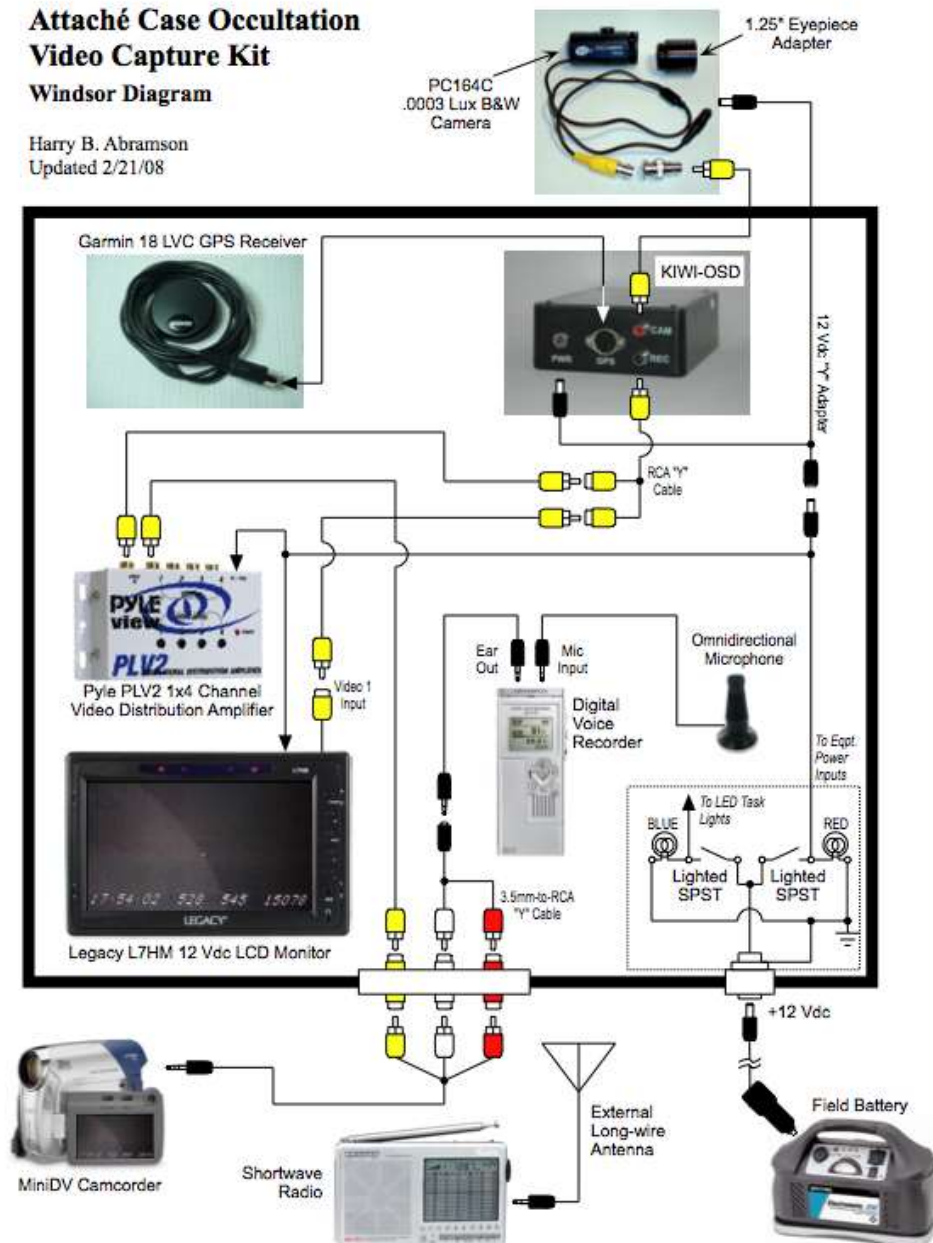
# PC164C Super Low-Light Video Camera



0.0003 Lux

# **Attaché Case Occultation Video Capture Kit** **Windsor Diagram**

Harry B. Abramson  
Updated 2/21/08





# Occultation Video Capture Kit



# Video Capture Kit (Closeup)





# Video Capture Kit in Operation



# Telescope & Video Kit at Viewing Site



Celestron CPC 925 Schmitt-Cassegrain Telescope

# Telescope & Video Kit at Viewing Site

The computerized “GoTo” telescope is now centered on the target star and tracks it automatically.

