The History, Observation, and Science of

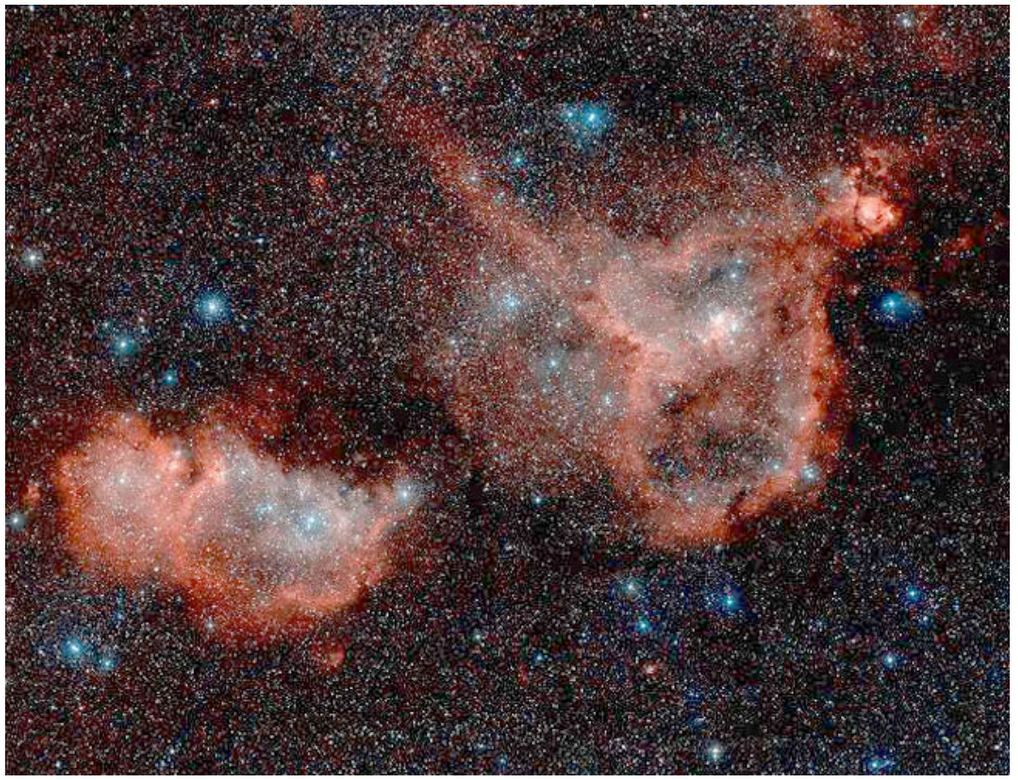
Planetary Nebulas

Plus: Mars Exploration Update (at end)

Tuesday, February 5, 2013

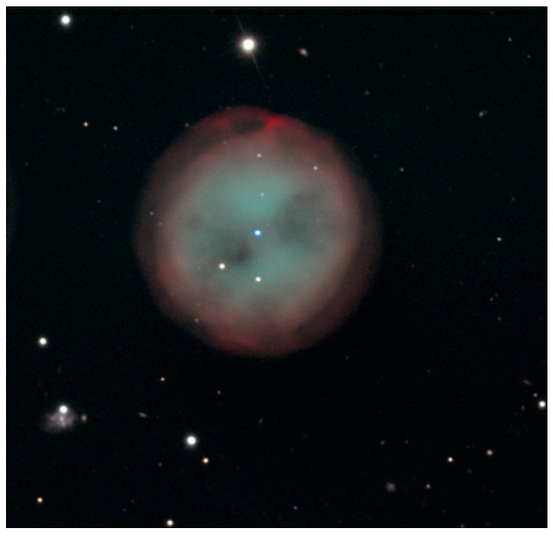
What is a “Planetary” Nebula?

Dark Nebula: We see it because of light it blocks.



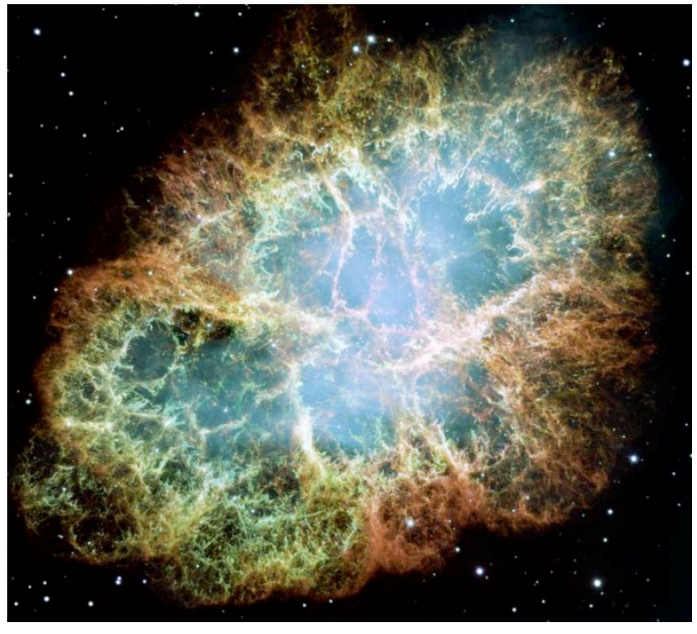
Emission Nebula: The cloud itself glows.

Reflection Nebula:
Reflects light from a star.



Planetary Nebula

Galaxies were once classed
as nebulas, too.



Supernova Remnant:
What’s left after a star goes “boom”

“nebula” is latin for mist, fog, or cloud.

Origin of the Term ‘Planetary Nebula’

William Herschel: Philosophical Transactions of the Royal Society, 1785, Volume 75, Page 263 ff*:

Planetary Nebulae

“I shall conclude this paper with an account of a few heavenly bodies, that from their singular appearance leave me almost in doubt where to class them...being all over of an uniform brightness, which it differs from nebulae, it light seems however to be of the starry nature, which suffers not so much as the planetary disks are know to do, when much magnified.

The planetary appearance of the first two is so remarkable that we can hardly suppose them to be nebulae; their light is so uniform, as well as vivid, the diameters so small and well defined as to make it almost improbable that they should belong to that species of bodies. On the other hand, the effect of different power seems to be much against their light’s being of a planetary nature, since it preserves its brightness nearly in the same manner as to the stars in similar trials.”

He describes five planetaries (Six listed, 5 and 6 appear to be repeats):
NGC 7293 (Helix), NGC 7662 (Blue Snowball), NGC 6369 (Little Ghost),
NGC 6853 (Dumbbell), NGC 6894 (Diamond Ring)

He makes two guesses in 1785 about what they are:

