3rd Yr Bachelor Astronomy Projects!

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The life cycle of stars

- Star formation, protoplanetary disks and (exo) planet formation

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- Stellar evolution
  - low mass: AGB ➠ post AGB ➠ PN ➠ WD
  - high mass: supergiant ➠ LBV ➠ WR ➠ SN ➠ NS/BH

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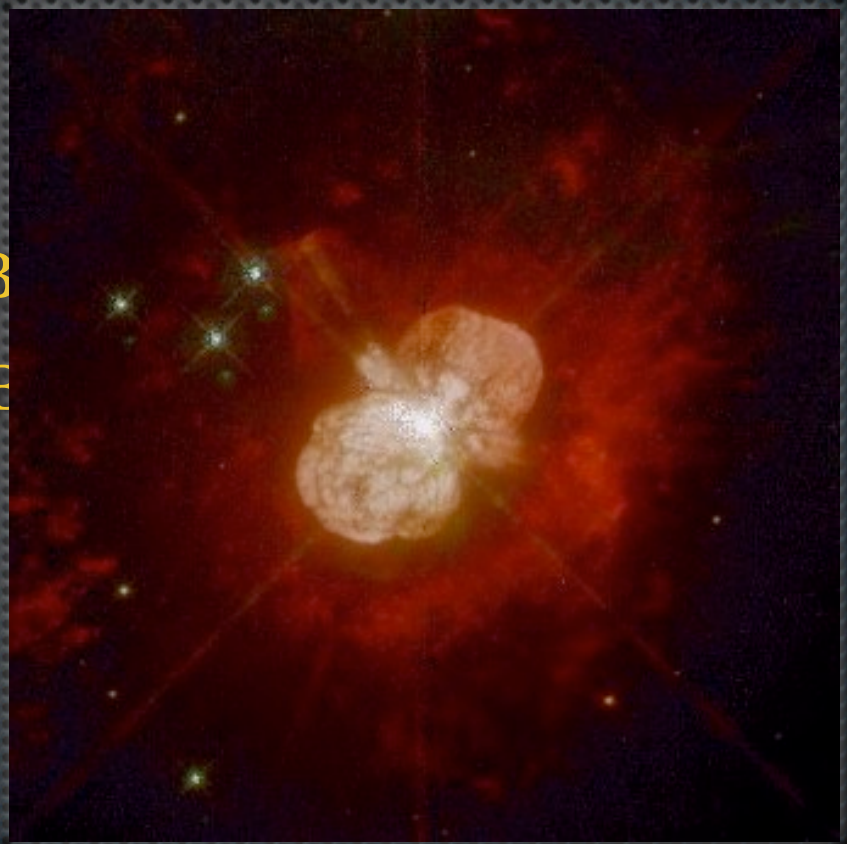

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The life cycle of stars

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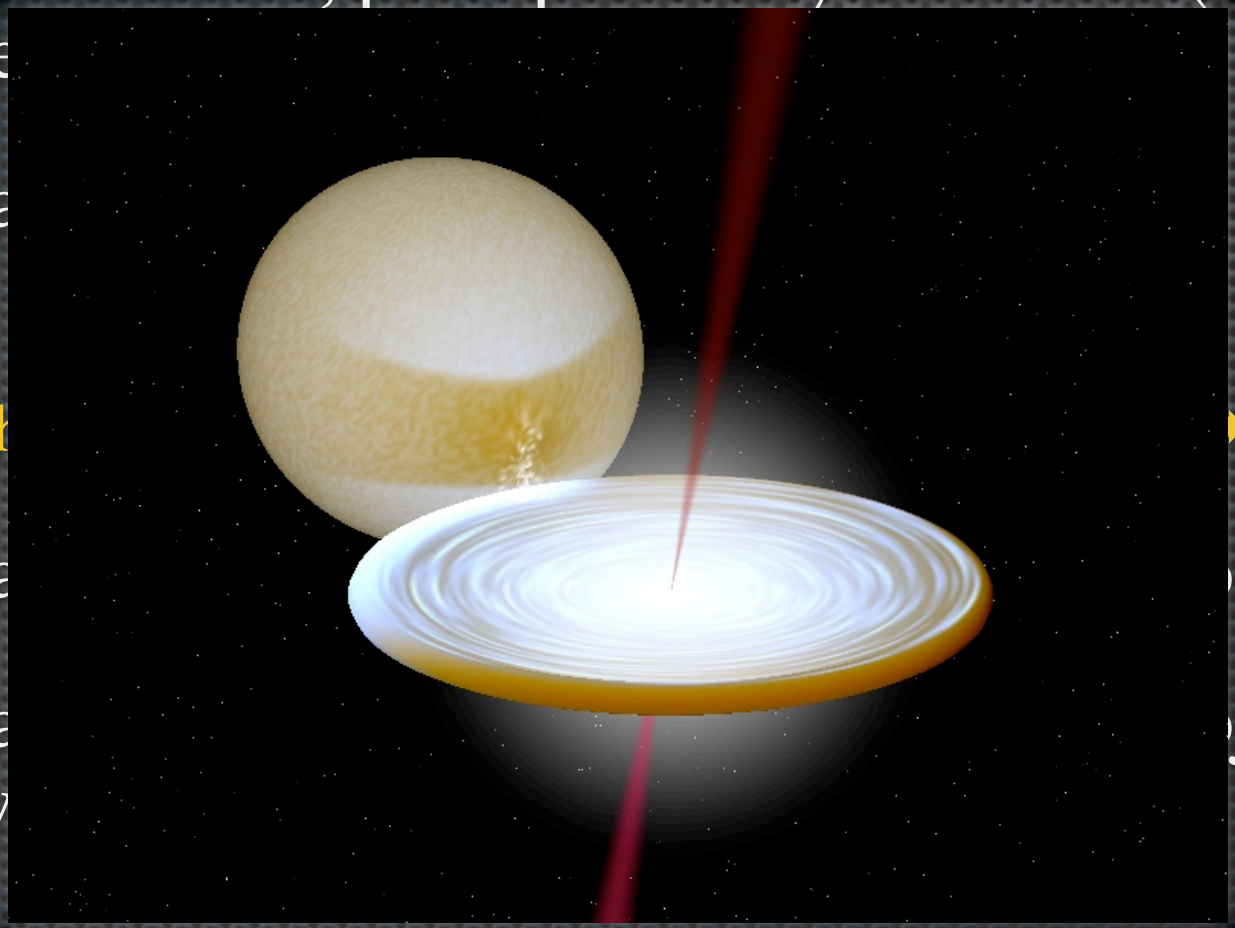
- Stella
  - low
  - high → NS/BH
- Stella n)
- Stella jects, X-ray



