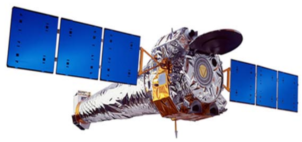
CHANDRA X-RAY OBSERVATORY

The Chandra X-ray Observatory is the third in NASA's family of Great Observatories that includes the Hubble Space Telescope and the Compton Gamma Ray Observatory. NASA's Marshall Space Flight Center manages the Chandra program. TRW is the prime contractor for the spacecraft. Key subcontractors include Ball Aerospace & Technologies, Inc., Eastman Kodak Company, and Raytheon Optical Systems, Inc. The scientific instruments were built by teams from MIT, Pennsylvania State University, the Smithsonian Astrophysical Observatory, the Laboratory for Space Research in the Netherlands, and the Max Planck Institute in Germany. The Smithsonian's Chandra X-ray Center controls science and flight operations from Cambridge, MA.

“Strange Matter” Press Kit Contents:



Cosmic X-rays Reveal Evidence For New Form Of Matter

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NASA's Chandra X-ray Observatory has found two stars - one too small, one too cold - that reveal cracks in our understanding of the structure of matter. These discoveries open a new window on nuclear physics, offering a link between the vast cosmos and its tiniest constituents.

Chandra's observations of RX J1856.5-3754 and 3C58 suggest that the matter in these stars is even denser than nuclear matter found on Earth. This raises the possibility these stars are composed of pure quarks or contain crystals of sub-nuclear particles that normally have only a fleeting existence following high-energy collisions.

By combining Chandra and Hubble Space Telescope data, astronomers found that RX J1856 radiates like a solid body with a temperature of 1.2 million degrees Fahrenheit (700,000 degrees Celsius) and has a diameter of about 7 miles (11.3 kilometers). This size is too small to reconcile with standard models for neutron stars -- until now the most extreme form of matter known.

"Taken at face value, the combined observational evidence points to a star composed not of neutrons, but of quarks in a form know as strange quark matter," said Jeremy Drake of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Mass., and lead author of a paper on RX J1856 to appear in June 20, 2002 issue of The Astrophysical Journal. "Quarks, thought to be the fundamental constituents of nuclear particles, have never been seen outside a nucleus in Earth-bound laboratories."

Observations by Chandra of 3C58 also yielded startling results. A team composed of Patrick Slane and Steven Murray, also of CfA, and David Helfand of Columbia University, New York, failed to detect the expected X-radiation from the hot surface of 3C58, a neutron star believed to have been created in an explosion witnessed by Chinese and Japanese astronomers in 1181 AD. The team concluded that the star has a temperature of less than one million degrees Celsius, which is far below the predicted value.

"Our observations of 3C58 offer the first compelling test of models for how neutron stars cool and, the standard theory fails," said Helfand. "It appears that neutron stars aren't pure neutrons after all -- new forms of matter are required."

A teaspoonful of neutron star material weighs a billion tons, as much as all the cars, trucks and buses on Earth. Its extraordinary density is equivalent to that of the nucleus of an atom with all of the typical space between the atoms and their nuclei removed. An atom's nucleus is composed of positively charged protons

Protons and neutrons are composed of even smaller particles called quarks, the basic building blocks of matter. Enormous atom smashers are designed to probe the forces between quarks and the structure of the nucleus by smashing high-energy beams of nuclei into each other and observing the violent aftermath for a fraction of a second.

Drake cautioned that the observations of RX J1856 could be interpreted as a more normal neutron star with a hot spot. Such a model is under consideration by Fred Walter of the State University of New York, Stony Brook, one of the discoverers of RX J1856, which was originally found in 1996 by the German Roetgen satellite. However, the hot spot model requires a very special orientation of the star with respect to the Earth to explain the absence of pulsations, which would be expected from the hot spot. The probability of such an orientation is quite small.

"Regardless of how these mysteries are resolved, these precise observations are highly significant," said Michael Turner of the University of Chicago. "They demonstrate our ability to use the universe as a laboratory where we can study some of the most fundamental questions in physics."

NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Chandra program, and TRW, Inc., Redondo Beach, Calif., is the prime contractor. The Smithsonian's Chandra X-ray Center controls science and flight operations from Cambridge, Mass.