Star clusters that can’t be resolved, or

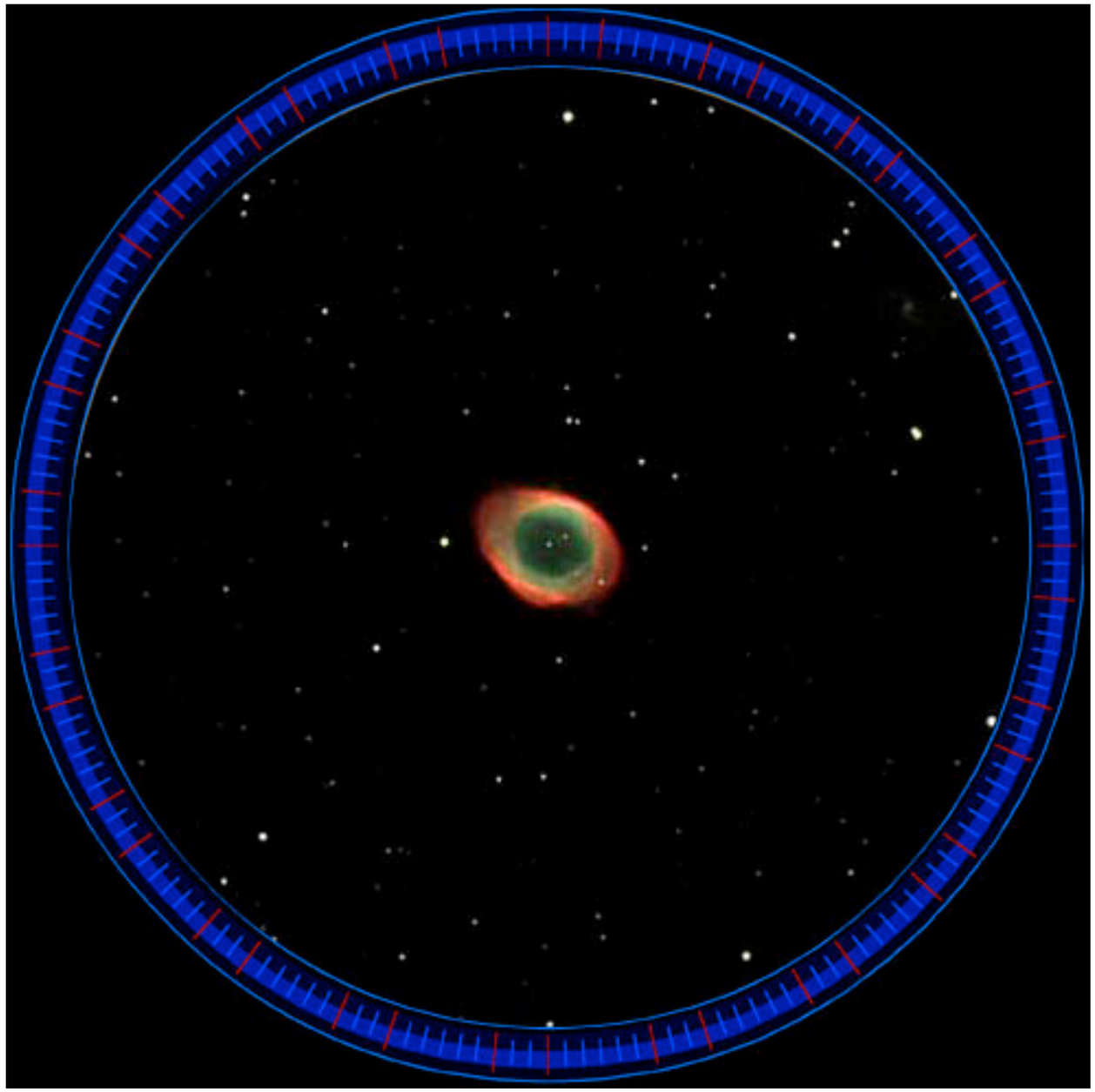
Dead or dying stars, possibly multiple stars falling into each other.

By 1791, with more found of varying appearance, he is convinced they’re nebulas, and strongly convinced that they are associated with dim central stars.

He never mistakes them for planets, or suggests that they are planets.

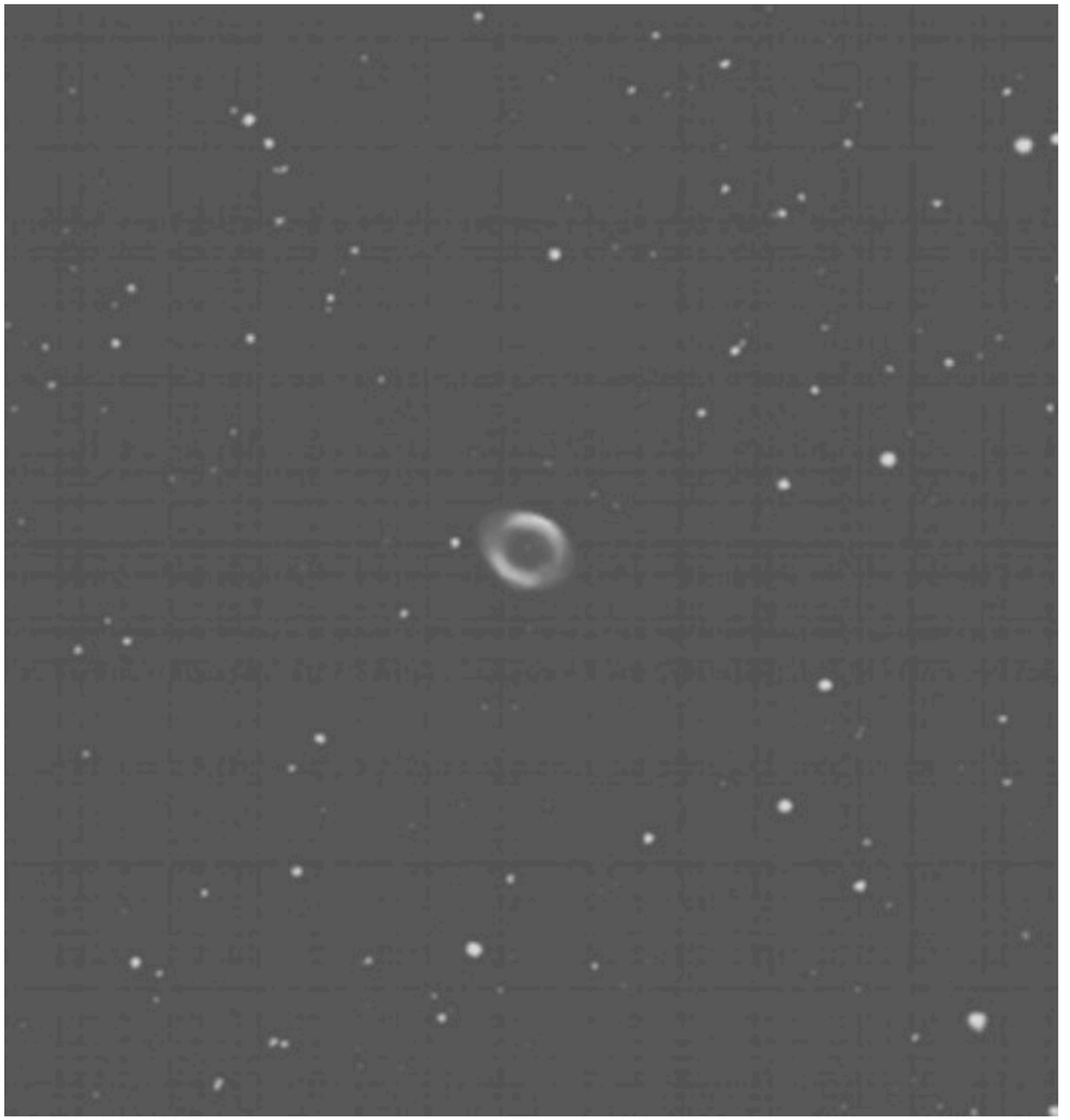
*Available for your perusal on Google Books.

What Gets Shown



science.hq.nasa.gov
"View of a Planetary Nebula Through a Newtonian Telescope"
This is a multi-spectral image, not a 'view', and it's a Newtonian unlike any you're likely to own.
(Not to mention it's "all scienced-up" with that flashy border.)

What You See



No color in the nebula, maybe some in the stars.
Poor contrast.
Little or no detail.
The real fun is in just *seeing* it, and trying to make out what detail you can.

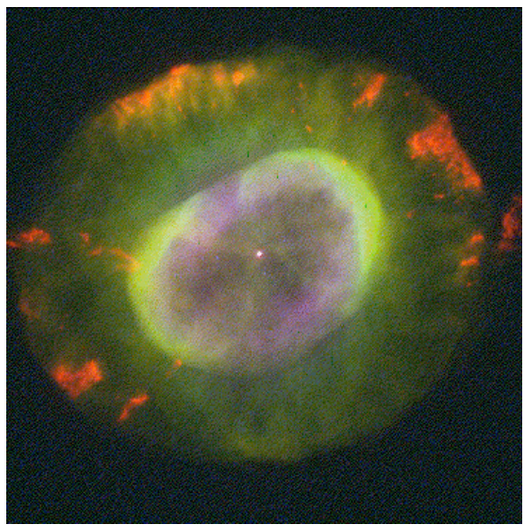
W w! It DOES l k like a ring!

Original image courtesy of Miodrag Sekulic via Wikimedia Commons,
this image processed to make it look like a so-so view of M-57 in a small scope.

Binocular & Naked-Eye Planetaries

There are about 50 planetary nebulas observable in ordinary binoculars, about 40 visible from northern skies.

The Cat's Eye Nebula in Draco is bright and easily seen once found. May be green!



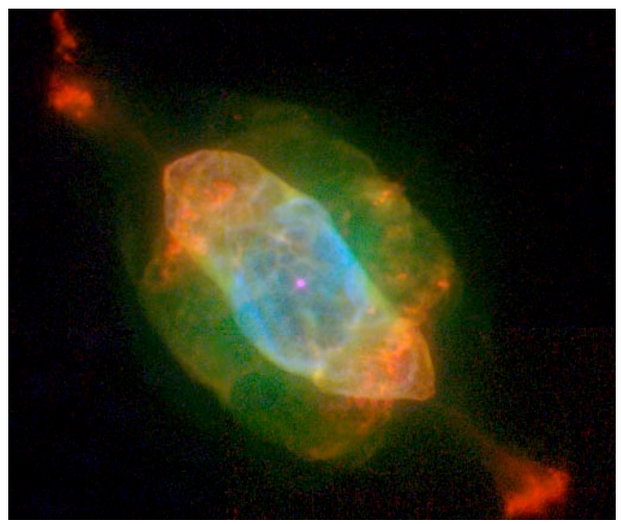
The Blue Snowball is a bright point, seeing it as a fuzzy patch requires 10x or better. Color requires a telescope.