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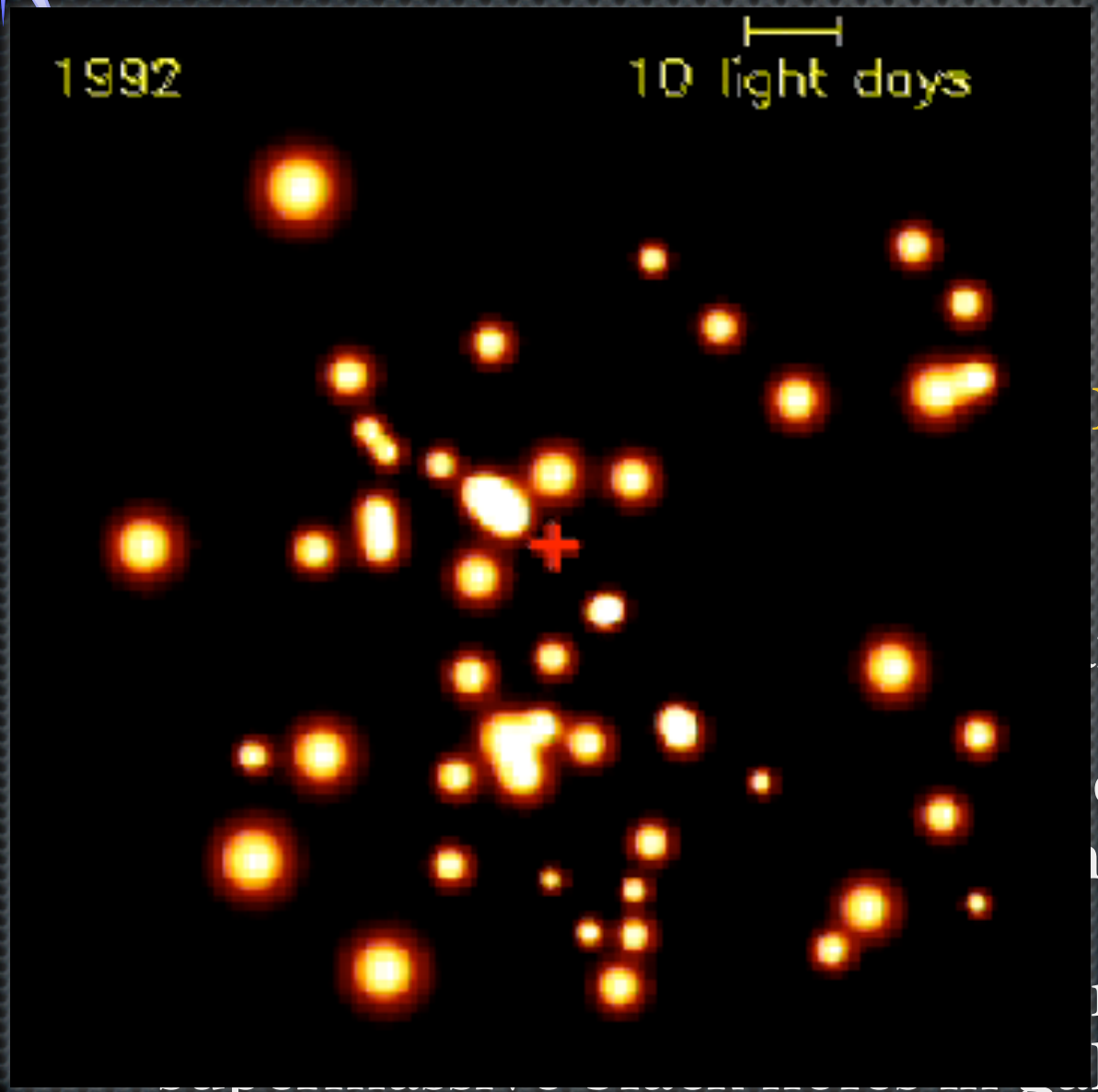
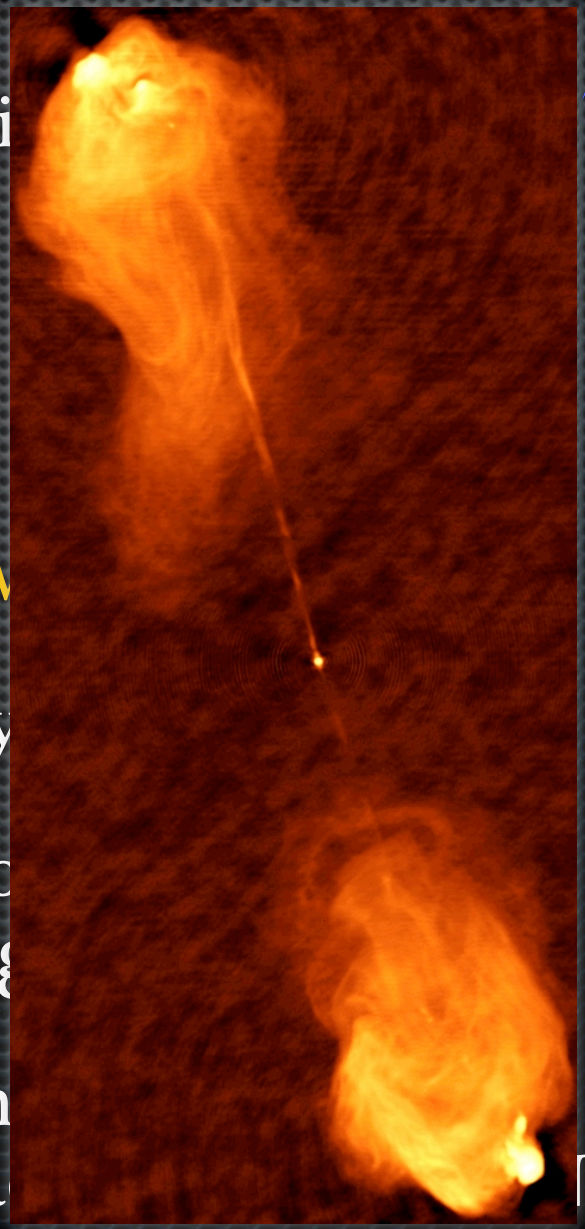
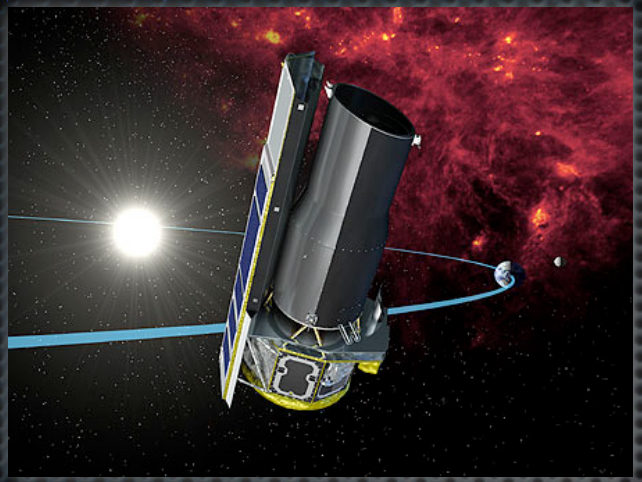
- Relationship between stellar remnant BHs and supermassive black holes in galactic centers (AGN)

