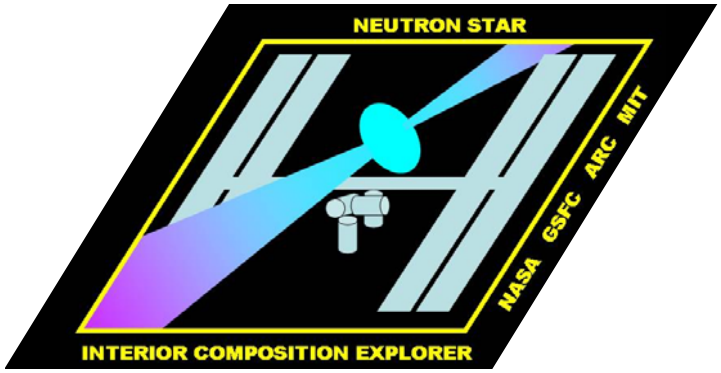
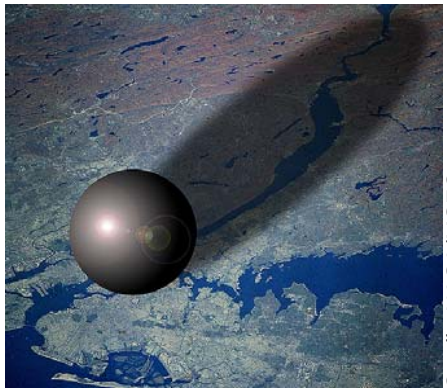


What happens when you pack 1.4 solar masses into a volume the size of New York City?

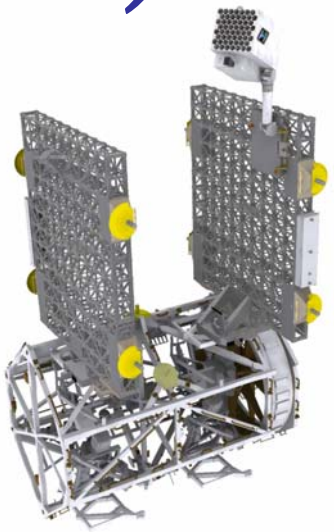


Credit: NASA/MSFC

Neutron Star Interior Composition Explorer (NICE)

PI: Keith C. Gendreau
(NASA GSFC)

Deputy PI: Zaven Arzoumanian
(CRESST/USRA)



NICE Mission Overview

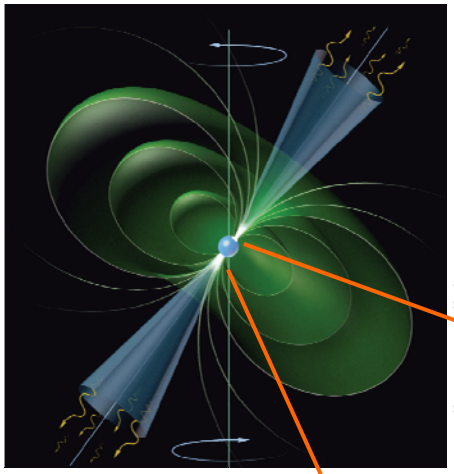
A flagship astrophysics experiment on the International Space Station: Understanding ultra-dense matter through soft X-ray timing

- ***Science:*** A proposed International Space Station (ISS) payload dedicated to the study of ***neutron stars***—a fundamental investigation of extremes in gravity, material density, and electromagnetic fields.
- ***Spacecraft:*** Hosted on the ISS Express Logistics Carrier
- ***Launch:*** JAXA *HII-B* or NASA TBD
- ***Duration:*** 18 (min.12) months
- ***Cost:*** $36M
- ***Team:*** NASA GSFC and ARC, MIT. Science co-Is from USRA, UMCP, UMBC, NRL, CfA, McGill, SUNY, MSU, F&M, NRAO, UNAM.

