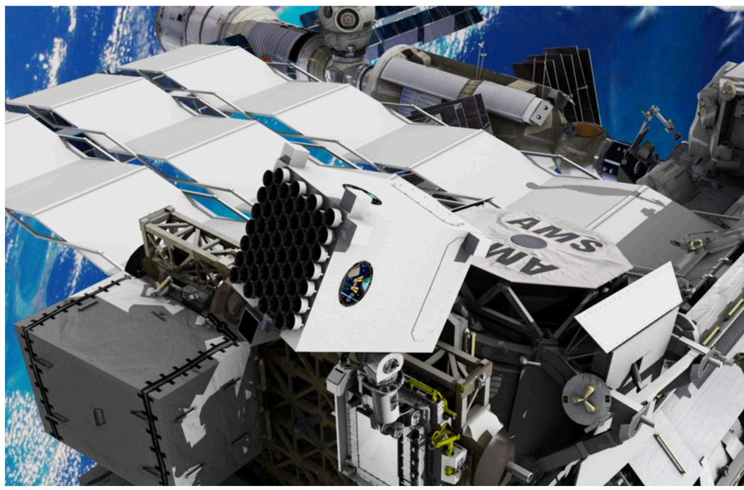
National Aeronautics and Space Administration

NASAfacts

NICER

Neutron star Interior Composition Explorer

INVESTIGATING THE DENSEST KNOWN OBJECTS IN THE UNIVERSE



"What's inside a neutron star?" is one of many long-standing astrophysics questions about the ultra-dense, fast-spinning, powerfully magnetic objects commonly observed as pulsars. The **Neutron star Interior Composition Explorer (NICER)** mission will reveal some of the extraordinary physics at work in and around neutron stars, confronting theoretical predictions with unique X-ray measurements of these stellar corpses. In particular, NICER will probe the nature of the densest stable form of matter, deep in the cores of neutron stars, by measuring the sizes of a handful of neutron stars.

NICER is the first mission designed specifically for the study of neutron stars, with simultaneous fast timing—some pulsars flicker and flash hundreds of times each second—spectroscopy, and sensitivity to faint X-ray emissions.

In addition to its principal science goals, NICER will enable the first demonstration of spacecraft navigation using pulsars as beacons, through the **Station Explorer for X-ray Timing and Navigation Technology (SEXTANT)** enhancement to the mission, which is funded by the NASA Space Technology Mission Directorate's Game-Changing Development program.

NICER team partners include NASA's Goddard Space Flight Center (GSFC), the Massachusetts Institute of Technology (MIT), the Technical University of Denmark (DTU), and Moog, Inc. Additional science team members come from the Naval Research Laboratory and universities across the USA, together with McGill University in Canada.

NICER was selected in 2013 by NASA's Science Mission Directorate as an Astrophysics Explorer Mission of Opportunity. NICER will launch in June 2017 aboard the eleventh SpaceX Commercial Resupply Services (CRS-11) flight to the International Space Station. The payload will be robotically installed on one of space station's zenith-side Express Logistics Carrier (ELC) platforms.

NICER SCIENCE OBJECTIVES

UNCOVERING THE NATURE AND BEHAVIOR OF NEUTRON STARS

Neutron stars embody extreme conditions impossible to replicate in a laboratory. NICER provides high-precision measurements of the structure, dynamics, and energetics of neutron stars through observations in "soft" X-rays (photon energies between 0.2 and 12 keV), the part of the electromagnetic spectrum in which these stars radiate both from their million-degree solid surfaces and from their strong magnetic fields. NICER seeks to:

- Make mass and radius determinations by measuring fast X-ray brightness variations with unprecedented precision. NICER's results will discriminate between dozens of proposed "equation of state" theoretical models, constraining a basic unknown of nuclear physics, the so-called nuclear symmetry energy at high densities.
- Discover periodic pulsations and other brightness oscillations in both steady and transient neutron star systems.
- Explore the maximum spin rate of neutron stars, and establish the long-term (months to years) spin stability of millisecond-period pulsars, nature's best clocks.
- Characterize outbursts and spin variations from dynamic phenomena associated with neutron stars, such as thermonuclear explosions on their surfaces and spin "glitches" arising from their superfluid interiors.
- Define the physical properties (mechanical, thermal) of the solid crusts of neutron stars, by measuring temperatures and detecting natural vibration frequencies in star-quakes.
- Determine X-ray radiation patterns and spectra, especially in relation to emissions in other wavelength bands such as radio and gamma-ray, to test models of radiation in ultra-strong magnetic and gravitational fields.

NICER MISSION OVERVIEW

ASTROPHYSICS ON THE SPACE STATION

NICER will achieve its science objectives by collecting X-ray photons from neutron stars distributed across the sky. Fifteen million seconds (equivalent to six uninterrupted months) of total exposure time distributed over 18 calendar months for several dozen identified targets will be needed to achieve the mission's science objectives. Typically, NICER will observe between two and four targets during each 91-minute International Space Station orbit.

A broader astrophysics agenda, aimed at black holes, galaxies, and other X-ray emitters, will also be possible.

NICER SCIENCE INSTRUMENT

56 OPTICS AND DETECTORS

The X-ray Timing Instrument (XTI) consists of an array of 56 X-ray "concentrator" optics and matching silicon detectors, which record the times of arrival and energies of individual X-ray photons. The payload uses an on-board GPS receiver to register photon detections to precise GPS time and position, while a star-tracker camera guides the pointing system, which uses gimbaled actuators to track targets with the XTI.

PLATFORM AND DESIGN

ESTABLISHED PLATFORM AND BENIGN ENVIRONMENT

The International Space Station offers established infrastructure for transportation, power, and communication for the NICER payload. The stable platform and generous resources simplify NICER's design, reducing cost and risk. NICER's design is tolerant of the space station vibration, contamination, and radiation environments.

NICER will launch in 2017 and operate from the International Space Station.

For more information about NICER:
www.nasa.gov/nicer

For technical information about NICER:
https://heasarc.gsfc.nasa.gov/docs/nicer/

For more information about SEXTANT:
http://go.nasa.gov/2kieLxa

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