The life cycle of stars

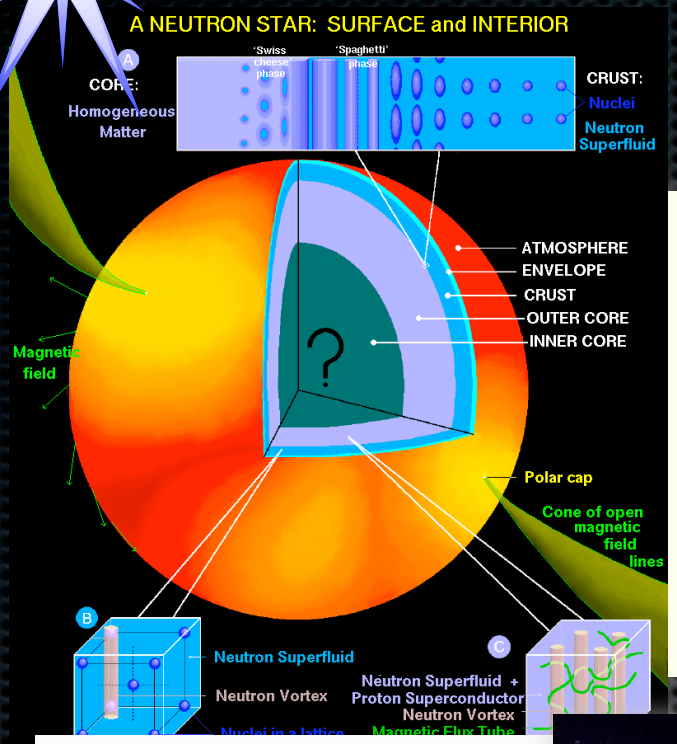


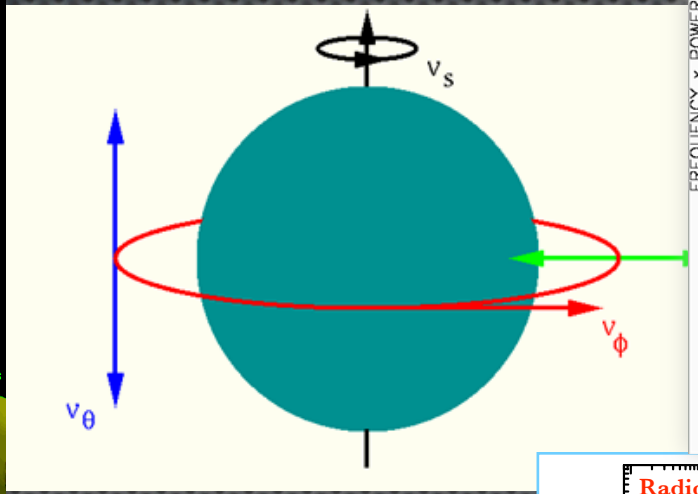


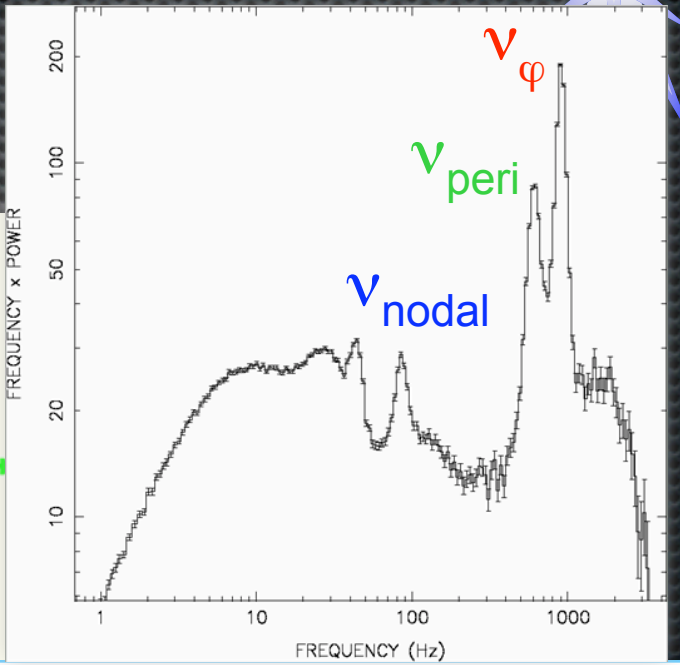
Observations

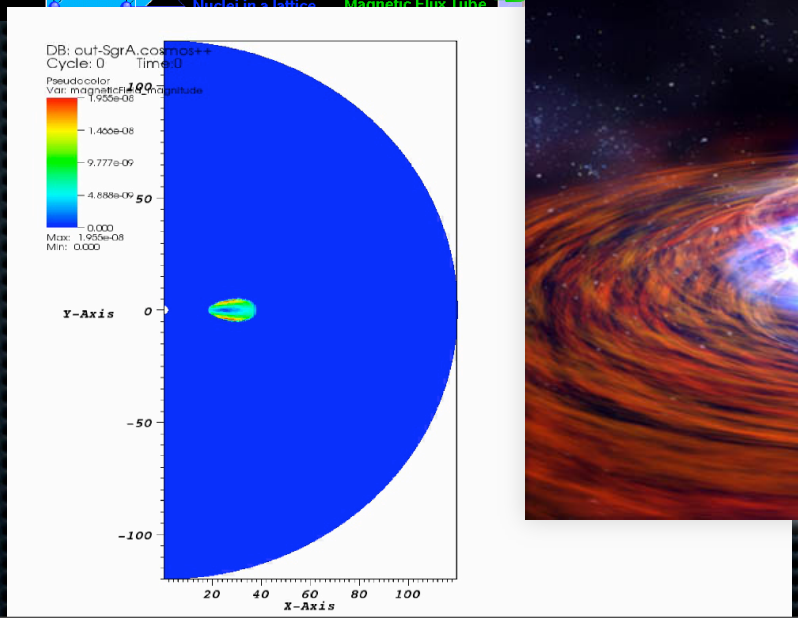


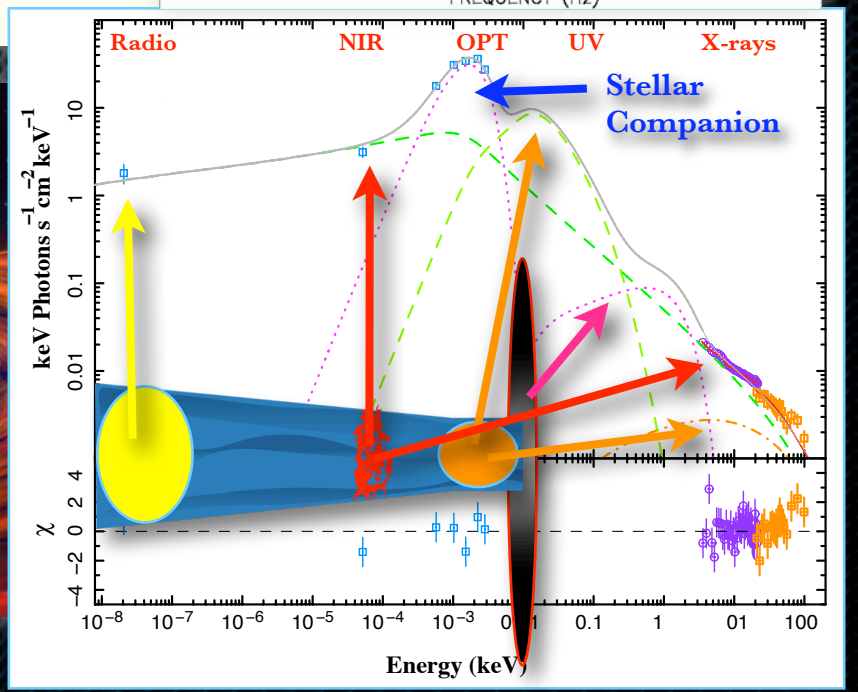
Theory


A NEUTRON STAR: SURFACE and INTERIOR
A
CORE:
Homogeneous Matter
'Swiss Cheese' phase
'Spaghetti' phase
CRUST:
Nuclei
Neutron Superfluid
ATMOSPHERE
ENVELOPE
CRUST
OUTER CORE
INNER CORE
Magnetic field
Polar cap
Cone of open magnetic field lines
B
Neutron Superfluid
Neutron Vortex
C
Neutron Superfluid + Proton Superconductor
Neutron Vortex
Magnetic Flux Tube