The Little Dumbbell, M-76, is a difficult challenge in binoculars, but an easy object even in small telescopes.

Three planetaries are regularly visible with the naked eye when local conditions are good.
The Helix, the Dumbbell, and the Saturn nebulas.

The Helix looks like a faint gray ring in the sky. It's big, and faint, but has a dark center. 50mm+ binoculars show it well.

The Dumbbell Nebula is a small glowing smudge. It's near stars that hide the shape. It's an easy binocular object.

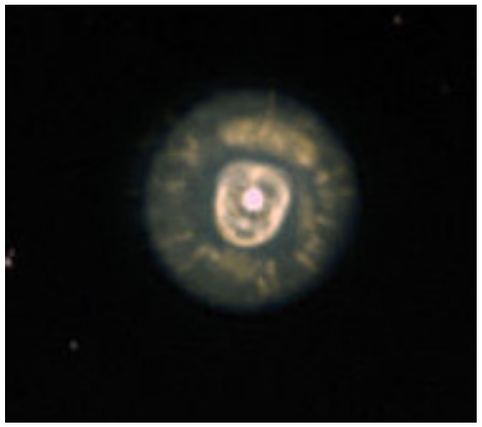


The Saturn Nebula looks like a very dim star to the eye. It looks green in binoculars. A telescope at ~60x shows the "ring".

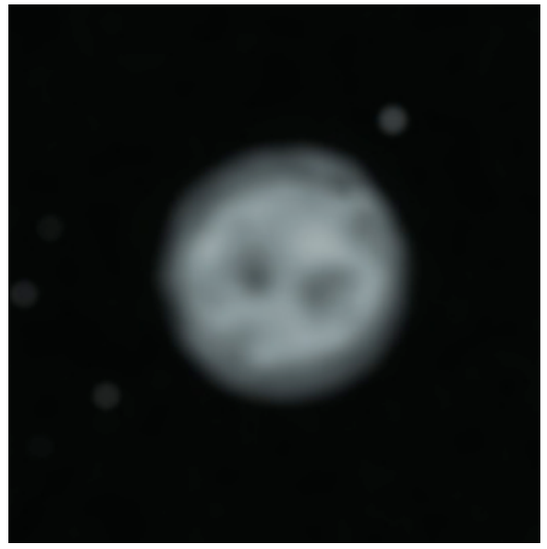
Showpiece Planetaries for Telescopes

The "Ghost of Jupiter" has a very high surface brightness, and has a color like Jupiter's.

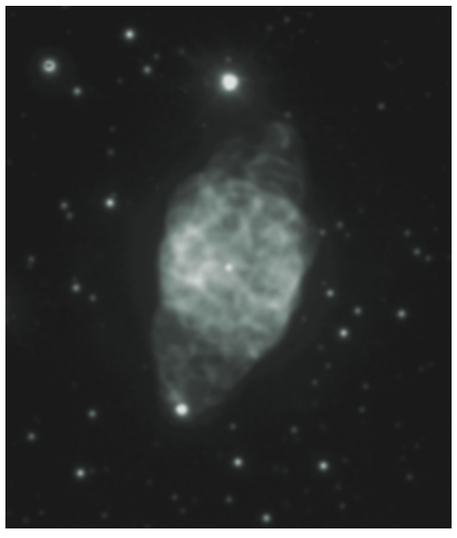
The Dumbell Nebula clearly shows its well-known "Twin Lobed" or "Apple Core" appearance depending on conditions.
Image courtesy Lukáš Kalista



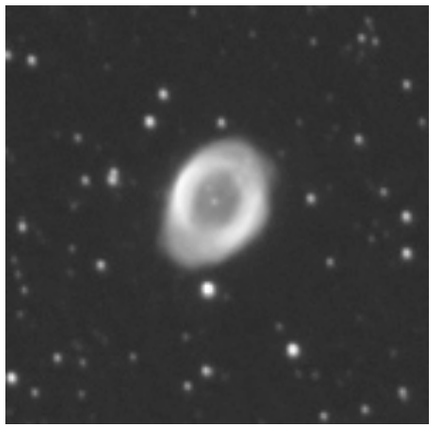
The Eskimo Nebula shows a central bright area and a fuzzy outer perimeter easily. It is quite bright.
Image courtesy Jjstott.



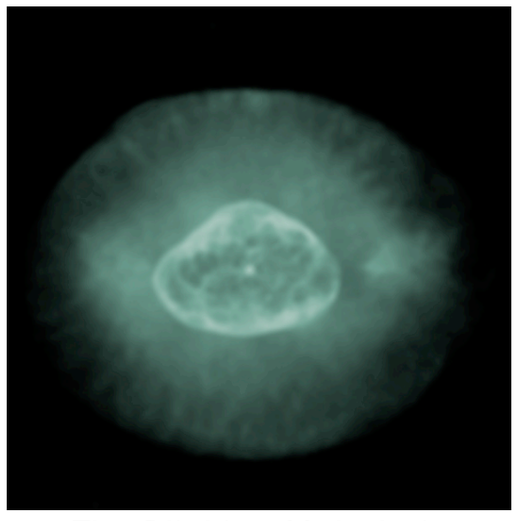
The Owl is visible in scopes ~90mm+, the Eyes are visible with averted vision when contrast is good even in small scopes.



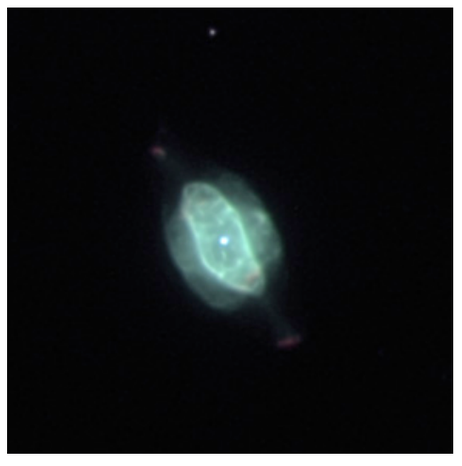
NGC 6905 "The Blue Flash" is visible in scopes from about 90mm+, is bright, and has an elongated shape.
From an original image by ESO.



The Ring Nebula.
Easy, easy to locate, and...it looks like a ring!



The Blinking Nebula is quite bright, and shows the "blinking" behavior under low magnifications (<~200x).



The "horns" or "rings" on the Saturn nebula show at moderate magnification levels, the nebula looks like a green star at low magnifications.