PRESS GUIDE TO SCIENCE CONTACTS

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THE CHANDRA X-RAY OBSERVATORY

The Chandra X-Ray Observatory, launched on July 23, 1999, has taken its place with the Hubble Space Telescope and Compton Gamma Ray Observatory in NASA's fleet of Great Observatories. As the world's premier X-ray observatory, Chandra gives astronomers a powerful new tool to investigate the hot regions of the universe where black holes, exploding stars, and colliding galaxies hold sway.

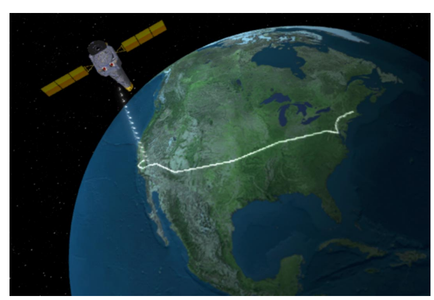
With its combination of four pairs of ultra smooth, high-resolution mirrors and efficient X-ray detectors, Chandra makes images at least thirty times sharper than any previous X-ray telescope. The High Resolution Camera, and the Advanced CCD Imaging Spectrometer record images electronically, and two transmission gratings enable scientists to make precise measurements of the energies of incoming X rays.

The Chandra X-Ray Observatory Center

The Chandra program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama, is an example of NASA's initiative to streamline the operations of its space science missions. The Smithsonian Astrophysical Observatory's Chandra X-Ray Center (CXC), under the direction of Dr.Harvey Tananbaum, is located at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. The CXC is responsible for planning the science observations based on proposals from the scientific community, processing data received from the observatory, and providing technical and scientific support to the scientists who use Chandra. The Center operates the observatory from its Operations & Control facility located at One Hampshire Street in Cambridge, Massachusetts.

The CXC is a collaboration of personnel from the Smithsonian Astrophysical Observatory, the Massachusetts Institute of Technology (MIT), and the Chandra prime contractor, TRW.

The Operations & Control Center (OCC) is staffed by the CXC, with the Flight Operations Team provided by TRW. The OCC has a glass-walled area outside the main control room where visitors and press can watch the Flight Operations Team and mission specialists as they communicate with the observatory and carry out the space flight operations.



Commands for executing the observation plan are transmitted from the OCC to one of three ground stations (in Spain, Australia, or California) that make up NASA's Deep Space Network (DSN). The DSN relays the commands to the orbiting spacecraft. The spacecraft carries out the commands and points the telescope to the specified targets, and moves the science instruments to their appropriate positions.

During routine operations, science data and monitoring data are sent from the spacecraft to the OCC, via the DSN, approximately every eight hours. Scientists and engineers use monitoring data to assess Chandra's condition. If the health or safety of the observatory appears to be in danger, the operating mode and the observation plans are modified.

Data from Chandra observations are processed at the Chandra Center. Observatory calibration data are made public as soon as possible. The scientific data belonging to guest observers and guaranteed time observers can be held by them for one year to allow time for analysis and publication of scientific results. The data are then placed in the public archive.

Dr. Anne Kinney
Director, Astronomy and Physics Division, NASA

Anne Kinney's broad experience in astronomy, from promoting astronomy to the public to working as a Hubble Space Telescope instrument scientist, serves as the background for her job as Director of the Astronomy and Physics Division. Her main challenges are to get the Next Generation Space Telescope and the Space Interferometry Mission launched and to interact with the astronomical community to keep informed of the latest science.

"Astronomy and Physics has spectacular new projects, and one of my duties is to keep them on track and on budget so that they actually fly," Kinney says. "By working closely with astronomers, I will seek out cutting-edge technologies and advocate new missions that will help deepen our understanding of the universe."

Another special role for Kinney is continuing her public outreach efforts.

"I want to cultivate an active relationship with the American public to bring science to people who pay for it," she explains.

Working at the Space Telescope Science Institute in Baltimore, Md., for 14 years has given her the skills to efficiently perform her science program director duties. As an instrument scientist for the Hubble telescope's Faint Object Spectrograph (FOS), Kinney learned the complexities of a spacecraft. She also saw the Hubble telescope before it was launched.

"I was testing the FOS camera at Lockheed Martin," Kinney recalls. "The four-story-tall telescope loomed above me, all covered in its shiny Mylar. Because of that experience, I have a real affection for the telescope and an appreciation for other spacecraft in the Astronomy and Physics program."