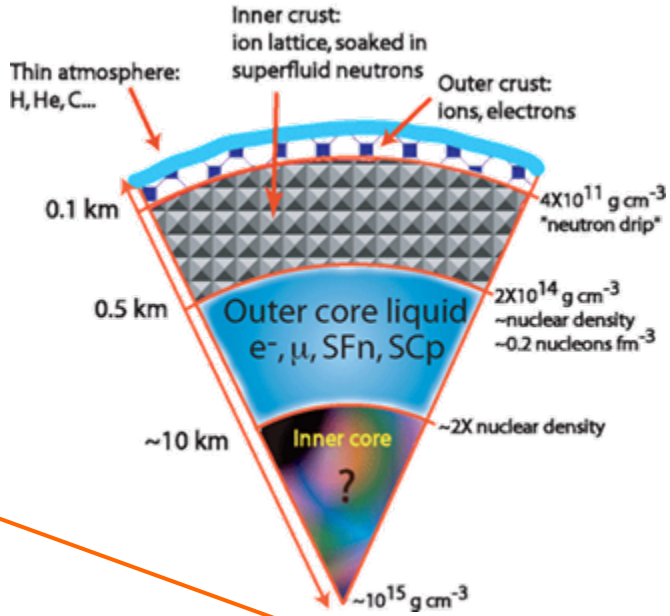
NICE Science Objectives

Neutron stars—Unique environments in which all four fundamental forces of Nature are simultaneously important.

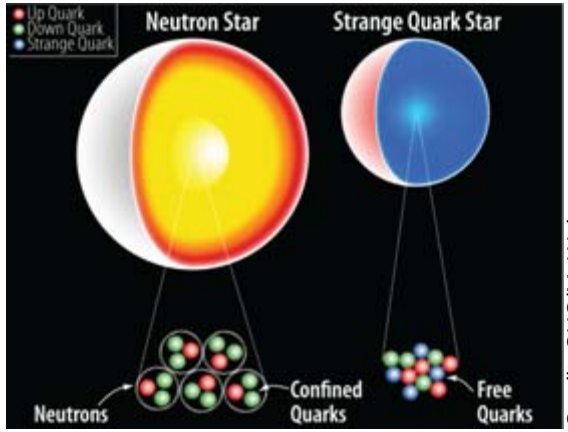
- To address NASA and National Academy of Sciences strategic questions
- To resolve the nature of ultradense matter at the threshold of collapse to a black hole
- To reveal interior composition, dynamic processes, and radiation mechanisms of neutron stars.



Credit: M. Garlick



Objective	Measurements
Structure—Reveal the nature of matter in the interiors of neutron stars.	Neutron star radii to ±5%. Cooling timescales.
Dynamics—Uncover the physics responsible for the dynamic behavior of neutron stars.	Stability of pulsars as clocks. Properties of outbursts, oscillations, and precession.
Energetics—Determine how energy is extracted from neutron stars.	Intrinsic radiation patterns, spectra, and luminosities.

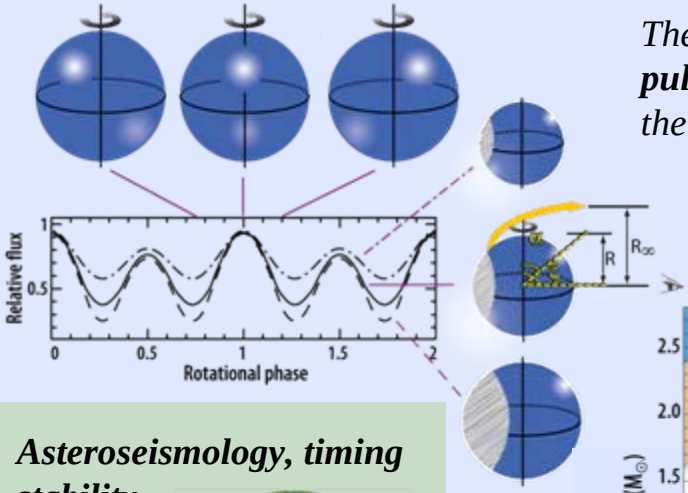


Credit: CXC/M. Weiss

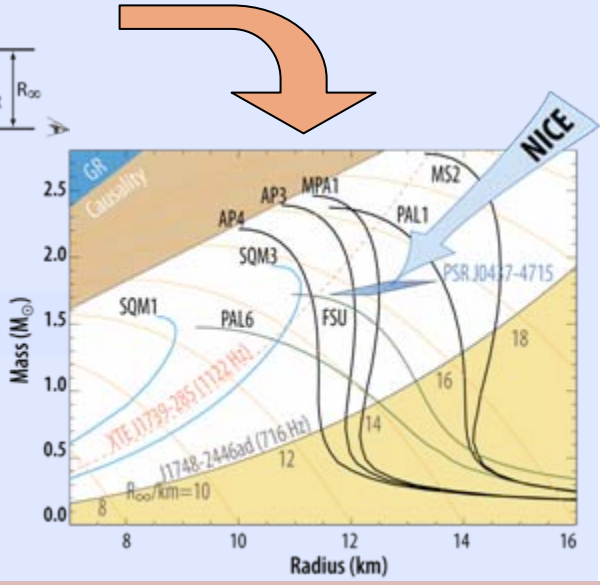
NICE Science Measurements

A Comprehensive Understanding of Neutron Star Structure, Dynamics, and Energetics

Structure: The unknown equation of state (EOS) of dense matter governs global properties such as radius for a given mass. *NICE will reveal the nature of matter at supranuclear densities*.