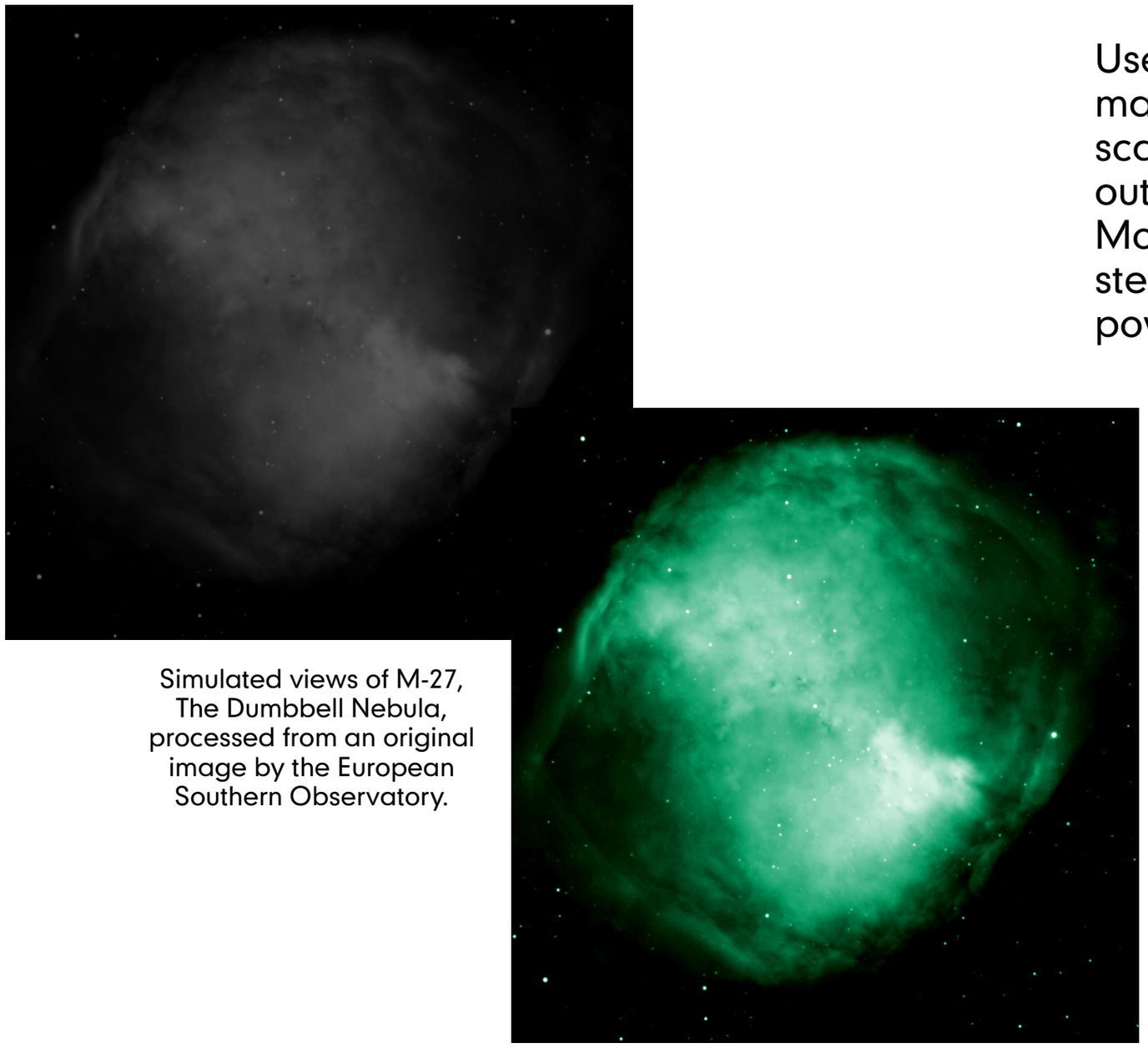
Brad Ehrhorn/Adam Block/NOAO/AURA/NSF

See More At: The Planetary Nebula Observer's Webpage: http://www.blackskies.org/

Tips for Observing Planetaries

OIII Filter: Your Best Friend

Light Pollution or UHC Filter: For brighter planetaries, or if you don't have an OIII yet.

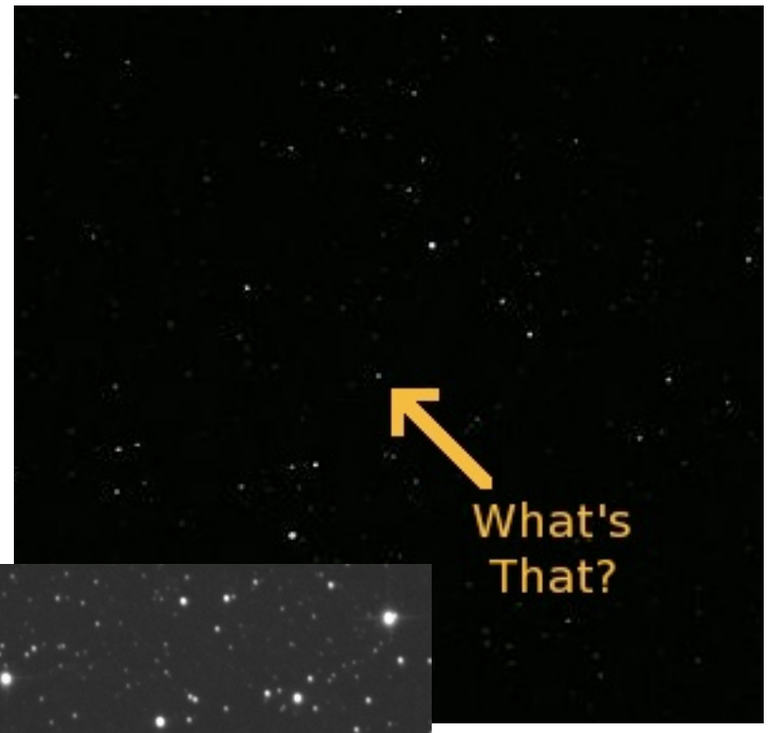


Simulated views of M-27, The Dumbbell Nebula, processed from an original image by the European Southern Observatory.

Averted Vision & Good Contrast: Dry skies bring out the detail.

Magnification: ~250-300x for smaller ones, lower for bright/near ones.

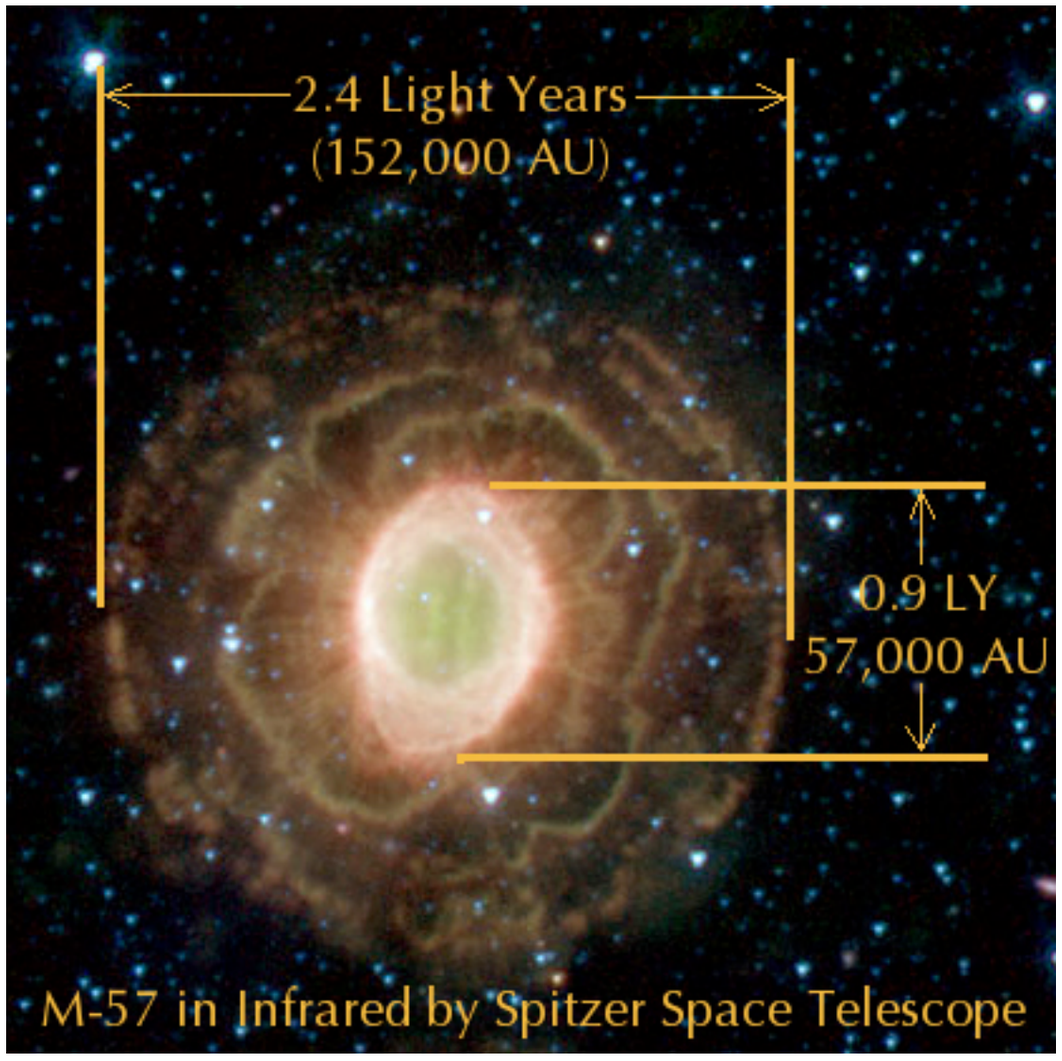
Use medium magnification for scanning to bring out the "fuzzy." Most appear stellar at low powers.



Upper image from an image by exlipse.sx. Lower image from an image by Miodrag Sekulic.

