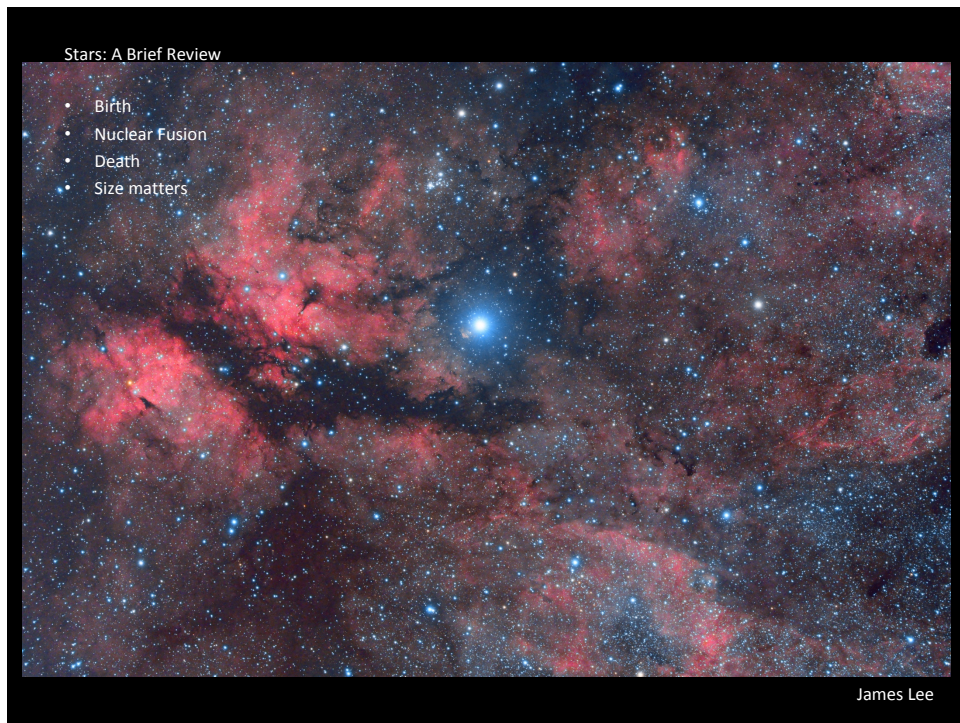


# Deep Sky Objects Part 2

Peterborough Astronomical Association  
Novice Astronomy Class # 11  
February 3, 2023  
Brett Hardy

Mike McCarthy



Stars: A Brief Review

- Birth
- Nuclear Fusion
- Death
- Size matters

James Lee

Novae

- "New star"
- Binary star systems: White Dwarf & Red Giant
- Hydrogen accretion
- 20 million K
- 5 %

*DELPHINUS*

Nova Serpentis – Feb. 2, 2020 (Mag. 11.8)

White Dwarfs

- Sirius B – Mag. 8.5
- Omicron<sup>2</sup> Eridani B – Mag. 9.5
- Van Maanen's Star (Pisces) – Mag. 12.4
- Stein 2051 (Camelopardalis) – Mag. 12.4

*Nova Delphini 2013*

*SAGITTA*

*Altair*

*"The Coathanger"*

Jimmy Westlake

Type I Supernovae

- Binary Sun mass stars
- White dwarf accretion
- Chandrasekhar Limit – 1.4 solar masses
- Type Ia supernova
- Consistent luminosity
- Measurement tool

ACCRETION SCENARIO

WHITE DWARF GROWS IN MASS

MASS LIMIT IS EXCEEDED → TYPE IA SUPERNOVA

NASA/CXC/M. Weiss



Type II Supernovae

- Stars 8x the Sun's mass & greater
- Precarious balancing act
- Iron synthesis
- Core collapse
- Create black holes
- From death comes life