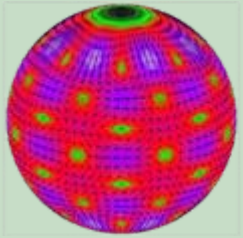


Thermal ***lightcurve modeling*** *and* ***pulsation searches*** *to constrain the mass-radius relationship…*



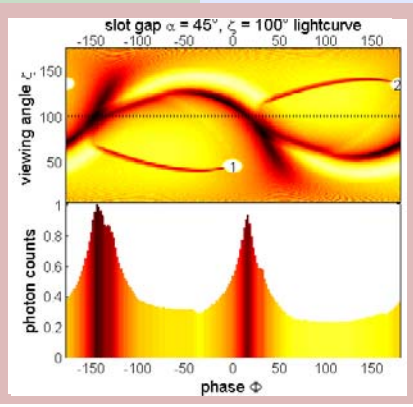
Dynamics: *NICE will reveal the bulk properties of neutron star crusts and the role of quantum fluids in time-dependent phenomena*.

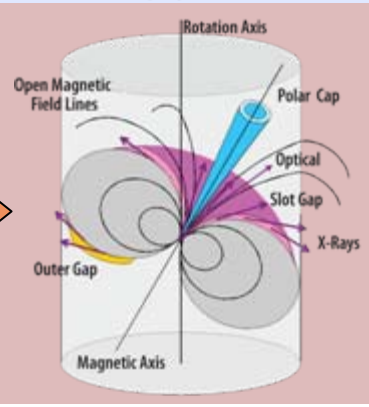
Asteroseismology, timing stability…



Energetics: Enormous magnetic fields drive particle flows and radiation across the electromagnetic spectrum. *NICE will pinpoint radiation sites and mechanisms*.