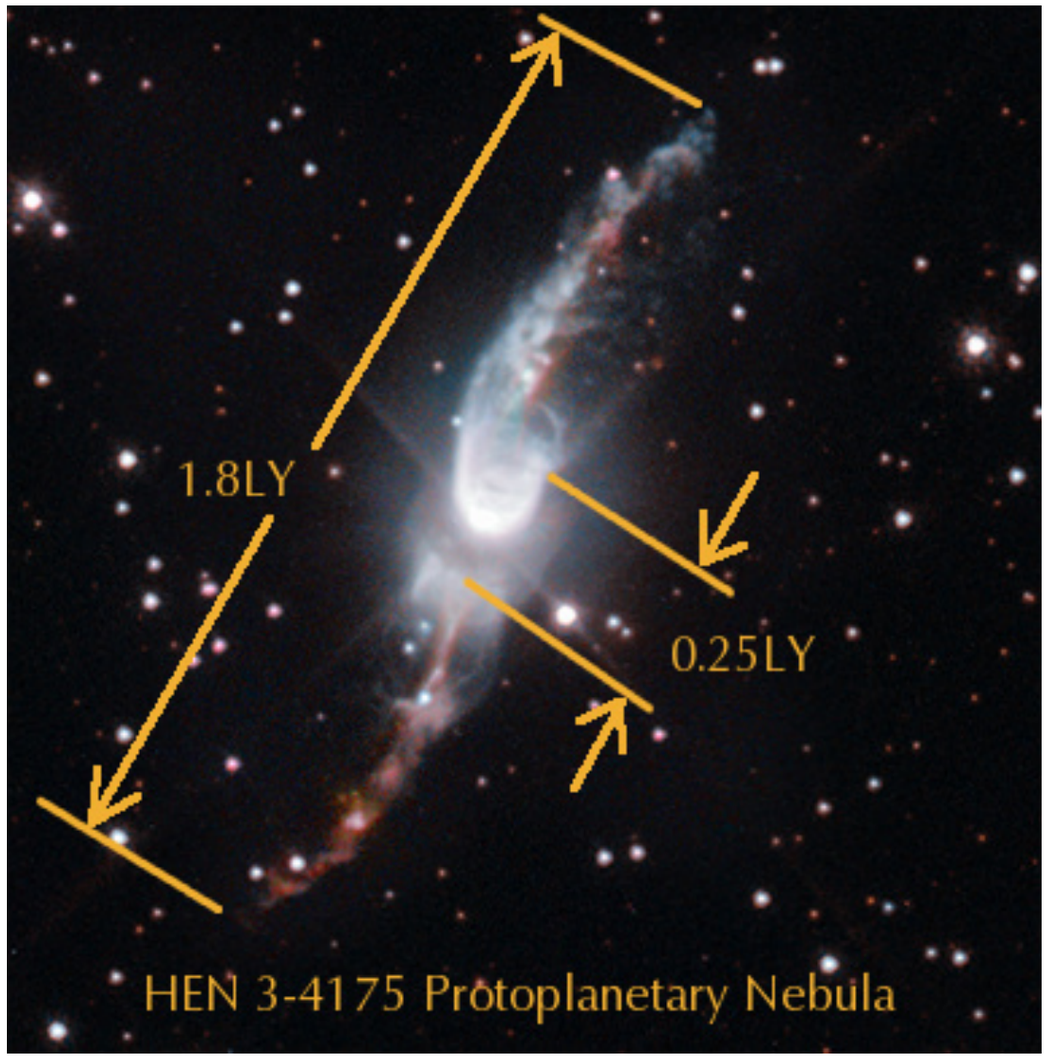
How Big is a Planetary Nebula?

The Ring Nebula (M-57)
An "Established" Planetary



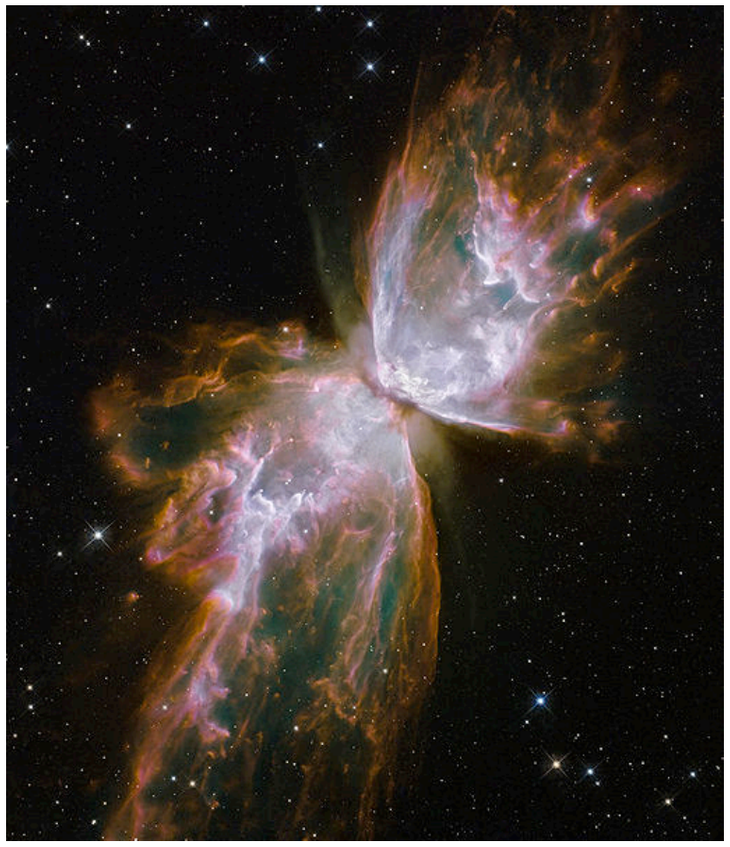
Time of Expansion: 6-8kY
Distance: ~2.3kLY
Mass of Nebula~0.2M ⊙
Central Star Luminosity: ~0.9L ⊙

HEN 3-1475
A Young Proto-Planetary



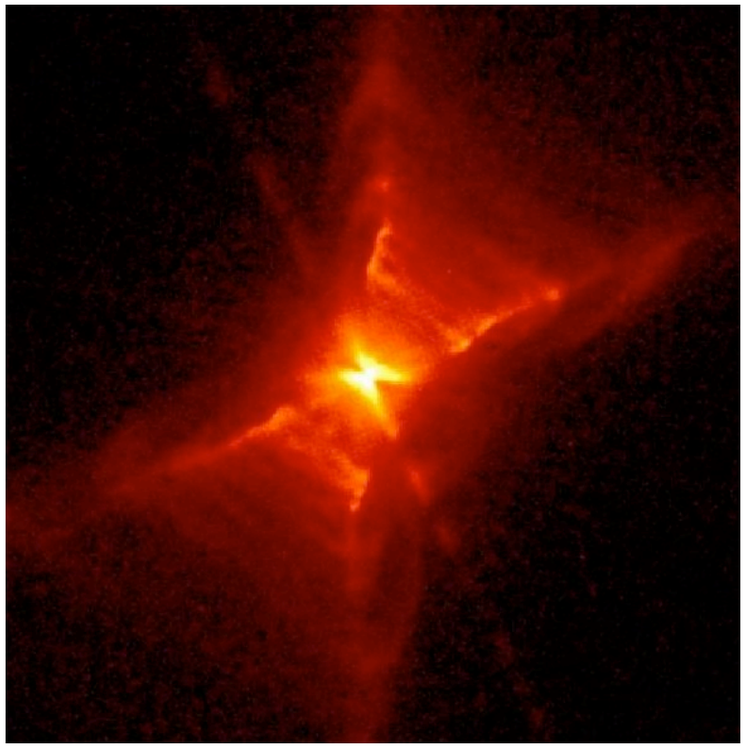
Time of Expansion: 1-1.5kY
Distance: ~18kLY
Mass of Nebula~0.04M ⊙
Central Star Luminosity: ~12kL ⊙