Kathy is monitoring the image from the PC164C camera through the video monitor built into the briefcase kit.

The camcorder is recording the image of the star on digital tape, along with the high-precision time stamp.



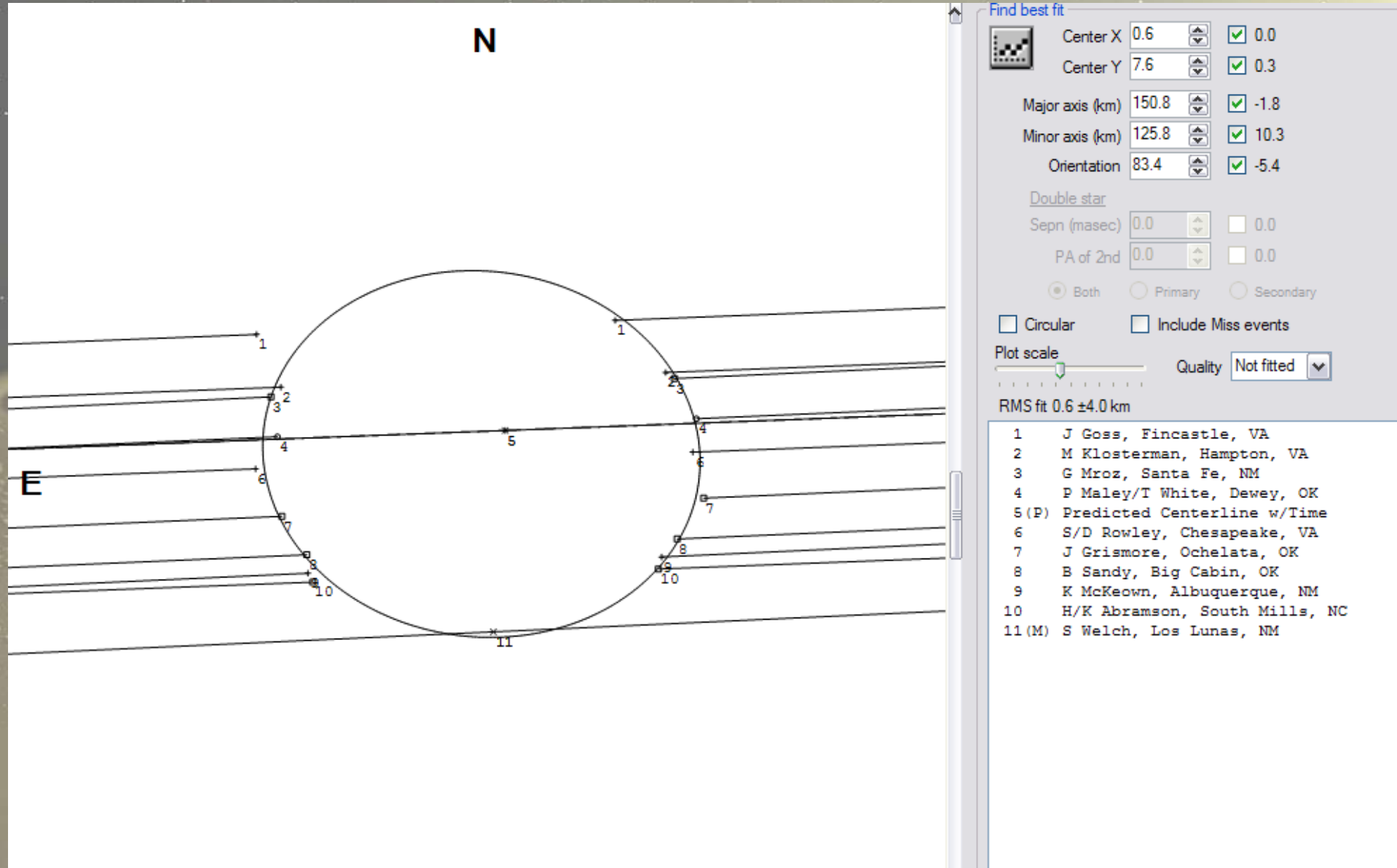




(187) Lamberta – 20 December 2007



# (187) Lamberta – 20 December 2007

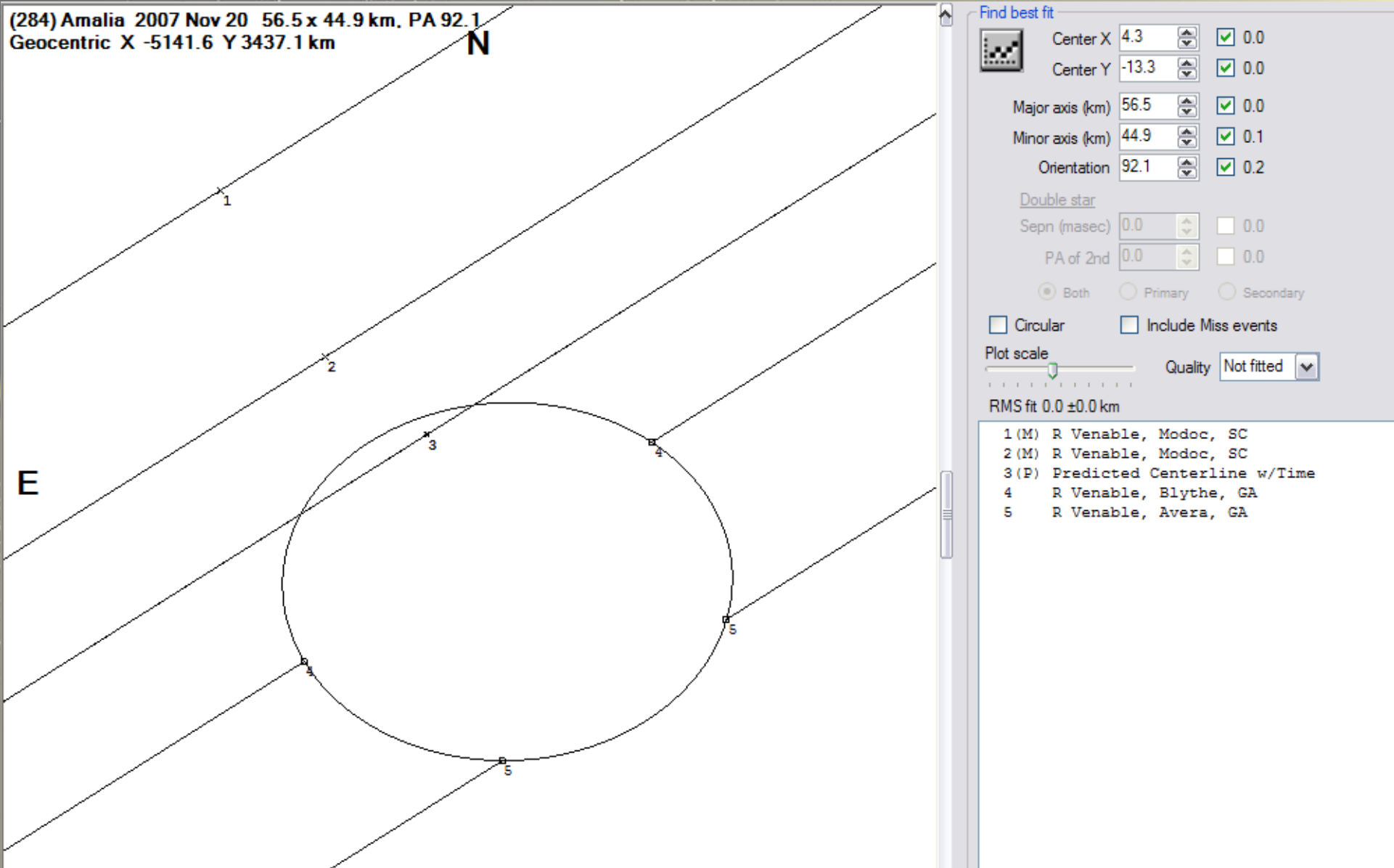