Nonthermal ***pulse shapes*** *and* ***spectra****…*

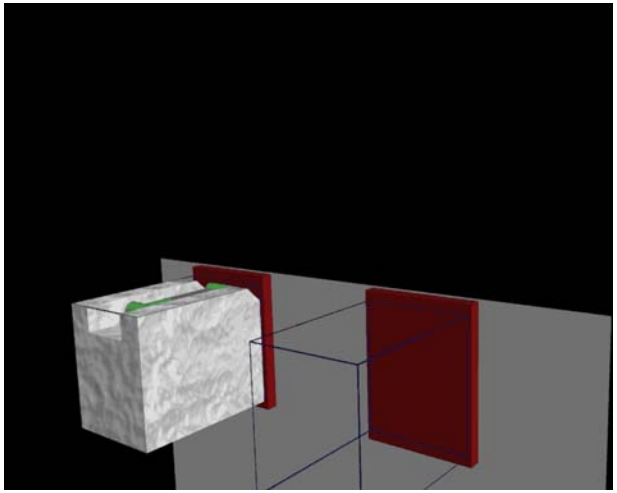


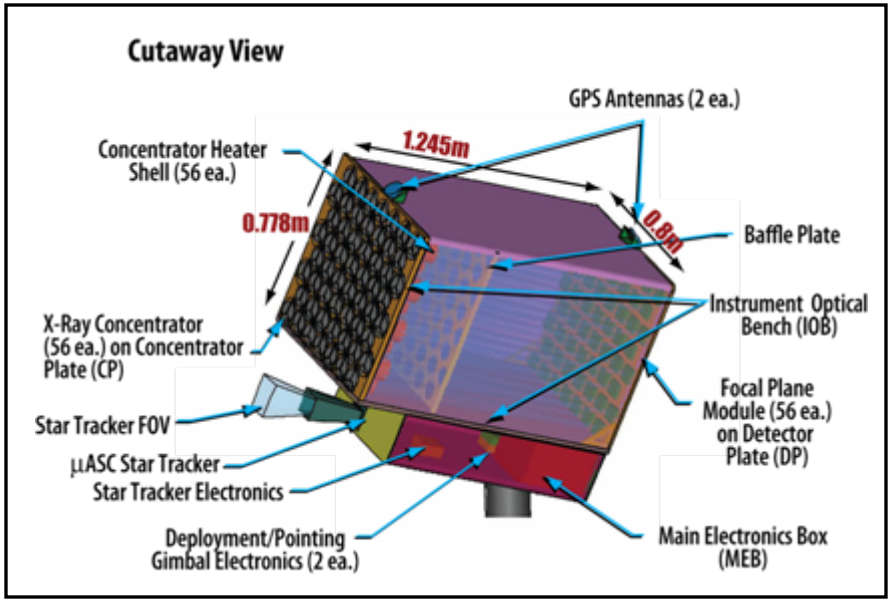


NICE Instrument Design

Technology with strong heritage, including actual flight and build-to-print hardware

- ***Optics:*** 56 grazing-incidence X-ray "concentrators"
- ***Detectors:*** 56 associated avalanche photodiode assemblies
- ***Timing:*** GPS position and absolute time reference to UTC
- ***Pointing:*** Active, star-tracker reference
- ***Environment:***
  - Tolerant of ISS vibrations
  - Contamination-insensitive, with safe-stow capability
- ***Mass:*** 165 kg
- ***Power:***
  - @ 28 V: 80 W (avg.), 107 W (peak)
  - @ 120 V: 295 W (avg.), 504 W (peak)
- ***Data Rate:*** 2 kbps (avg.), 4.8 Mbps (peak, for ~100 sec durations).