SN 2020fqv



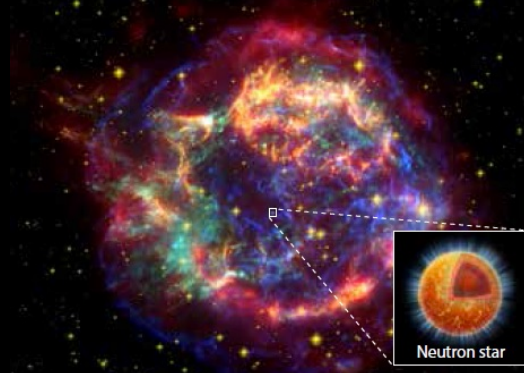
Brett Hardy

This image shows a field of stars against a dark background. A label 'SN 2020fqv' is positioned to the right of a specific star, with a vertical line pointing to it and a horizontal line extending to the right. The star field contains several bright stars of varying colors and sizes.



### Neutron Stars

- Stars > 10 solar masses produce neutron stars
- Neutron degeneracy pressure
- < 20 km
- Most dense, magnetic, fastest rotation
- 1 Tablespoon = 900 billion kg
- Magnetic field trillions > than Earth
- Rapid rotation rate
- Most are difficult to detect



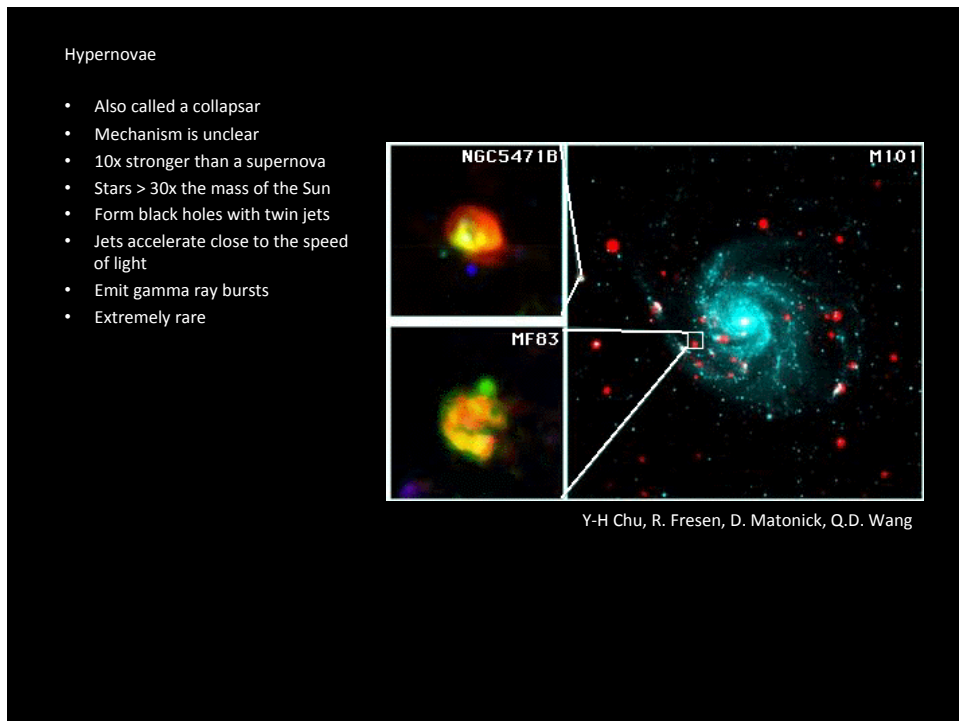
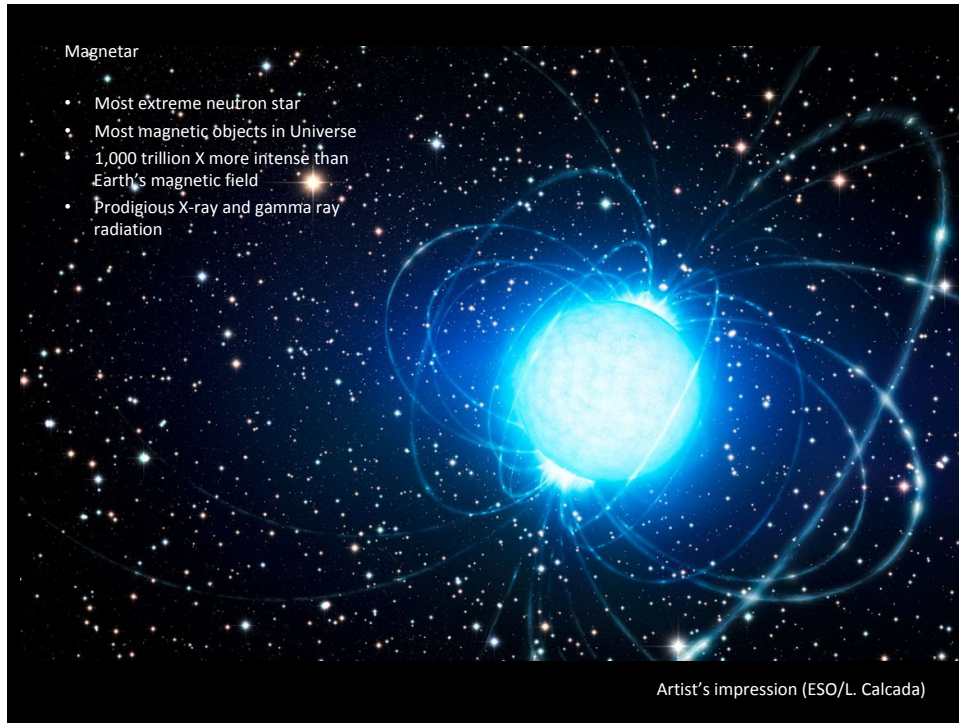
NASA/CXC/UNAM/loffe/D. Page, P. Shternin et al/STScI/M. Weiss