ν_s
ν_ϕ
ν_θ


ν_φ
ν_{peri}
ν_{nodal}
FREQUENCY × POWER
FREQUENCY (Hz)


DB: out-SgrA.cosmos
Cycle: 0
Pseudocolor
Max: 1.955e-08
Min: 0.000
Y-Axis
X-Axis


Radio
NIR
OPT
UV
X-rays
Stellar Companion
keV Photons s^{-1} cm^{-2} keV^{-1}
χ
Energy (keV)

Projects 2010

- Thermonuclear explosions on neutron stars: how do they get their spots (AWatts)
- Radio dim or quiet rotation powered pulsars (WHermsen)
- Searching for radio millisecond pulsars (JHessels)
- Fitting multiwavelength spectra from stellar mass accreting black holes (SMarkoff)
- How similar are young stellar object jets to black hole jets? (SM)
- Finding X-ray bursts with the RXTE All Sky Monitor (DAltamirano & MvdKlis)
- The existence of intermediate mass black holes (APatruno)
- Magnetars' rotational stability (APatruno)
- Protoplanetary disks: initial phase of planet formation (RWaters)
- The2175: An extinction feature in QSO and GRB sightlines (LKaper)
- Finding transients with LOFAR (RWijers)

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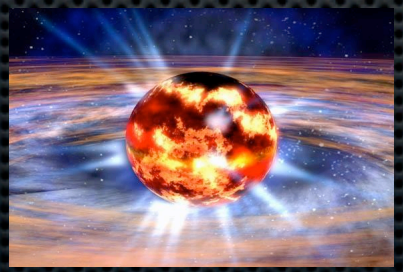
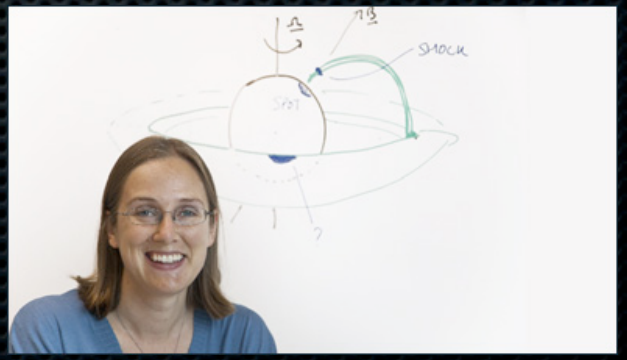
Thermonuclear explosions on NS's: how do they get their spots?

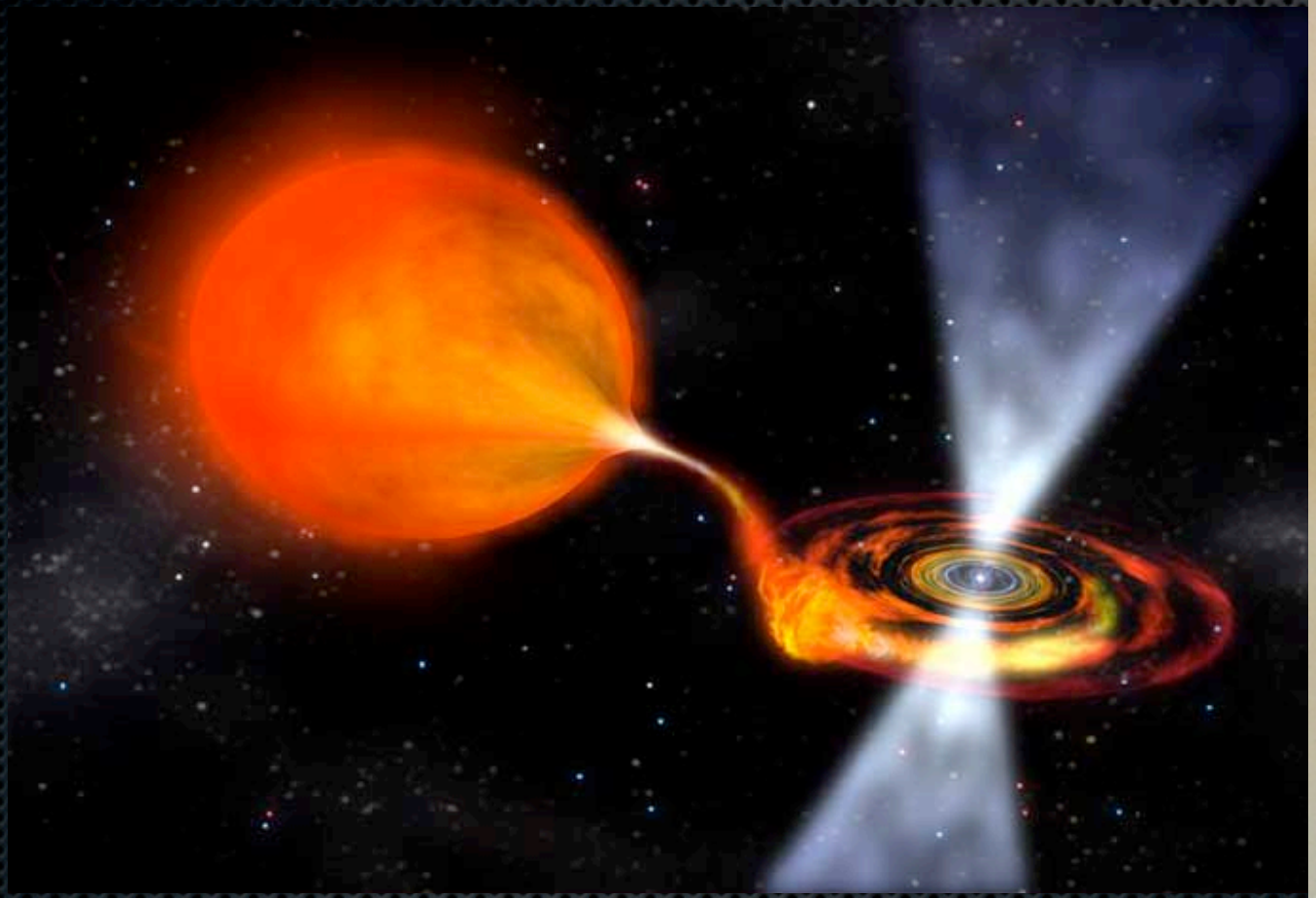
Thermonuclear explosions on NS's: how do they get their spots?