Types of Planetary Nebulae

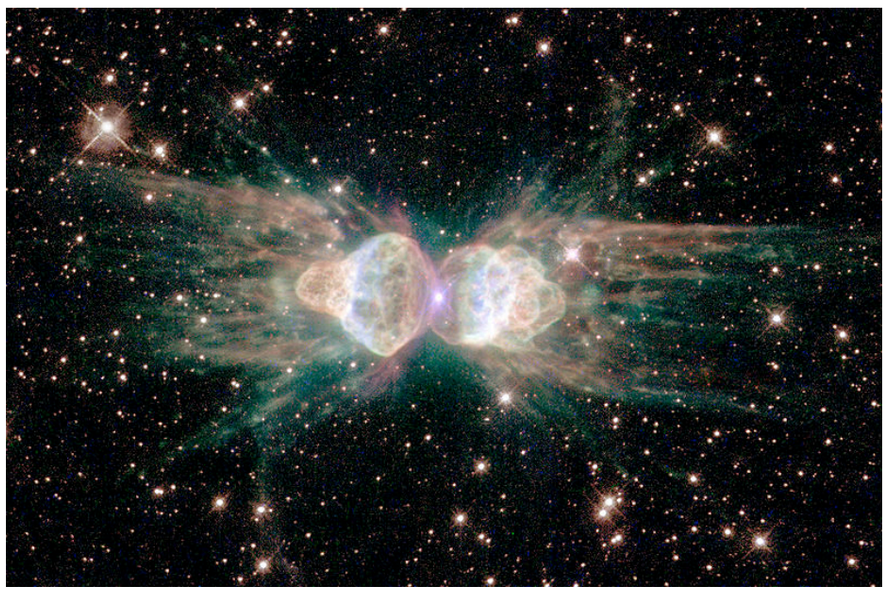


Bipolar (NGC 6302)

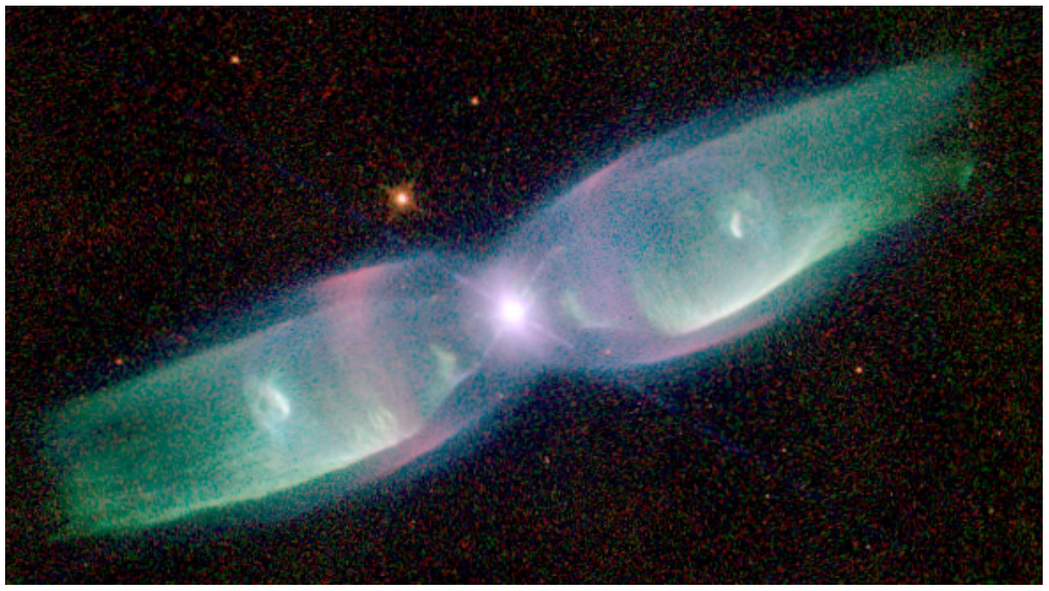
Spherical
(Abell 39)



Bipolar (Red Rectangle)



Bipolar (Ant Nebula, Mz3)



Bipolar (Twin Jet Nebula, M2-9)

Is Every Bipolar PNe a Unique, Peculiar, or Unusual Nebula?

"KjPn 8 thus unfolds a unique situation among PNe" - Lopez, et al, 2001

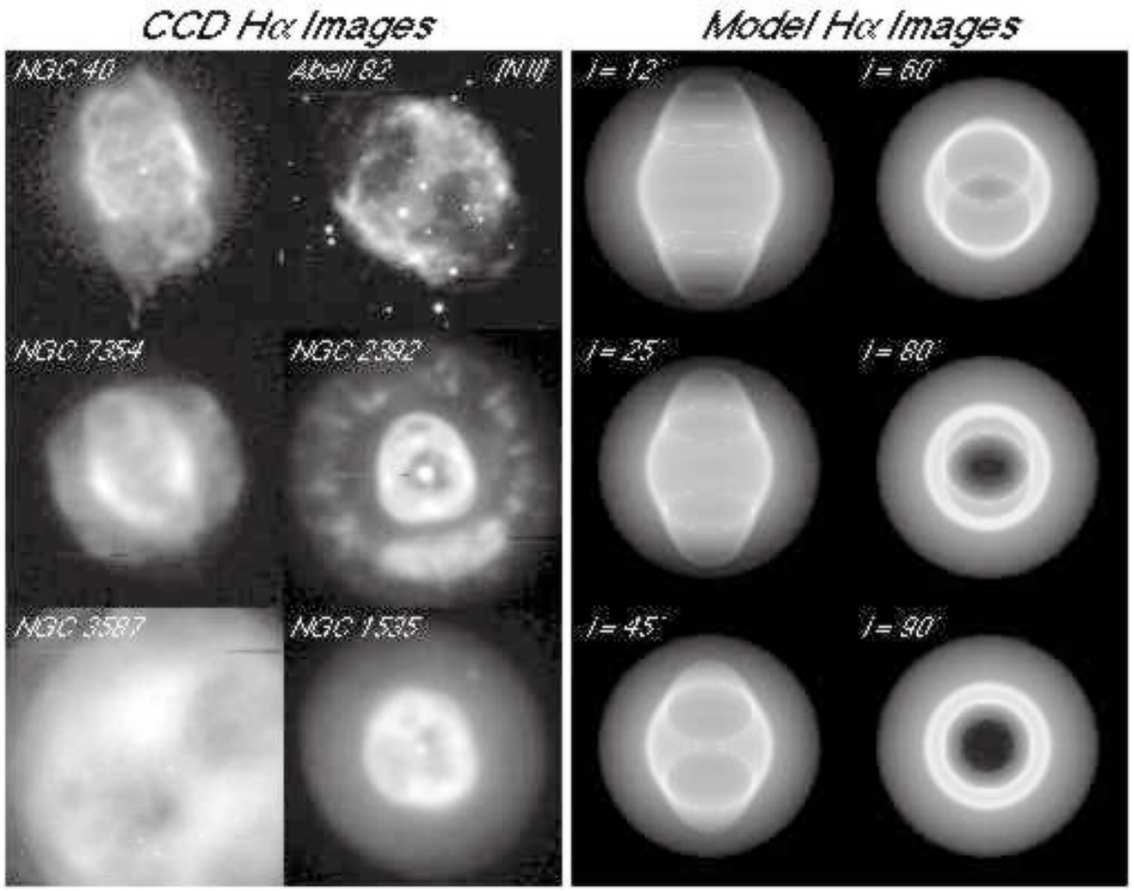
"The Frosty Leo Nebula, IRAS 09371+1212, remains unique..." - Bourke, et al, 2000

"...multi-wavelength study of the peculiar planetary nebula Abell 48..." - Frew, et al, 2013

"Kn 26 is particularly unusual among PNe..." - Guerrero, et al, 2013

"With more sensitive observations in recent years a trend has arisen of attaching adjectives such as 'peculiar' and 'unique' to bipolar planetary nebulae and proto-BPNe. In many cases such adjectives are followed by a claim that a new theory is required to explain the formation of such 'peculiar' and 'unique' BPNe...The goal is simply to show that in the binary model for the formation of BPNe there are more than a hundred different evolutionary routes to form BPNe, hence every BPN is 'unique', and there is no need to invoke new evolutionary paradigm for each one." -Soker, 2001

Differences Seen in Planetary Nebulae



Many of the different shapes are explained as the same shape seen from different angles.