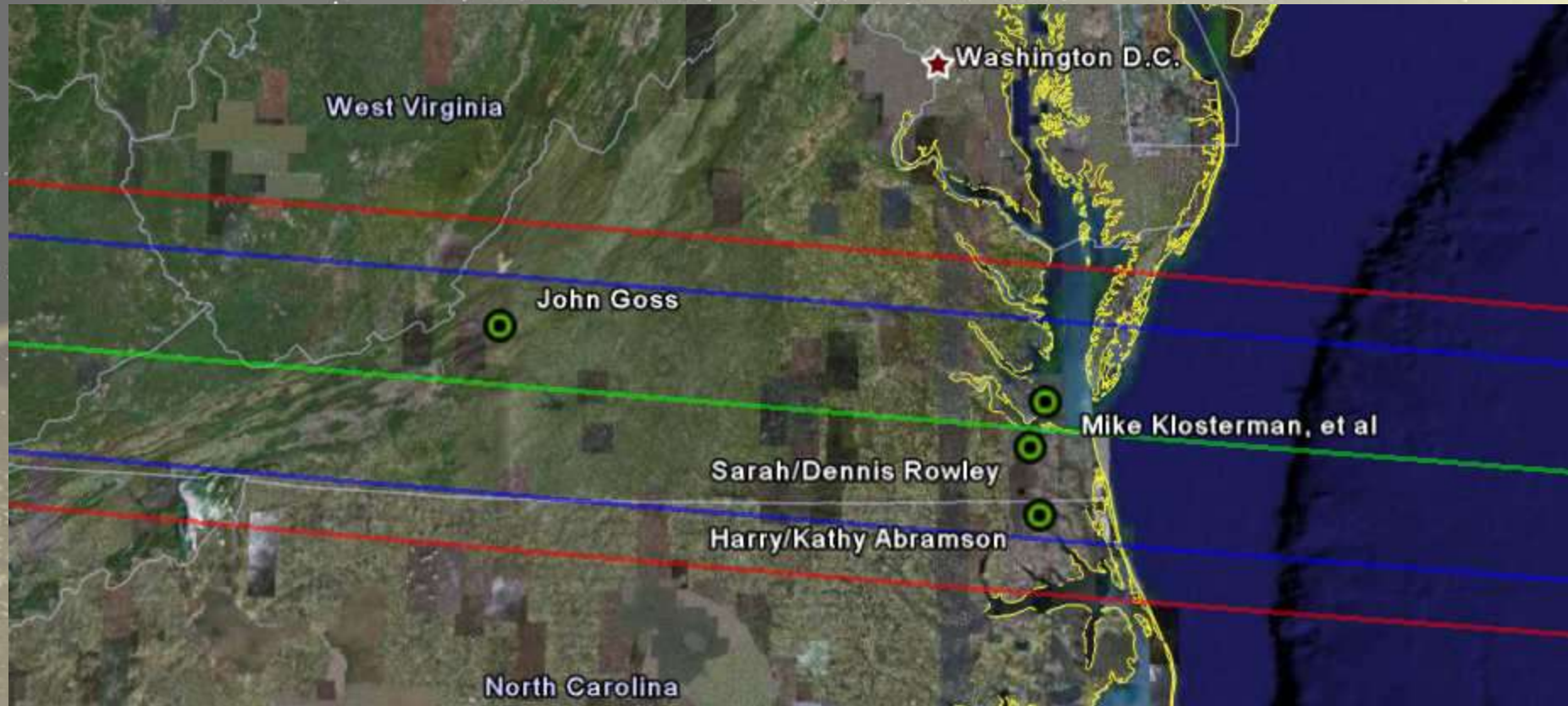




# (284) Amalia – 20 November 2007



## (187) Lamberta – 20 December 2007





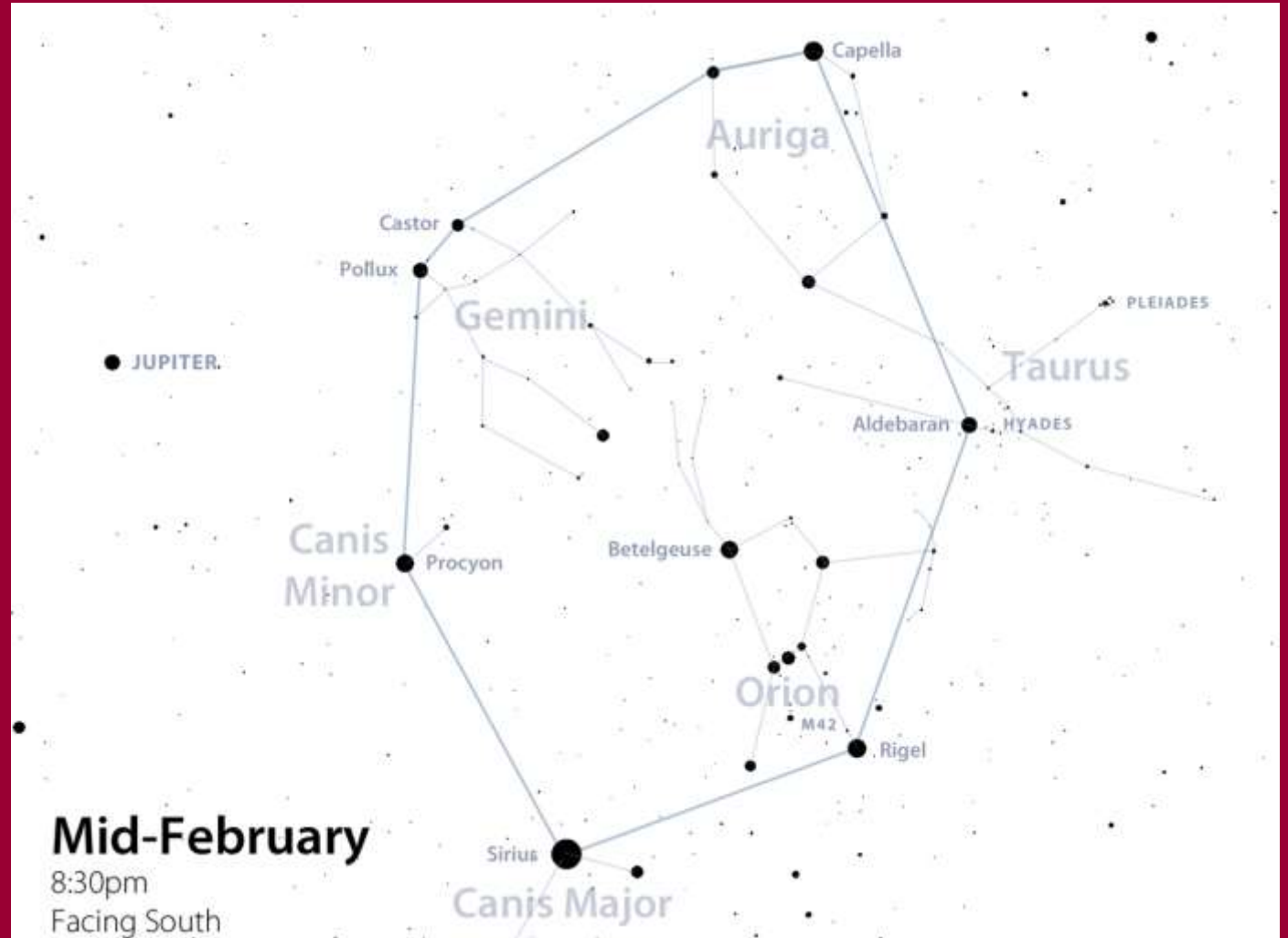
A space scene featuring a ringed planet in the upper left, a bright sun in the upper right, and a field of asteroids in the foreground. The word "Questions?" is written in red in the center.