- Observational and theoretical project (Anna Watts)
  - Type I X-ray bursts = thermonuclear explosions in oceans of accreted matter on neutron stars (NS), cause by an imbalance between nuclear heating and radiative cooling
  - Probes of dense matter physics, extreme gravity and high magnetic fields near NS surface, thus very complex and many open questions
  - Project 1: Use burst oscillation "spots" to study orbits
  - Project 2: Study relationship between spot formation and physical processes on the NS surface
  - Project 3: Are spots similar to Jupiter's storm? Search for rapidly moving spot systems!



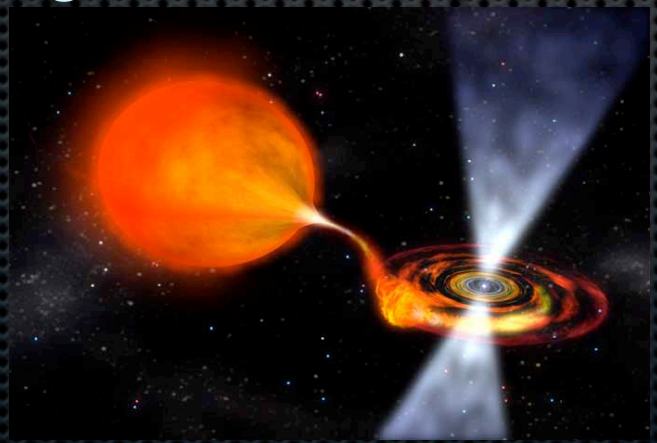


Searching for radio millisecond pulsars

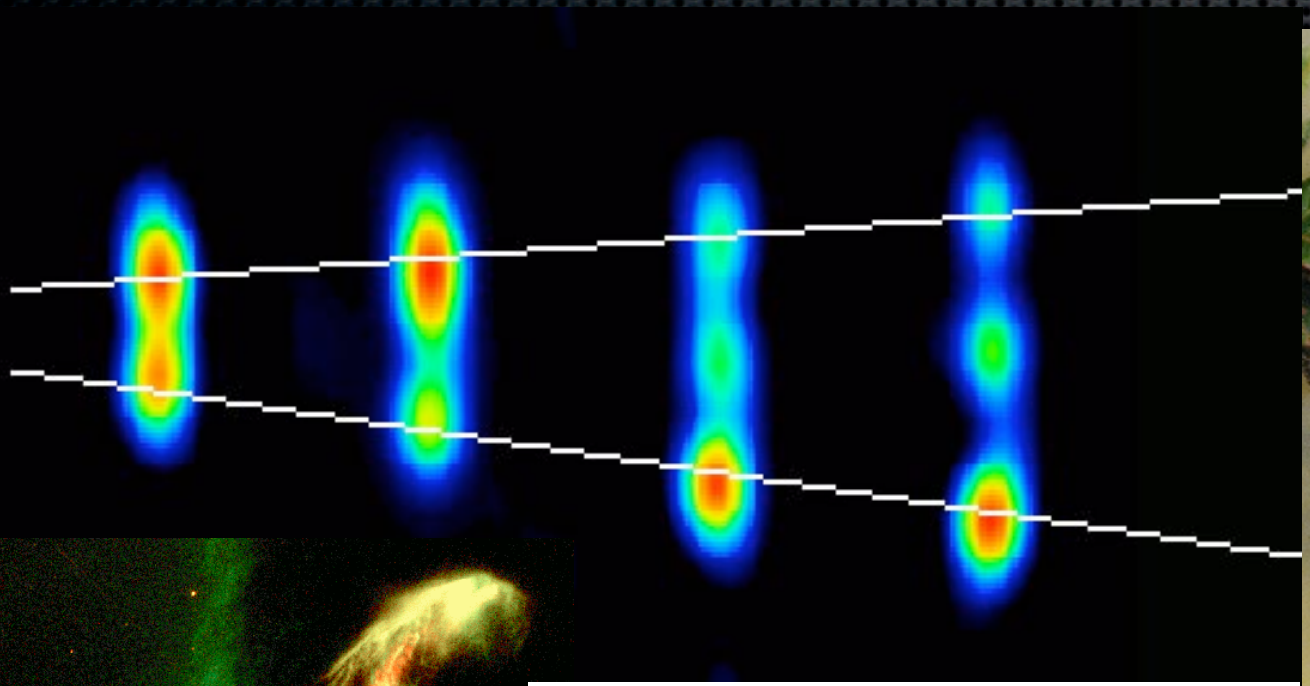


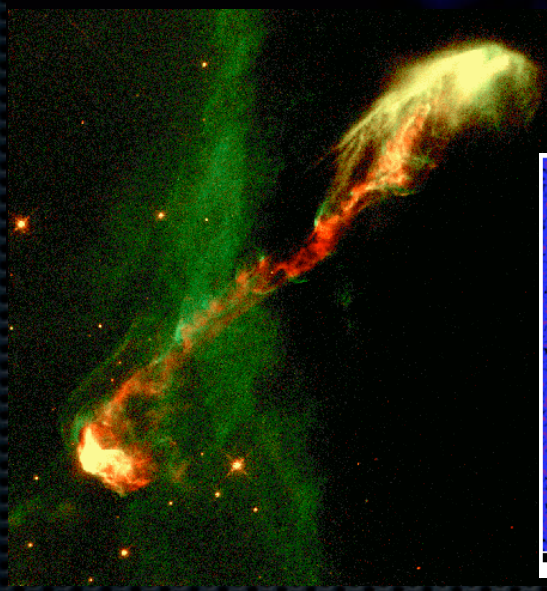
Searching for radio millisecond pulsars

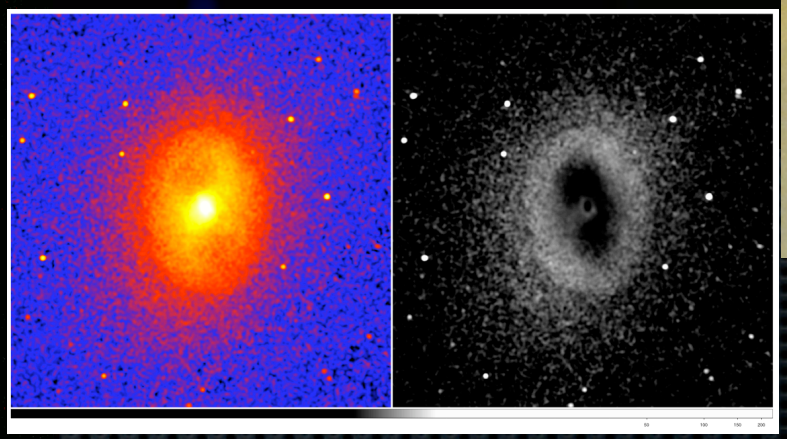
- Observational project, some time @ ASTRON (Jason Hessels)
  - MSPs are the fastest rotating stars known (~1000 cycles/s!), close to speed where theory predicts they should break apart
  - Thought to have begun life as "normal" pulsars spun-up by accretion in a compact binary, with angular momentum transfer
  - Only about 90 known in our Galaxy, and not well understood. Important to find more to probe extremes and test the physics
  - Project: search for new MSPs in terabytes of data from the largest radio telescopes in the world, using complex search algorithms. Compare to known population for new insights.



How similar are young stellar object jets to black hole jets?

