

PLANETARY NEBULAE

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Astrodon

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Linz, Austria

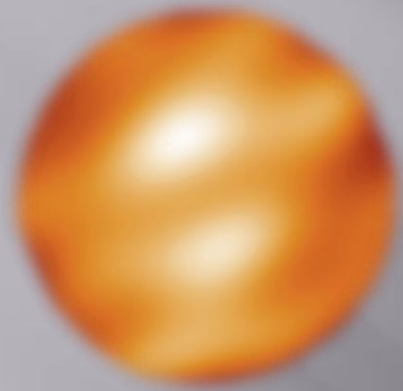
Topics

- ▣ What are planetary nebulae (PNe)?
- ▣ How do they form?
- ▣ Why so many different shapes?
- ▣ Extended Halos
- ▣ Imaging Challenges
- ▣ References
- ▣ Conclusions

What Are PNe?

- ▣ Glowing shell of ionized gas
- ▣ UV radiation from hot central star
- ▣ Strong emission lines (H-a, SII, HeII, NII, OIII)
- ▣ Late-stage evolution to White Dwarf
- ▣ Dumbbell (M27) first PN discovered 1764 (Messier)
- ▣ Herschel called them planetary nebulae
- ▣ Resembled greenish planet disks (e.g., Neptune)
- ▣ Not planets
- ▣ ~3000 PNe in Milky Way

End Of Life



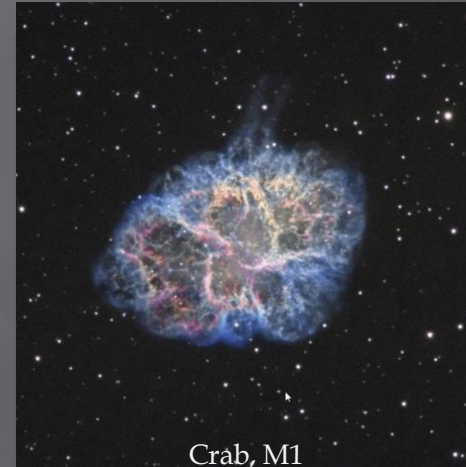
$> 8 \times M_{\odot}$

Supernova (~5%)

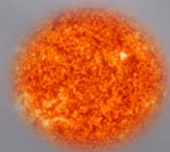
Wolf-Rayet



Crescent, NGC 6888



Crab, M1



$> 0.8 \times M_{\odot}$

Planetary Nebula (~95%)