Kinney also worked in the institute's Office of Public Outreach, leading the education department and offering her expertise as a guest commentator on NASA's Space Science Updates (SSUs). She also is a co-investigator for the Hubble Heritage Project.

Among the 17 SSUs in which Kinney participated, her most memorable were the programs on debris striking the inner ring of Supernova 1987A and the dynamic weather on Mars. After the Mars SSU, Kinney reported on Mars's weather patterns for a Washington, D.C., television station.

Kinney has written 75 scientific papers, including one on an atlas of galaxy spectra taken in ultraviolet light. The paper was produced at a time when astronomers didn't have an overall picture of how galaxies looked in the ultraviolet. Kinney's data are important to understand the populations of stars in the galaxies and eventually to comprehend the relationship between galaxies of different types. Kinney serves on the editorial board of Astronomy Magazine and is an American Astronomical Society council member. She earned a Bachelor of Arts degree with honors from the University of Wisconsin in 1975 and a doctorate in astrophysics from New York University in 1984.

Dr. Jeremy Drake
Astrophysicist, Smithsonian Astrophysical Observatory

Jeremy Drake is an Astrophysicist at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. His research has included work in different fields of astrophysics, including: stellar atmospheres, stellar coronae and activity; the chemical compositions of stars and stellar evolution; the interstellar medium; EUV-X-ray spectroscopy; and X-ray instrumentation.

Drake was an undergraduate at the University of Newcastle-Upon-Tyne, and obtained a doctorate in Astrophysics at Oxford University in 1989. He held a NATO postdoctoral fellowship at the University of Texas at Austin between 1990-1992, where he worked on the chemical compositions stars and stellar evolution. He took up a postdoctoral fellowship at the Center for EUV Astrophysics of the University of California, Berkeley, during 1992-1993, followed by a position as Research Astronomer from 1993-1995. In Berkeley, Drake worked in areas including stellar outer atmospheres and magnetic activity, and research involving the NASA Extreme Ultraviolet Explorer satellite. He took up his present position at the Smithsonian Astrophysical Observatory in 1995, where he works with the Chandra X-ray Observatory and different areas of X-ray astronomy and stellar physics.

Dr. David J. Helfand
Professor of Astronomy, Columbia University

David J. Helfand is Professor of Astronomy at Columbia University. He received his undergraduate degree from Amherst College and his Ph.D. from the University of Massachusetts. Apart from several years spent visiting several European institutes, most recently as the Sackler Distinguished Visiting Astronomer at the University of Cambridge, he has spent his entire career at Columbia where he served as Chair of the Department for twelve years. He is also a past Chair of the High Energy Astrophysics Division of the American Astronomical Society, and was also a Councilor of the Society.

His work has spanned a wide range of topics from large-scale radio surveys of the Universe to X-ray observations of astronomical objects ranging from nearby stars to the most distant quasars. For nearly twenty-five years, he has been pursuing the detection of X-rays from the surface of neutron stars, and is delighted that Chandra now provides the requisite sensitivity and resolution to make such observations possible.

Dr. Norman K. Glendenning
Senior Scientist Emeritus, Lawrence Berkeley National Laboratory

Norman K. Glendenning started his career in theoretical nuclear physics, an area he researched for about 20 years. He has studied theoretical astrophysics for the past two decades, with a focus in the area of compact stars. Glendenning was born in Canada, and is now a US citizen. After receiving his Ph.D. in 1959 at Indiana University, he joined the Lawrence Berkeley National Laboratory at the University of California, where he has spent his entire professional career except for frequent visits abroad. For many years, he held a visiting position at the University of Paris at Orsay.