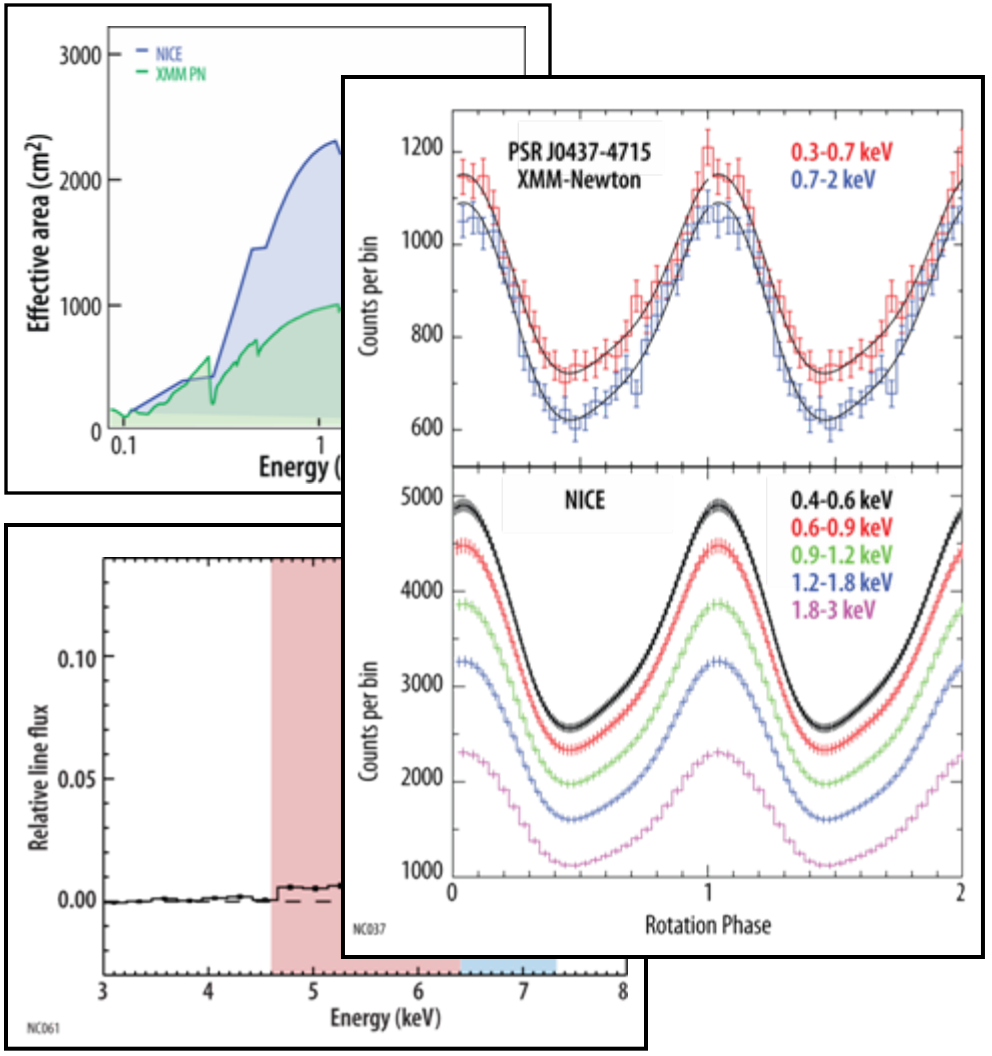




NICE Instrument Performance

High-throughput, low-background soft X-ray timing and spectroscopy

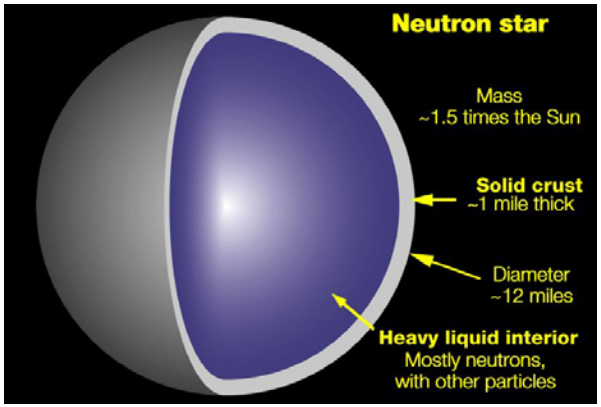
- ***Bandpass:*** 0.4–10 keV
- ***Effective area:***
  2300 cm^2 @ 1.5 keV,
  600 cm^2 @ 6 keV
  XMM-like collecting area (2x timing-capable EPIC-PN camera)
- ***Energy resolution:***
  20% @ 1 keV,
  5% @ 6 keV
  4x better than RXTE
- ***Timing resolution:*** 100 nsec absolute
  50x better than RXTE
- ***Spatial resolution:*** 3 arcmin
- ***Background:*** Dominated by diffuse cosmic XRB (soft)
- ***Sensitivity:*** 2.2 x 10^{-14} ergs/s/cm^2 (0.4–10 keV, 5σ in 10 ksec for steady source)
  ~20x better than RXTE.



Why NICE Now?

Science

- Superior combination of X-ray timing and spectroscopy advances neutron star science beyond discoveries of *Chandra*, *RXTE*, and *XMM*



- High resolution timing provides continuity for much *RXTE* science, new capability in the soft X-ray band
- Coordinated science with *GLAST* increases return on investment.

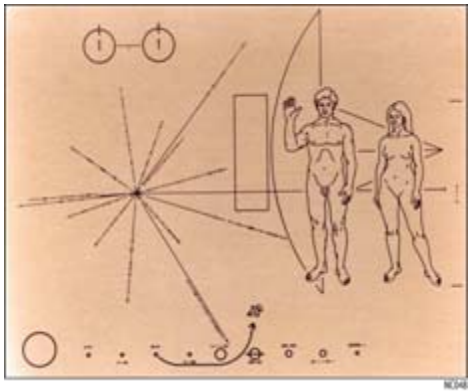
Opportunity

International Space Station provides:

- A stable platform for arcminute astronomy
- Established infrastructure (power, comm, etc.) that reduces risk
- Generous resources that simplify design and reduce cost.

Technology

- NICE will demonstrate X-ray pulsar navigation (XNAV), potentially a low-cost Solar system-wide navigation solution for the Vision for Space Exploration.



GSFC up-close: Holidays Ruined by Proposals! p.12

Pullout X-Ray Sky Chart!

SKY & TELESCOPE

THE ESSENTIAL MAGAZINE OF ASTRONOMY

S&T TEST REPORT:

- First XNAV Portables p.38
- Precision Pointing for only $5,000,000 p.41

Is NASA Naughty or NICE

The International Space Station's first astronomical observatory, Dr. Keith Gendreau's X-Ray array delivers jaw-dropping data. p.4

Neutron Star Interiors Revealed: *"We could have never guessed what we found..."* p.7

HTVs, ELCs, & DEXTRE..Oh My! Read about the long journey from Greenbelt to the ISS. p.14

Is there a Magnetar in your future? p.54

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