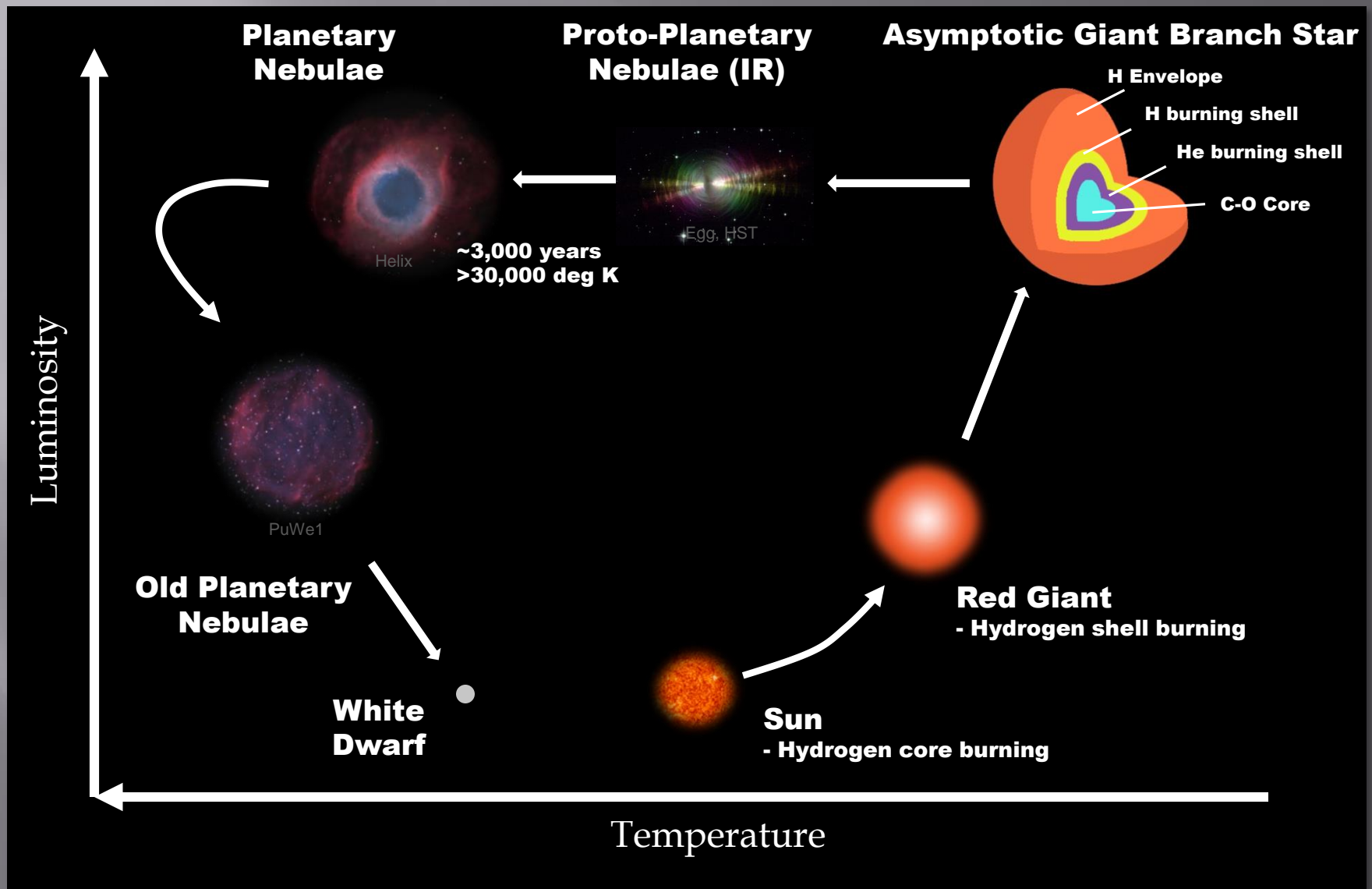
Helix, NGC 7293

Solar Image from Atmospheric Imaging Assembly (AIA) for the Solar Dynamics Observatory (SDO)

Betelgeuse H-band image from IOTA: X. Haubois et al. (arXiv:0910.4167)

All images by Don Goldman unless otherwise specified

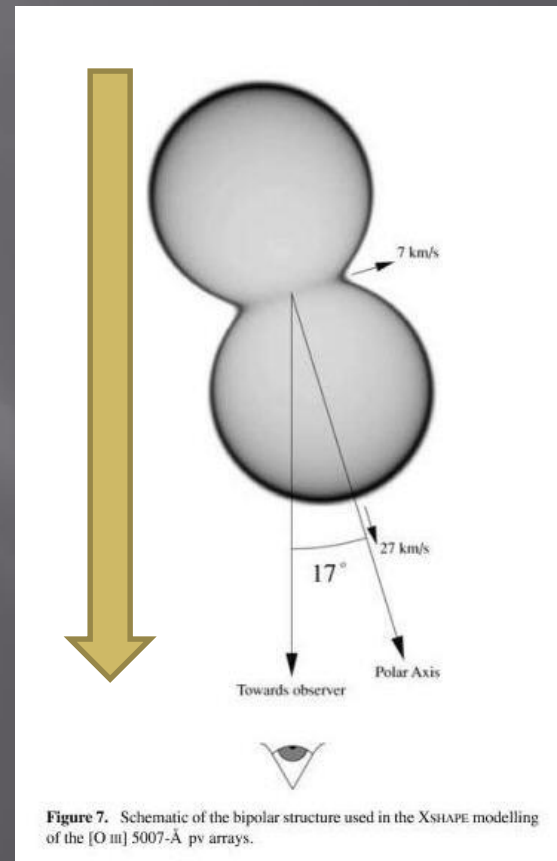
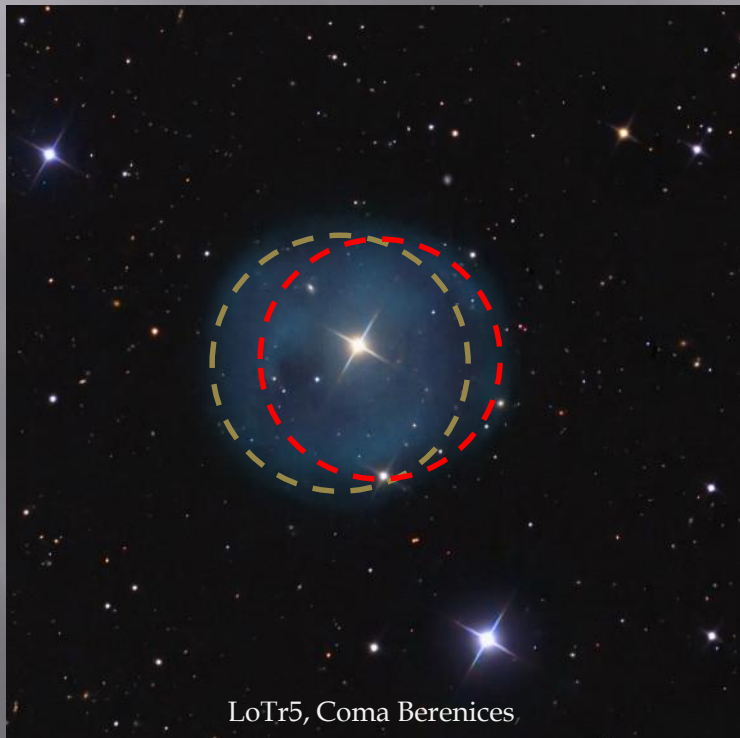
How Do PNe Form?