### Pulsars

- Special kind of neutron star
- Create powerful magnetic fields
- Twin beams of light



NASA/CXC/CfA/P



**Gamma Ray Bursts**

- Most energetic light
- Distant galaxies
- Late 60's
- Two types: Short-duration & Long-duration
- Swift & Fermi
- Mass extinctions?

**Gamma-Ray Burst Host Galaxies**  
*Hubble Space Telescope*

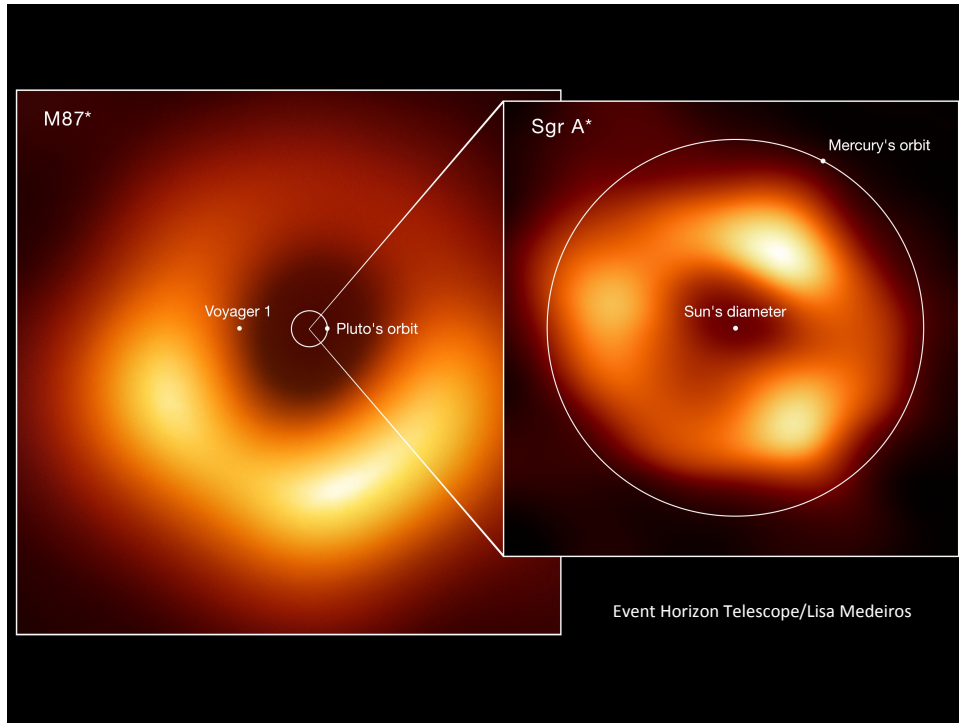
NASA, ESA, A. Fruchter (STScI), and the GOSH Collaboration STScI-PRC06-20