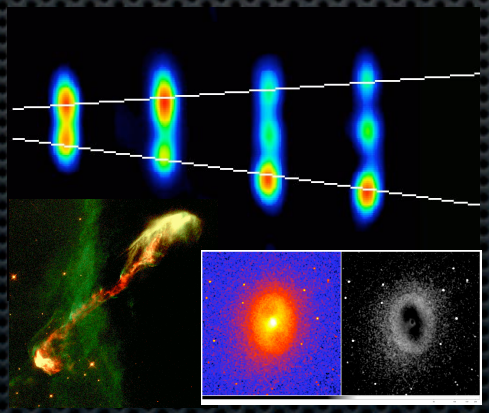




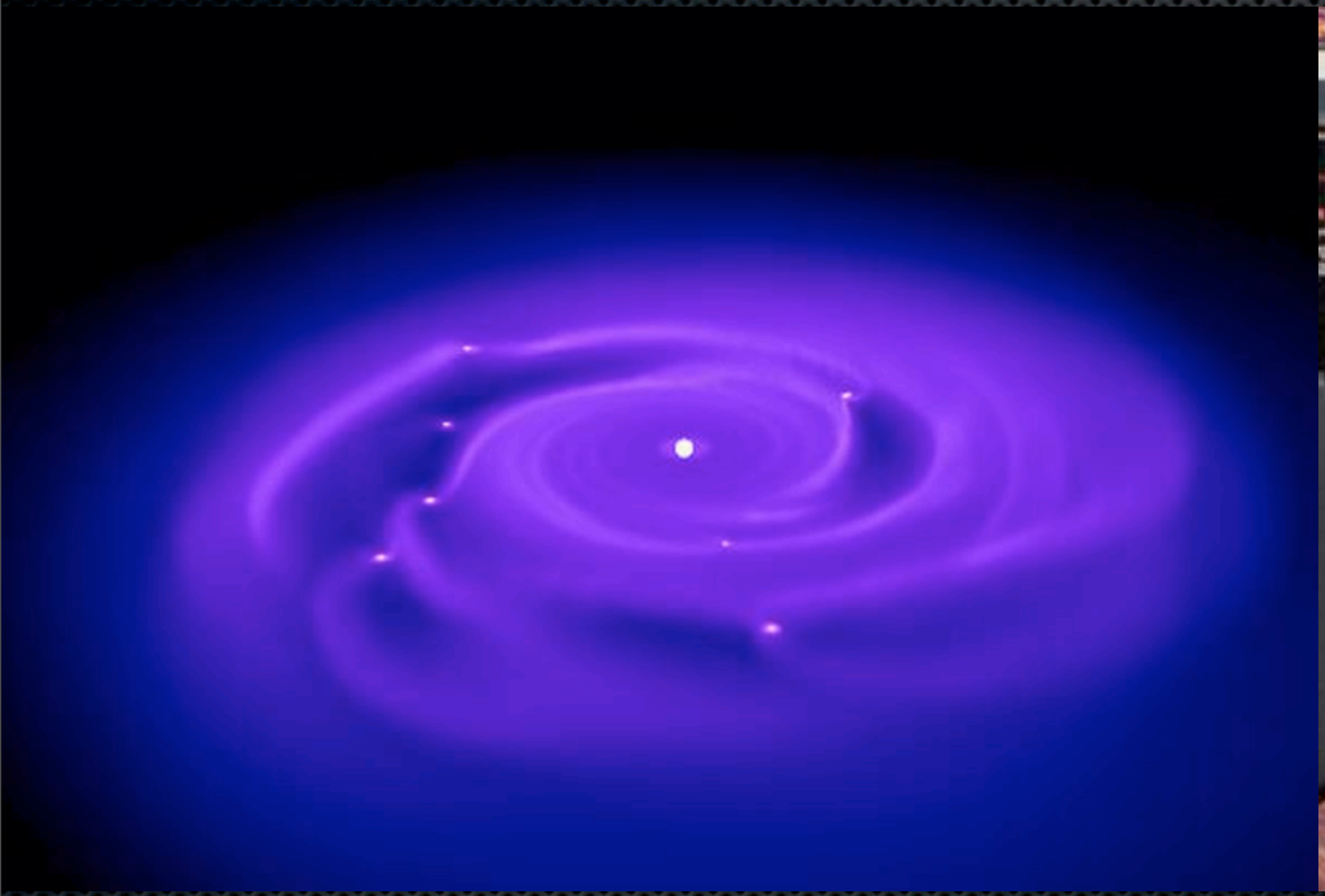


How similar are young stellar object jets to black hole jets?

- Observational & theoretical project (Sera Markoff)
  - All accreting/collapsing objects, from young stars to black holes, emit collimated outflows of plasma called jets, but we still don't fully understand how!
  - Are the jets seen around young stellar objects (YSOs) similar at all to those launched from extreme gravity and magnetic environment of BHs and NSs? If so, could rule out processes that depend on GR as the main driver (or thermal in YSOs)
  - Project: lead effort to compile a new multiwavelength data set of a YSO jet and attempt to model it using an existing BH jet model. See if it works!

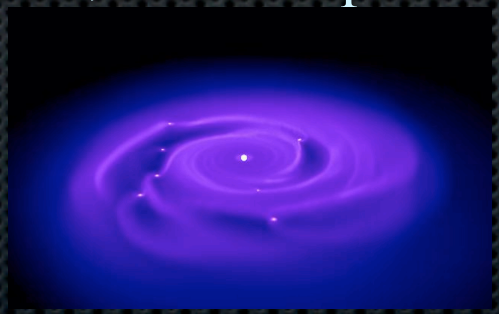


Protoplanetary disks: initial phase of planet formation



Protoplanetary disks: initial phase of planet formation

- Observational & theoretical project (Rens Waters)
  - All young low/intermediate mass stars have protoplanetary disks, a remnant of their formation, but there are two competing theories about how the planets themselves form
  - One theory favors slow growth of dust particles sticking together until the clump can itself accrete more dust/gas
  - The other theory favors gravitational instabilities and collapse.
  - A key diagnostic would be detecting (using IR observations of thermal emission) a gradient in the dust grain size
  - Project: use disk structure model to play with different dust grain distributions, and a radiative transfer code to predict IR spectra, and compare to real observations