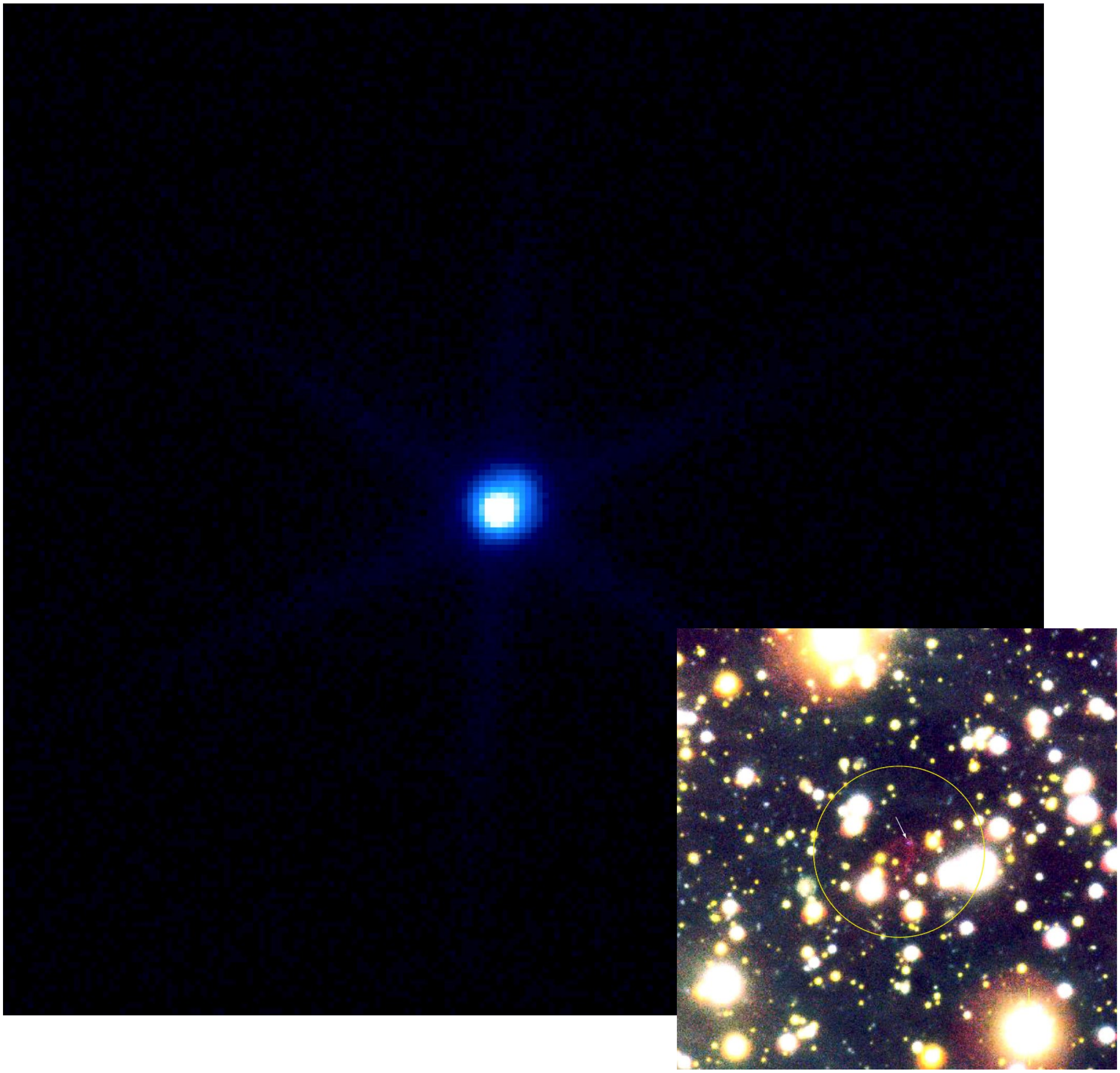
He has published two technical books, the first on Direct Nuclear Reactions (Academic Press, 1983) and the second on Compact Stars (Springer-Verlag, 1st edition 1996, 2nd edition 2000). He has published almost 200 research articles in scholarly journals. One of his papers was featured among 10 highlights in astrophysics in Physics News in 1997. He was awarded an Alexander von Humboldt Prize in 1994 for his outstanding research in nuclear and astrophysics.

Dr. Michael S. Turner
Professor and Chair of the Department of Astronomy & Astrophysics, The University of Chicago

Michael S. Turner is the Bruce V. and Diana M. Rauner Distinguished Service Professor and Chair of the Department of Astronomy & Astrophysics at The University of Chicago. He also holds appointments in the Department of Physics and Enrico Fermi Institute at Chicago and is a member of the scientific staff at the Fermi National Accelerator Laboratory. Turner received his B.S. in Physics from the California Institute of Technology (1971) and his Ph.D. in Physics from Stanford University (1978).

Turner is a cosmologist whose research focuses on the earliest moments of creation. His current research deals with the mystery of why the expansion of the Universe is speeding up and not slowing down and the dark energy that is causing the accelerated expansion. Turner is one of the pioneers of the interdisciplinary field that has brought together cosmologists and elementary particle physicists, and chairs the National Academy's Committee on the Physics of the Universe, which is exploring the opportunities for research at the intersection of physics and astronomy.