**Questions?**



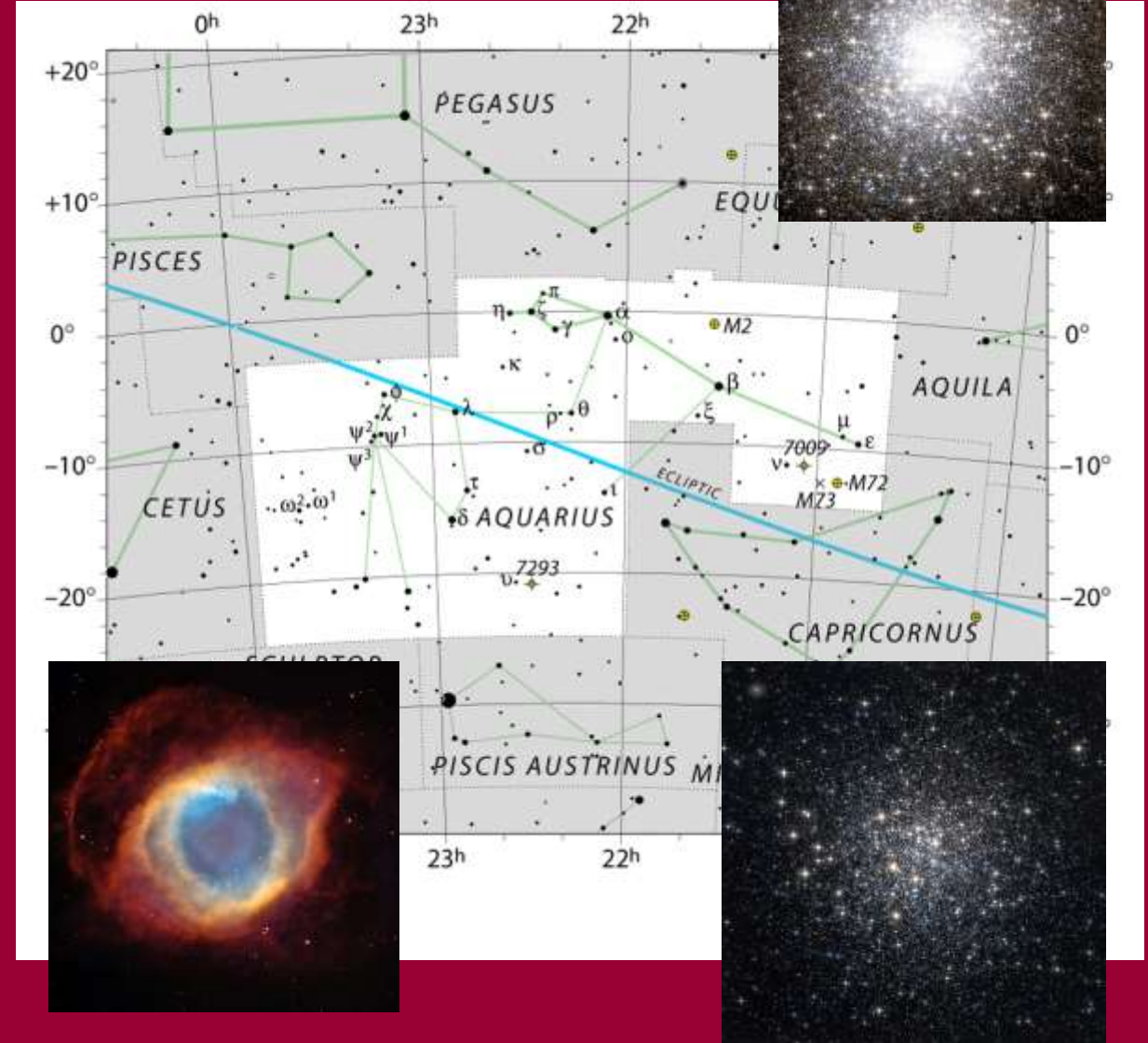
# Constellations

- The Winter Circle or Hexagon
- Orion can be used to locate several Winter constellations
- Will explore several starting in November
- Three this evening
  - Aquarius, Water Bearer
  - Pegasus, The Horse
  - Pisces, The Fish