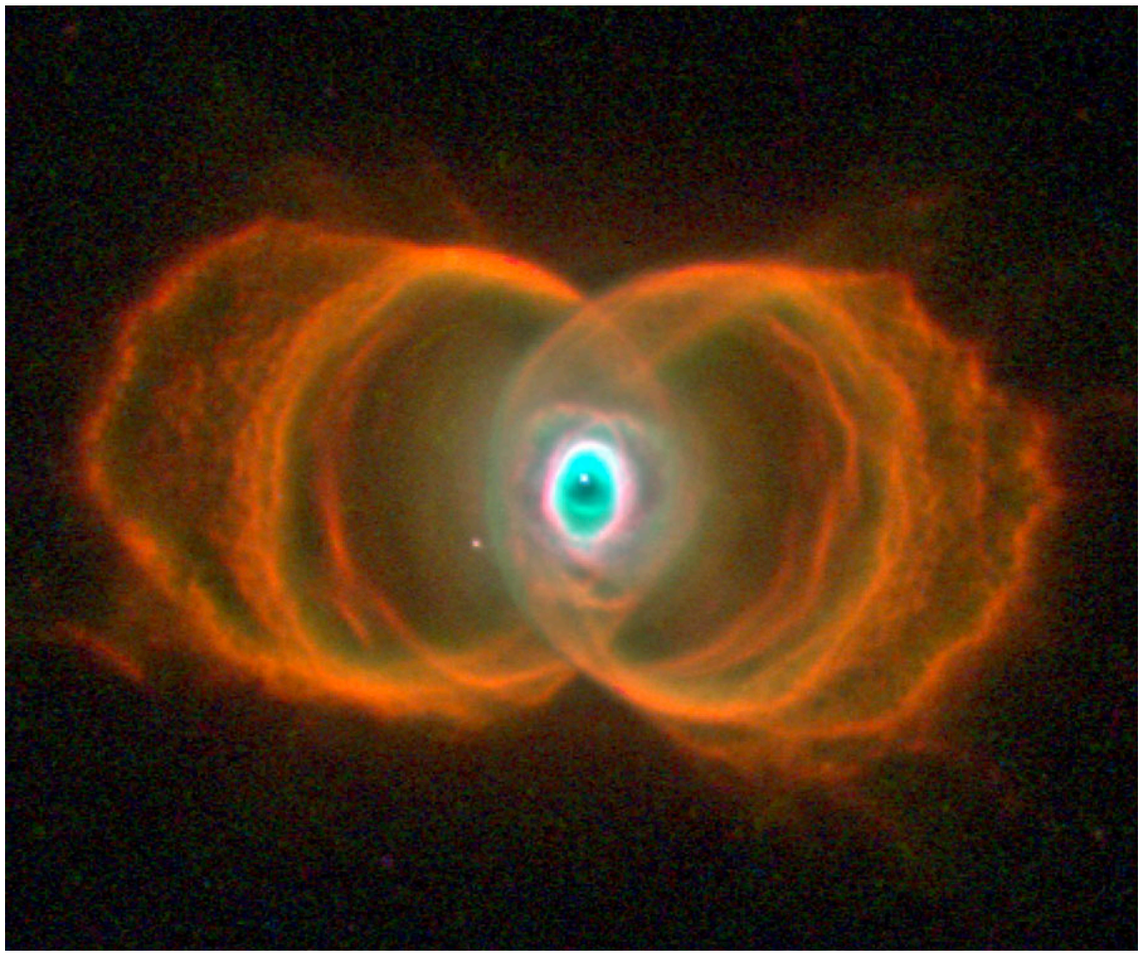
http://www.astro.washington.edu/users/balick/

The magnetic fields of the star can also shape the flow of the wind driving the escaping stellar atmosphere.

Hubble image of Cat's Eye Nebula

Planetary Nebulae Formed in Binary Systems

Magnetism is not enough to explain the Angular Momentum changes in PNe.



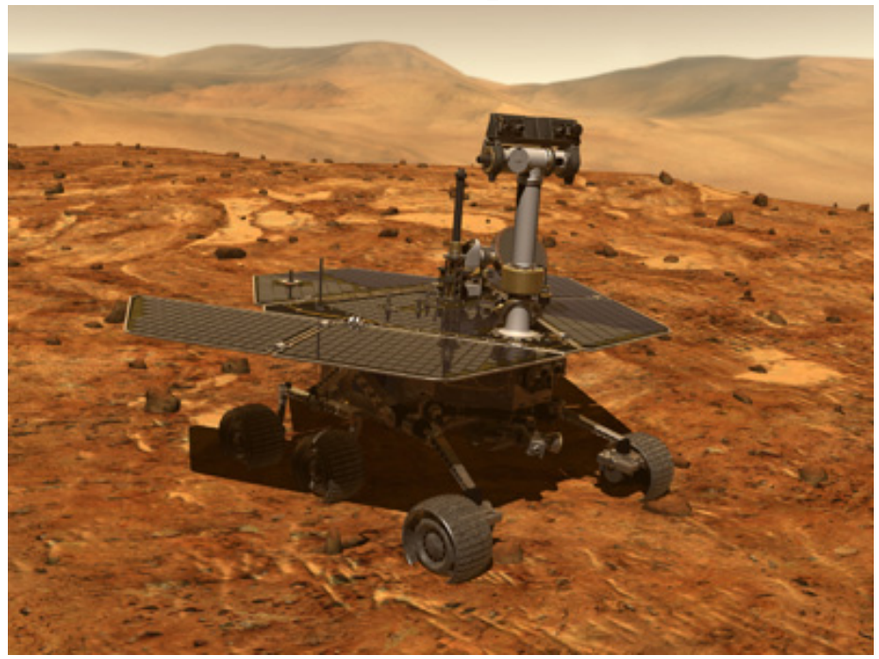
Hubble image of MyCn18

Magnetism of the parent star, unseen binary companions, and magnetism in the local interstellar medium all contribute to formation of PNes, but the companion is likely to have the greatest effect.

Hubble image of Heinize 3-401

Part 2: Mars Exploration Update

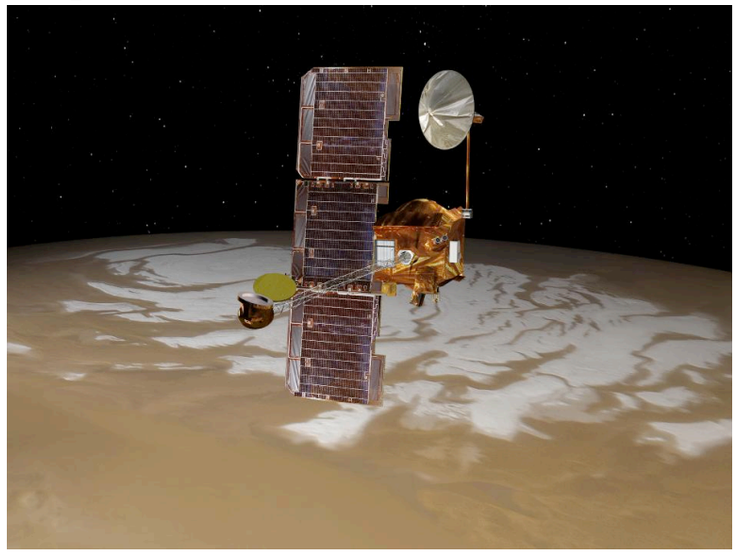
MSL/Curiosity Rover:
180 sols on Mars
~700 meters traveled
(~2300 ft)
Currently preparing to
do its first drilling,
has done testing with its
impact tool,
will be trying to use
impact and drill tools in
next few days.



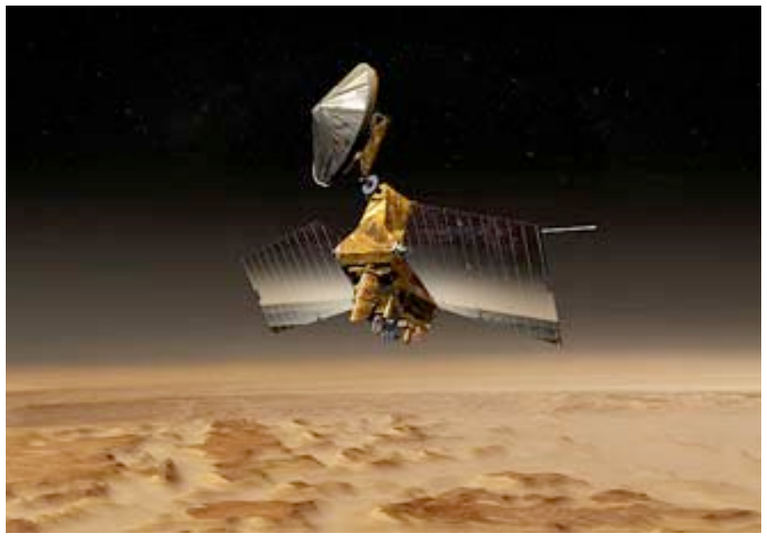
Opportunity Rover:
2313 sols on Mars
~34.5km traveled (~22mi)
Investigating outcrops on rim of
Endeavour crater ("Matijevic Hill")

Spirit: 3233 sols. 7.7km (4.8 mi.)
Incommunicado since March 2011.

Mars Express
Orbiter
Radar mapping of
surface and data
relay.
Dec. 2003 to
present.