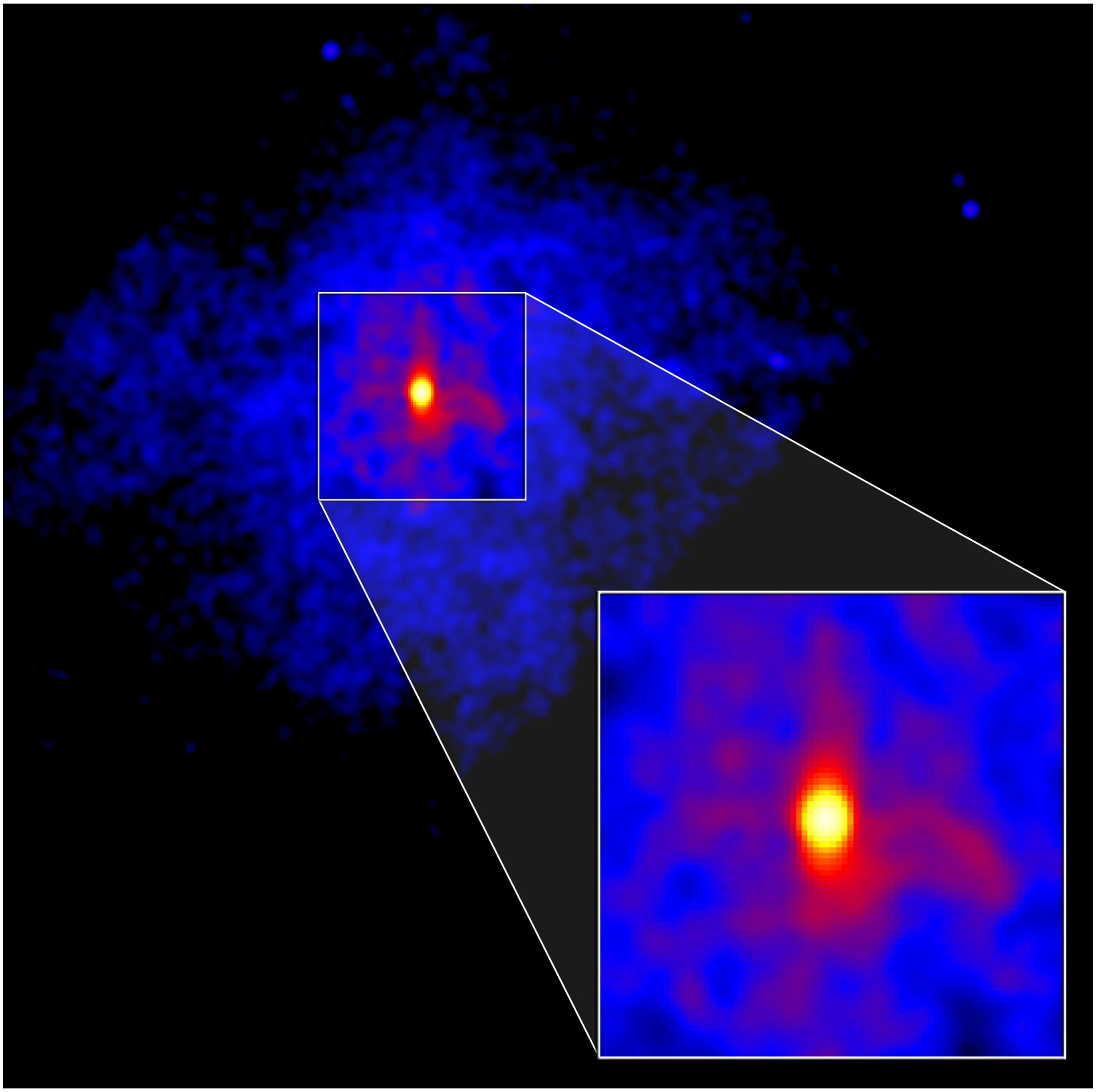
RX J1856.5-3754



Chandra's X-ray image (main image) shows that RX J1856.5-3754 outshines all of the other sources in the field, indicating it is both extremely hot and very small. The optical image of RX J1856.5-3754 (lower right) shows a crowded region of star formation.