Adapted from S. Kwok, "Cosmic Butterflies", Cambridge University Press, 2001

Why Different Shapes?

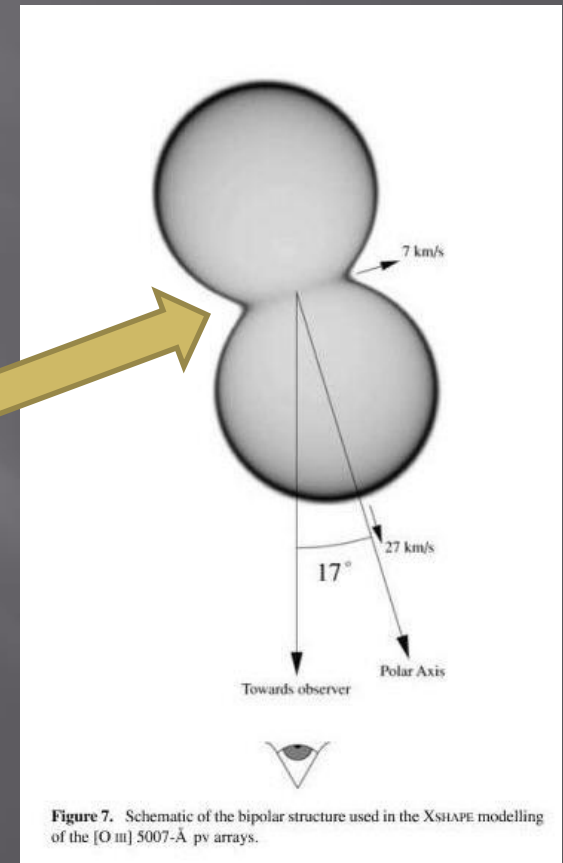
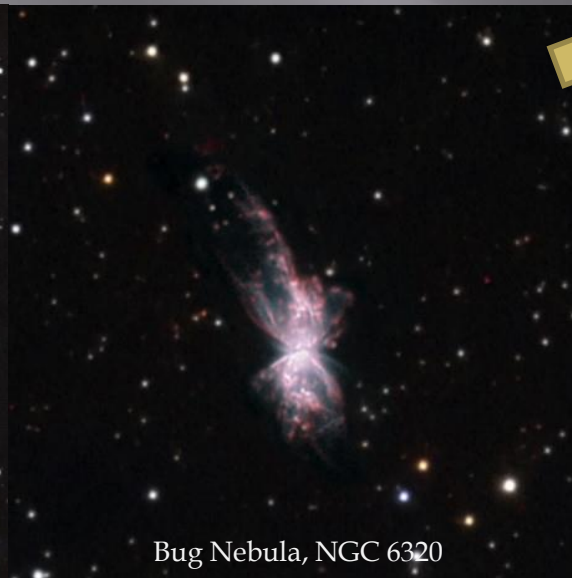
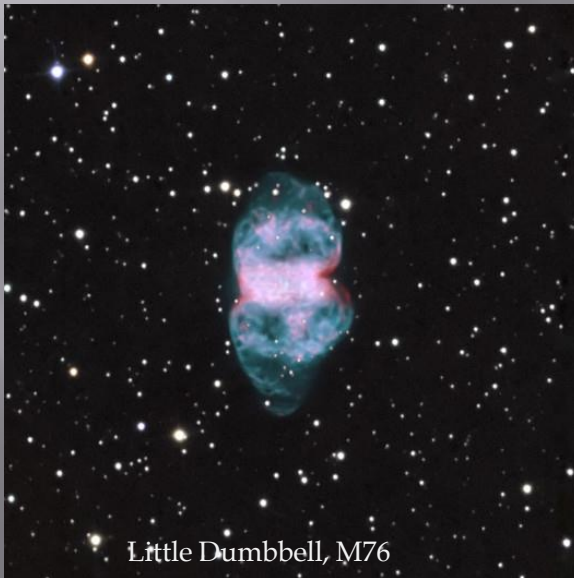
- Binary stars common
- Bipolar shape common
- Shape depends upon our line-of-sight
- “Almost” End-on