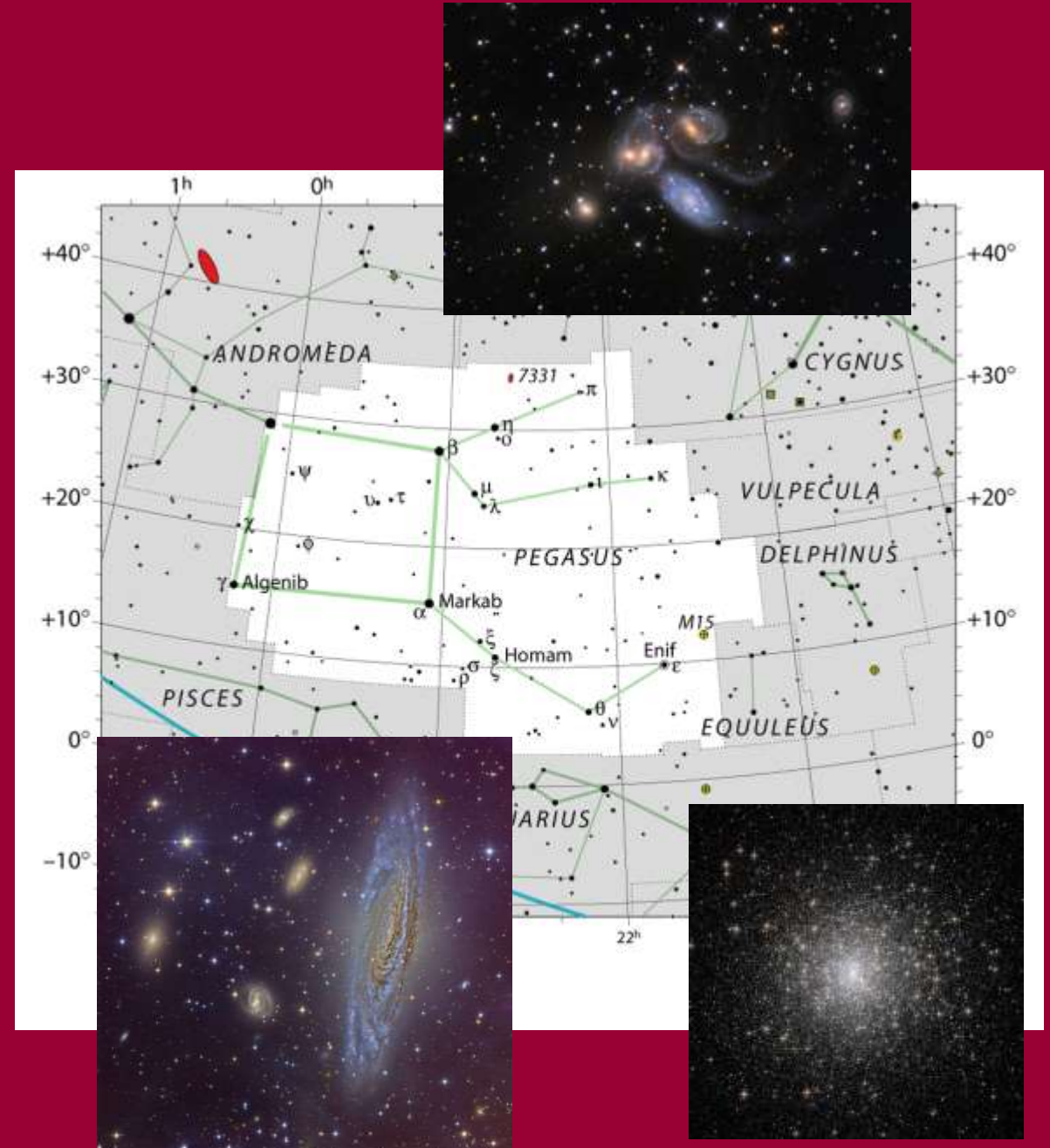
# Aquarius – “The Water Bearer”

- Aquarius is usually associated with Ganymede, the son of King Tros, in Greek mythology
- Double Stars:
  - 91 Aquarii: Triple star system 148 LY distant; pri (4.2 mag); sec (10 mag)
- Deep Sky Objects:
  - M2 - globular cluster; 13B years old; contains about 150K stars, including 21 variables; 175 LY diameter; one of the largest globulars
  - M72 - globular cluster; 53K LY distant; about 106 LY in diameter; apparent magnitude of 9.3; contains several blue giant stars and is considered to be a young cluster
  - NGC 7293 - Helix Nebula: large planetary nebula, one of the closest to Earth at 700 LY distant; nicknamed the “Eye of God”