Most projects involve relevant and important research

Astronomy & Astrophysics

LETTER TO THE EDITOR

On the interplay between flaring and shadowing in disks around Herbig Ae/Be stars

B. Acke[1,*], M. Min[2], M. E. van den Ancker[3], J. Bouwman[4], B. Ochsendorf[2], A. Juhasz[4], and L. B. F. M. Waters[1,2]

Mon. Not. R. Astron. Soc. 000, 000–000 (0000) Printed February 9, 2010 (MN LATEX style file v2.2)

High luminosity jets: Can the GRS 1915+105 plateau state be compared to the canonical hard state?

Pieter van Oers[1,2], Sera Markoff[1], Dipankar Maitra[1,3], Michael Nowak[4], Jörn Wilms[5], Alberto Castro-Tirado[6], Farid Rahoui[7,8], Jerome Rodriguez[7], Vivek Dhawan[9], and Emilios Harlaftis[10]*

February 9, 2010

ABSTRACT

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CORONA, JET, AND RELATIVISTIC LINE MODELS FOR SUZAKU/RXTE/CHANDRA-HETG OBSERVATIONS OF THE CYGNUS X-1 HARD STATE

Michael A. Nowak[1], Manfred Hanke[2], Sarah N. Trowbridge[1], Sera B. Markoff[3], Jörn Wilms[2], Katja Pottschmidt[4], Paolo Coppi[5], Dipankar Maitra[3], John E. Davis[1], Frank Tramper[2]

Submitted 2009 Feb. 18

ABSTRACT

Visit us, talk to us

- We have started a monthly Bachelors Forum for interested students to come interact with staff and students in our institute
- If you have an idea for a project that's not on our list, talk to me or one of the other staff. These projects shown today are just representative, we can always add new ones!