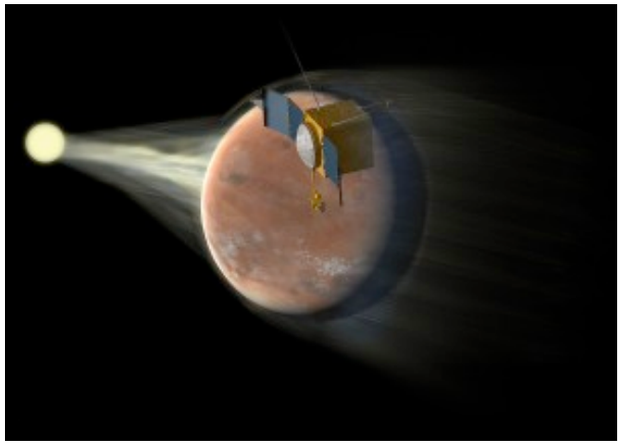


Mars Odyssey Orbiter
Longest-Serving Martian Spacecraft
24 Oct, 2001 to Present
4123 days
Just changed to "Side B" due to IMU

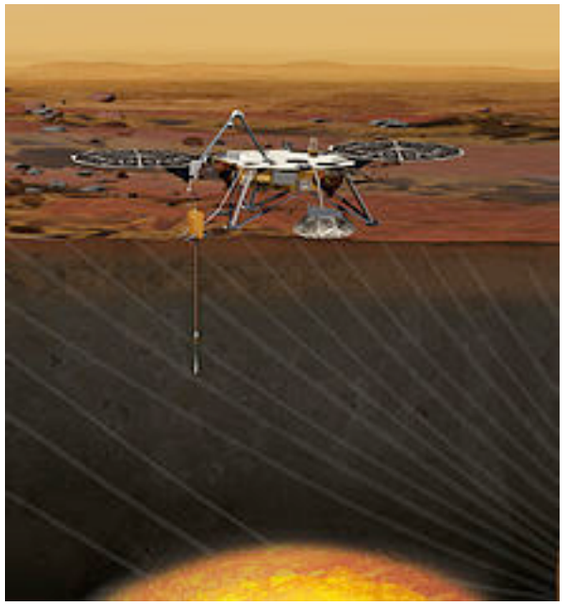


Mars Reconnaissance Orbiter
187 Terabits of Data (>20TB)
Observing seasonal changes and
tracking rovers by their tracks.
10 Mar, 2006 to present

Planned New Missions



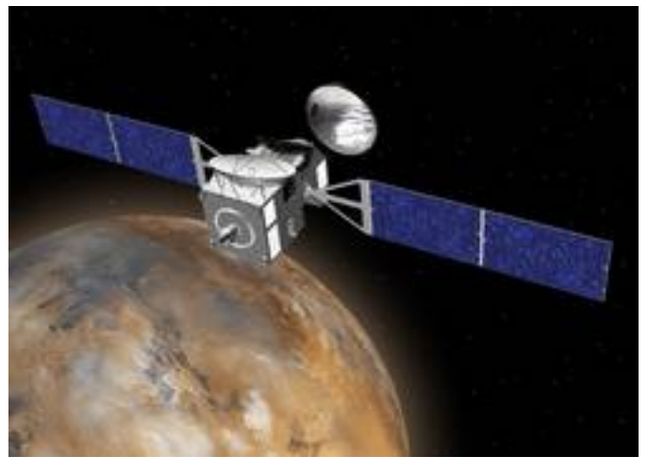
MAVEN (Mars Atmosphere and Volatile Evolution)
NASA/UCB Late 2013.
Mission to determine if solar storms stripped away much of Mars' atmosphere.
http://lasp.colorado.edu/home/maven/



InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport)
NASA/JPL 2016
Seismic and magnetic study of the internal structure of Mars.
http://insight.jpl.nasa.gov/

Unnamed Mars Rover
NASA/JPL 2020
A rover based on the design of the Curiosity, using the same landing method, has been announced for the 2020 launch window.

Mangalyaan (Hindi: Mars-Craft)
ISRO Nov. 2013
Engineering/Technology development craft carrying a camera, Lyman-alpha spectrometer, IR spectrometer, and exosphere analyzer.
All-indigenous mission launched on PSLV.



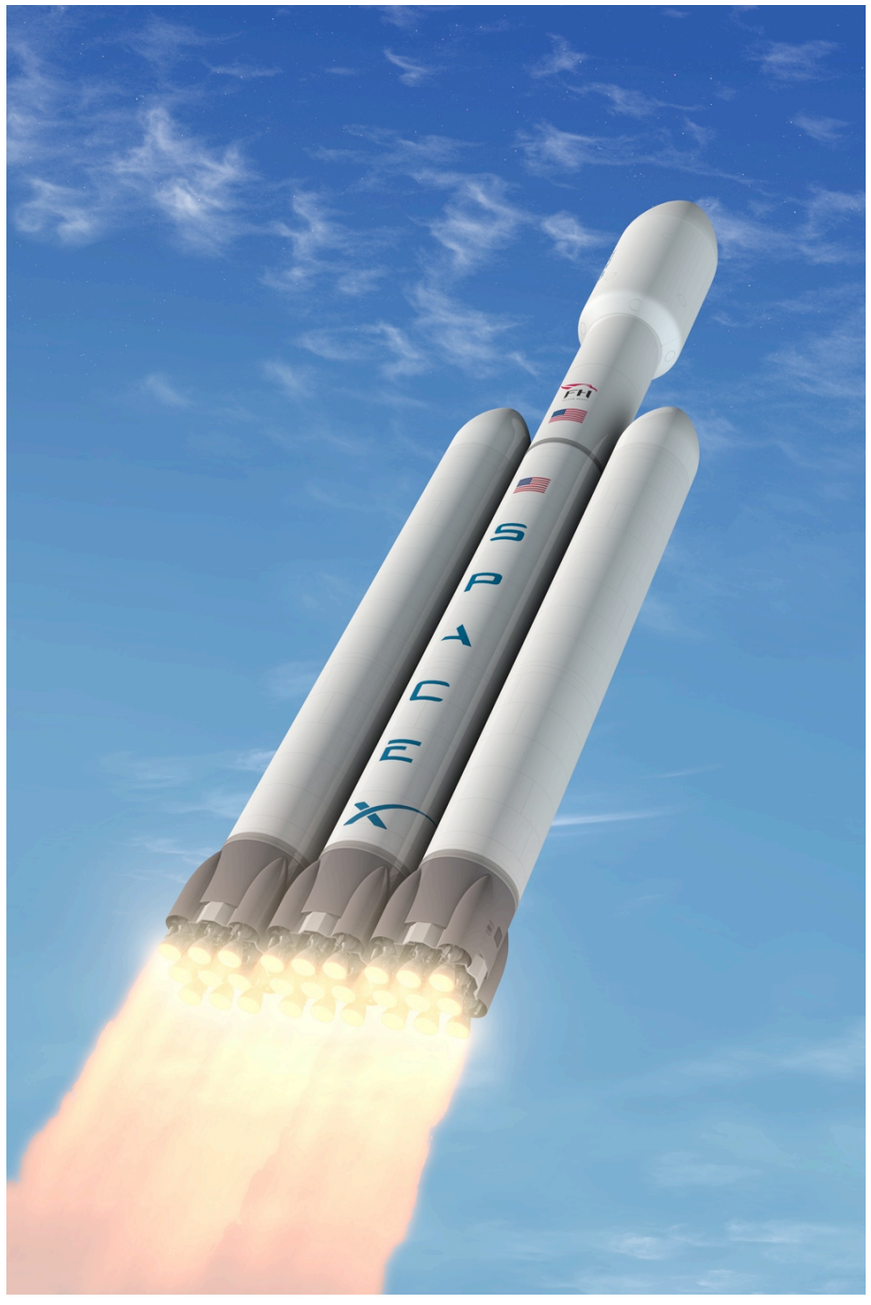
ExoMars Trace Gas Orbiter
ESA/RSA 2016
Orbiter carrying static lander.

To be followed in 2018 by an orbiter carrying a small rover.

Commercial Mars?

NASA Ames Research Center is working with SpaceX on a possible 2018 lander mission to Mars.

The mission would use a version of the SpaceX Dragon capsule to deliver about 1 tonne of instruments to Mars looking for life in subsurface water.



The mission would launch on the Falcon Heavy launch vehicle, scheduled for first launch this year from Vandenberg AFB, with a later launch from Cape Canaveral either late this year or early next.

The mission would have a side effect of providing initial experience and data on the use of spacecraft and systems relevant to human spaceflight to Mars.