**Black Holes**

- Death of massive stars & neutron star mergers
- Singularity
- Warping of spacetime
- Stellar-mass & supermassive black holes
- Cygnus X-1
- M87\*
- Sagittarius A\*

Event Horizon Telescope





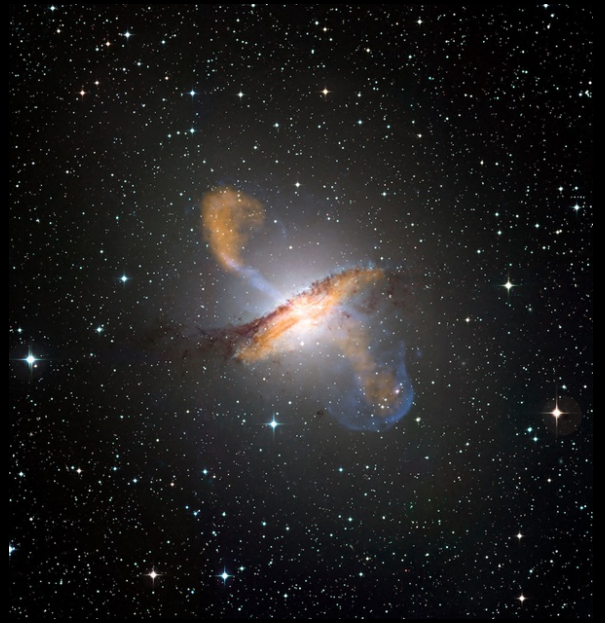
Quasars

- Quasi-stellar radio source
- A type of active galaxy
- Supermassive black hole
- Millions or billions the mass of the Sun
- Galaxy nucleus very bright
- Emit jets of material and high energy gamma rays
- X-rays, radio waves & neutrinos
- Velocities close to the speed of light

ESA/Hubble/NASA

Blazars

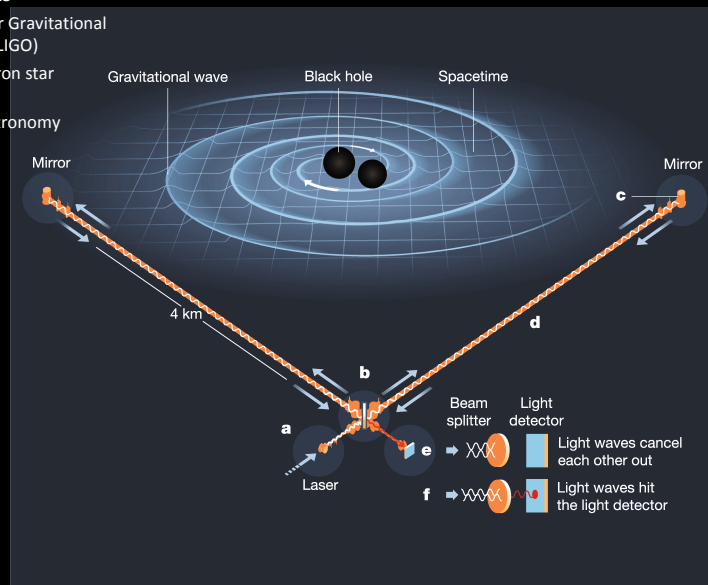
- Special type of Quasar
- Jets pointed at Earth
- Emit high-energy neutrinos



ESO/WFI/MPIfR/APEX/A. Weiss et al/NASA/CXC/CfA/R. Kraft et al

Gravitational Waves

- First recorded in 2015
- Laser Interferometer Gravitational Wave Observatory (LIGO)
- Black hole and neutron star mergers
- Multi-messenger astronomy



Johan Jarnestad/The Royal Swedish Academy of Sciences