# Pegasus – “The Horse”

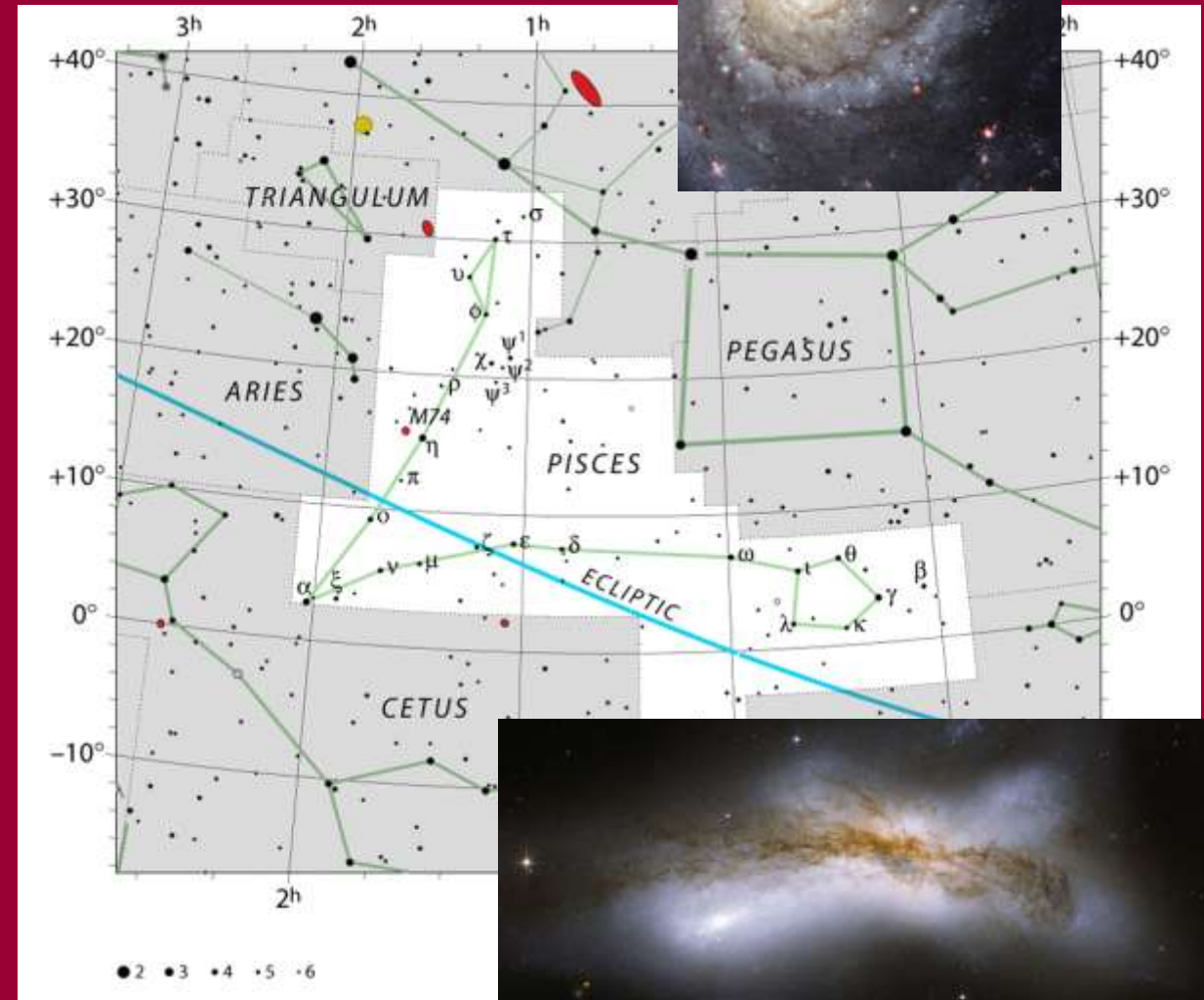
- It is one of the largest constellations in the sky
  - Named the winged horse in Greek mythology
  - Identifiable as the “Great Square of Pegasus”
- Double Stars:
  - Struve 2799: 1.9”; Matched White-white
  - Struve 2968: 3.3”: Yellow-Gray
- Deep Sky Objects:
  - M15 - Globular Cluster; one of the oldest at 12B years old; contains 100K stars; significant variables and pulsars
  - Stephan’s Quintet (of Galaxies) - Four of the five galaxies were the first compact galaxy group ever discovered; NGC 7320, is only 40M LY distant
  - NGC 7331 - Spiral galaxy; mag 10.4; 40M LY distant; similar to Milky Way





# Pisces – “The Fish”

- The Babylonians saw it as a pair of fish joined by a cord. The constellation is usually associated with the Roman myth of Venus and Cupid
- Double Stars:
  - Alpha Piscium - components separated by 1.8 arc sec; primary star (4.33 mag) and the companion (5.23 mag); period of 700 years
- Deep Sky Objects:
  - M74 - spiral galaxy seen face-on; 10 mag; 30M LY distant; textbook example of a grand design spiral galaxy; contains about 100B stars
  - NGC 520 - pair of interacting spiral galaxies about 90.7M LY distant; 12.2 Mag



# Meteor Showers

- Some of the best are listed below along with dates when the most meteors are visible
  - Quadrantids, January 3-4 (Comet 2003 EH1)
  - Lyrids, April 22-23 (Comet Thatcher)
  - Perseids, August 12-13 (Comet Swift-Tuttle)
  - Orionids, October 20-21 (Halley's Comet)
  - Leonids, November 17-18 (Comet Tempel-Tuttle)
  - Geminids, December 13-14 (Asteroid 3200 Phaethon)
  - Ursids, December 23-24 (Comet 8P/Tuttle)
- The name of each shower refers to the constellation to which the meteors trace their apparent paths



# Upcoming Events

- Next Meeting: November 26
  - Primary Topic: Variable Stars
  - Last meeting for 2018!
- Leonid Meteor Shower – November 17/18 (New Moon)
- Geminid Meteor Shower – December 13/14