Credit: X-ray: NASA/CXC/CfA/J. Drake et al.
Optical: European Southern Observatory Very Large Telescope

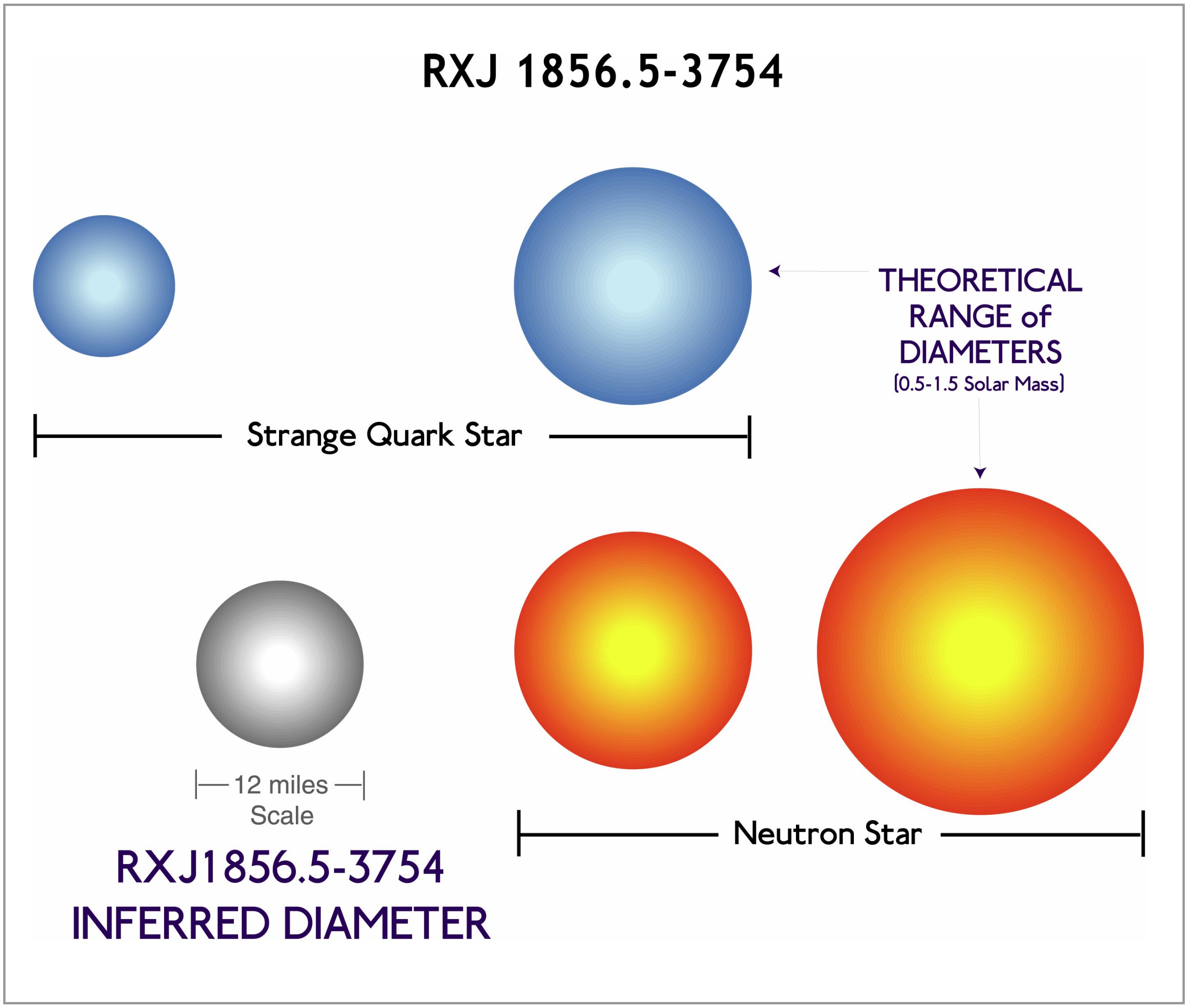
SUPERNOVA REMNANT 3C58



Chandra observations of 3C58, the remnants of a supernova noted on Earth in AD 1181, reveal that the neutron star in the core has a temperature much lower than expected. This suggests that a new state of nuclear matter might exist inside the star.

Credit: NASA/CXC/CfA/P. Slane et al.