Graham, et. al (Mon. Not. R. Astron. Soc. 347, 1370D1378, 2004)

More Shapes

- Binary stars common
- Bipolar shape common
- Shape depends upon our line-of-sight
- **Perpendicular**



Graham, et. al (Mon. Not. R. Astron. Soc. 347, 1370D1378, 2004)

Imaging Challenges

- ▣ Most PNe are small or very faint
- ▣ Need larger apertures
- ▣ Bright cores are easy
- ▣ Narrowband filters for structure
- ▣ Narrowband filters for extended halos
- ▣ Need many long exposures
- ▣ H-a, OIII, RGB “natural color”
- ▣ We have time

What Does FAINT Mean?



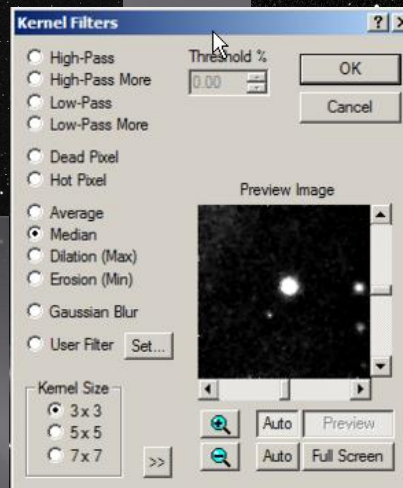
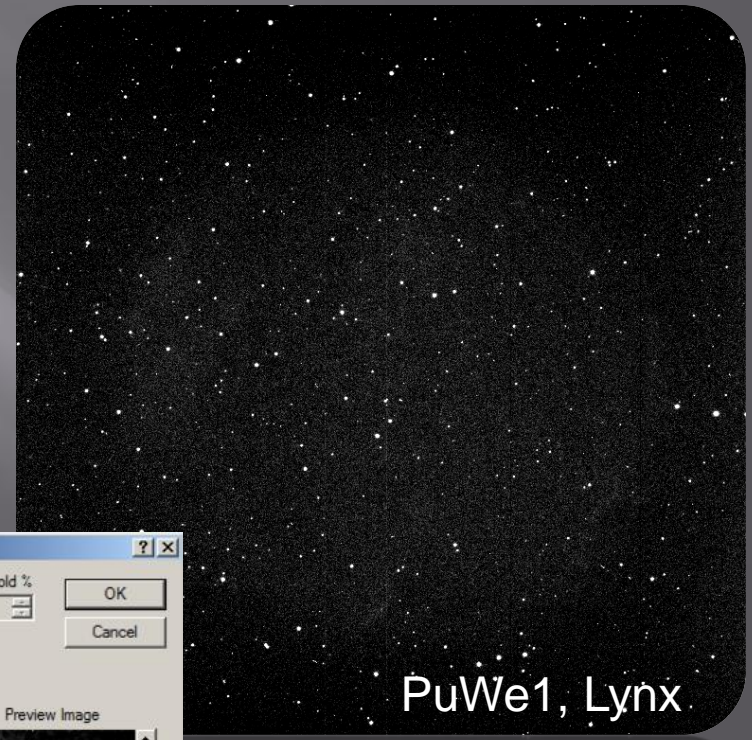
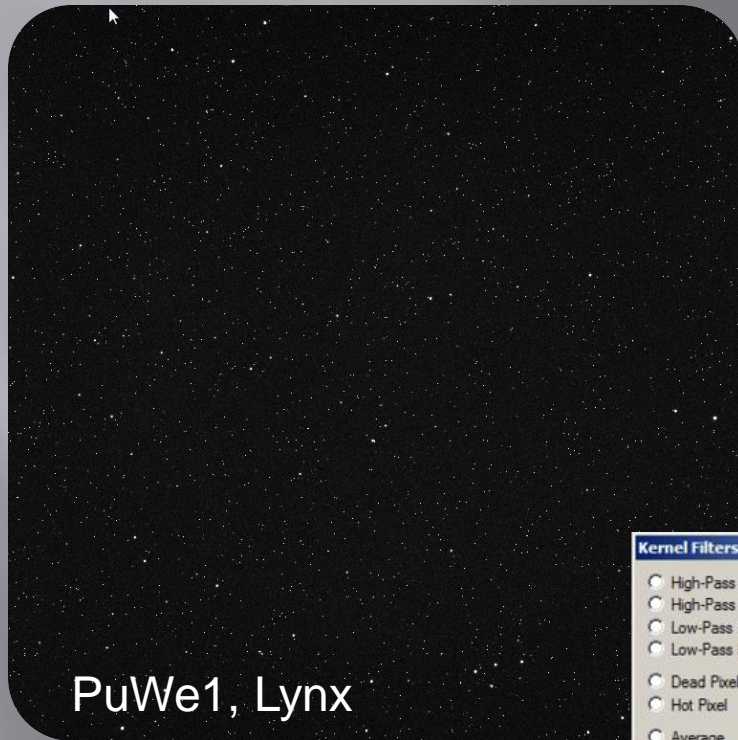
30 min., 3 nm H-a, 16" RCOS RC, uncalibrated sub-exposure. Screen capture from MaximDL after median Kernal filter to remove hot pixels