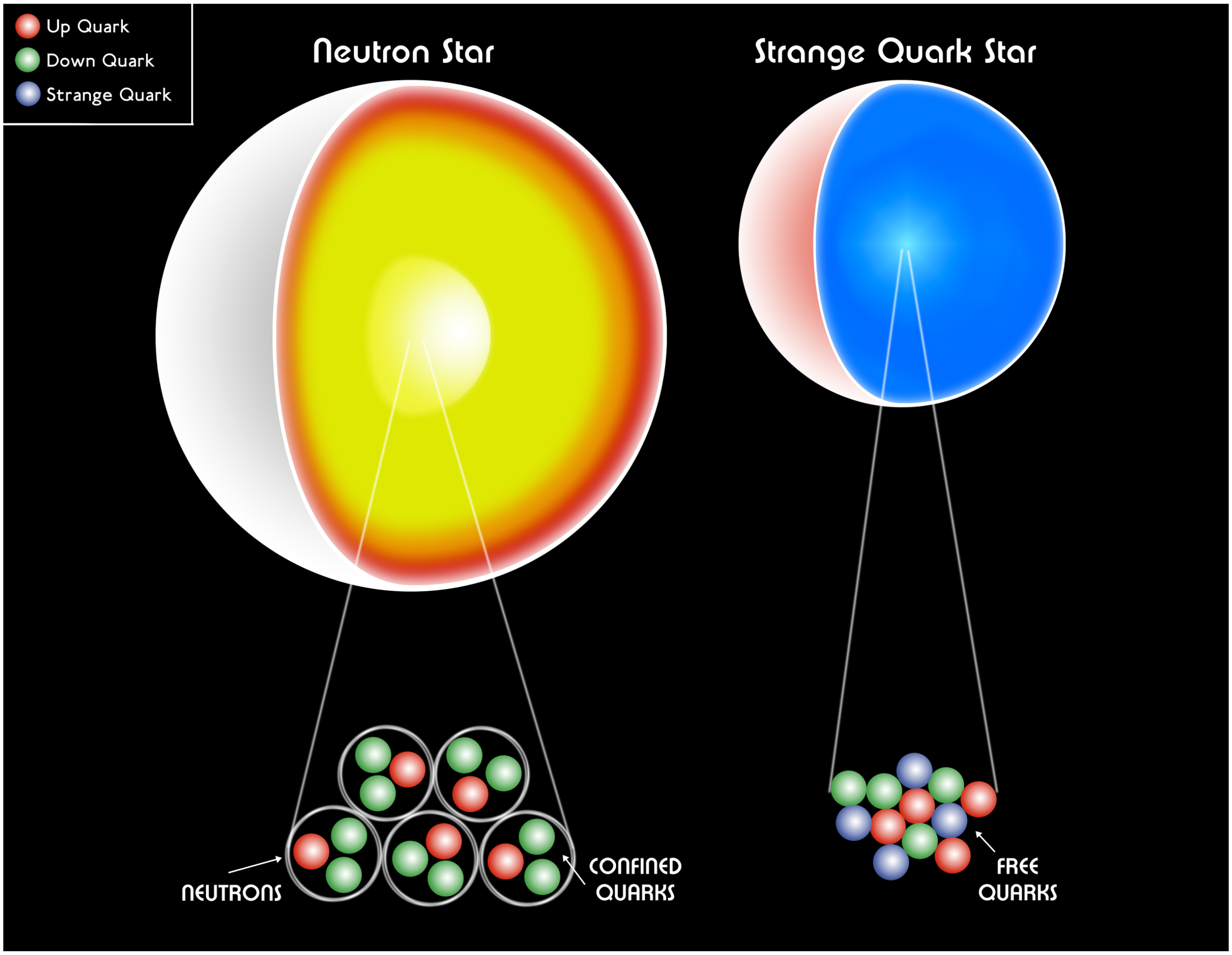
Size Comparison of RXJ 1856.5-3754 to Neutron and Quark Stars



This artist's rendition shows the diameter of RX J1856.5-3754, determined by data from NASA's Chandra X-ray Observatory, is too small to be a neutron star. The data are consistent with predicted size for a strange quark star, an object never before seen in nature.

Credit: CXC/M.Weiss

Neutron Star/Quark Star Interior Illustration



In a neutron star (left), the quarks that comprise the neutrons are confined inside the neutrons. In a quark star (right), the quarks are free, so they take up less space and the diameter of the star is smaller.

Credit: CXC/M.Weiss