PuWe1, Lynx

MaximDL Median Kernel Filter

30 minute Uncalibrated H-a Sub-Exposure

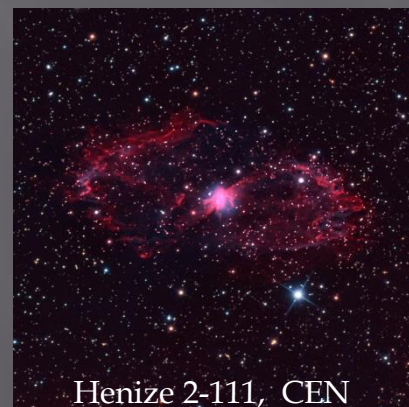


Extended Halo

- Important research area
- Need narrowband filters for high contrast
- Narrower the better



M27



Imaging PNe – Helix



Short RGB
Star Color



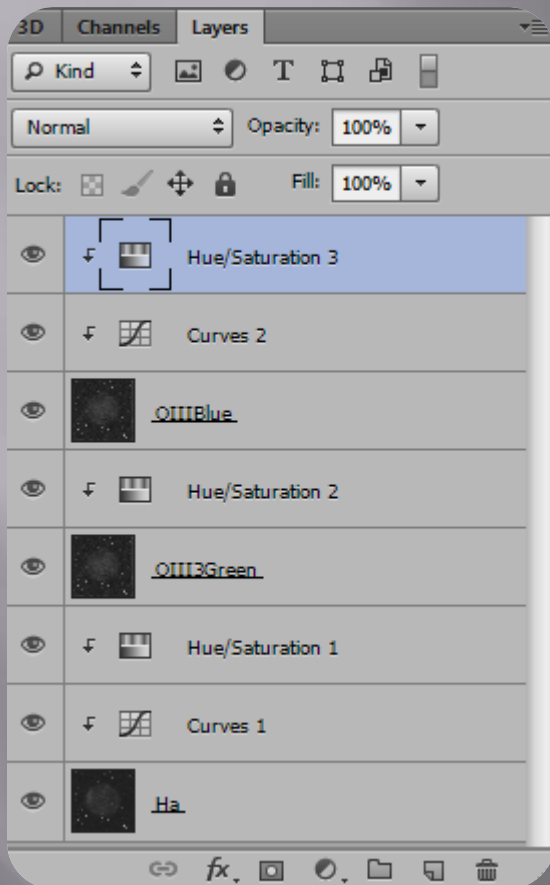
Deep OIII
Blue/Green



Deep H-a
Red/Magenta



Clipping Layer Masks For Mapped Color



References

- Bruce Balick
 - <http://www.astro.washington.edu/users/balick/index.html>
- Sun Kwok
 - Cosmic Butterflies, Cambridge, 2001
- Wikipedia
 - http://en.wikipedia.org/wiki/Planetary_nebula
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- Reiner Vogel
 - http://www.reinervogel.net/pdf/Large_PN.pdf
- Don Goldman
 - <http://www.astrodonimaging.com/gallery>
 - Email: don@astrodon.com

Conclusions

- ▣ Great imaging targets
- ▣ Variety of shapes, structures
- ▣ Cores are often bright

- ▣ Extended halos are very faint
- ▣ Good narrowband targets
- ▣ Many are rarely imaged
- ▣ It's a hobby.....have fun!!