

SEPTEMBER LECTURE

Dr. Kent S. Wood, U.S. Naval Research Laboratory, addressed the September meeting of National Capital Astronomers on the recently discovered phenomenon, quasi-periodic X-ray sources. Some of these sources have been observed at X-ray wavelengths for as long as 20 years, but their quasi-periodic oscillator (QPO) behavior has been known for only a year or less; Much work remains to discern their nature.

Roughly ten different characteristics of neutron stars have been observed (flares, pulsars, bursters, etc.). The brightest X-ray sources appear to be binary systems in which one star is accreting mass from the other. The three QPO's that have been discovered are Scorpius X-1, GX 5-1, and Cygnus X-2. All are accreting binaries with the accreting object being a neutron star which is not a pulsar in the traditional sense. The typical accreting binary system contains a main sequence late K or M dwarf of 0.1 to 0.9 solar masses. Although some accreting binary systems are thought to be powered by stellar winds, all QPO systems appear to be powered by Roche-lobe overflow, with the transferring material forming a disk around the neutron star. This accretion disk transfers angular momentum to the neutron star. Near the outer edge of the disk the material orbits with a period approaching that of the binary-system orbit, which can range from a few tens of minutes to a few hours. Near the inner edge, the Kepler orbit period can approach a millisecond. At some distance (the Alfvén radius), the magnetic pressure of the neutron star exceeds the gas pressure of the accreting matter. It is this region where QPO behavior is thought to originate.

Some questions which have been raised are:

1. In some cases, what is the exact nature of the accreting object (neutron star, white dwarf, or black hole)?
2. What is the magnetic field strength?
3. How old are those objects which emit bursts but do not pulse? Does this have anything to do with the magnetic field? Does the field decay with time?
4. How fast are the neutron stars spinning? (Ed. note: This has not yet been directly observed in QPO's; it is hoped that much larger spacecraft-borne instruments may do so in the future.)
5. What is the origin of millisecond pulsars?

Typical binary pulsars appear to have magnetic-field strengths of 10^{12} to 10^{13} gauss, while the faster-spinning pulsars seem to have fields of 10^{10} to 10^{11} gauss; the weaker field permits faster rotation. QPO's may have fields as weak as 10^7 Gauss. Evidence from radio pulsars indicates that magnetic fields decay over 10^6 to 10^7 years. Could QPO's be evolved millisecond pulsars? The mechanism for spin-up may be transfer of angular momentum from the companion star. The spin period decreases until at the Alfvén radius, where the magnetic field begins to channel the flow of the accreting material, the spin period equals the Kepler orbit period at that radius. The spin frequency is thus limited by the magnetic field.

The QPO X-ray flux has not been seen directly to exhibit quasi-periodic behavior over time, but only in the frequency domain: The Fourier power spectrum of a 2-second sample of X-ray flux data, added to that of many other similar samples, displays a frequency spike at about 10 to 50 Hz. The position of the peak varies with the strength of the source; as the X-ray flux count increases, the pulse frequency increases. GX-5's spike is at 10 to 50 Hz, while Sco X-1 oscillates at 6 Hz after previous flaring subsides. EXOSAT data of Cyg X-2 showed QPO's at 30 to 50 Hz. The QPO accounts for about 2 percent of the total flux detected. If burst sources exhibited oscillations at the 2-percent level, they would be detected at the 3- to 20- σ level -- but this has not yet been seen.

One theory of the origin of the oscillations is that the frequency of the QPO is a beat frequency between the Kepler orbit period at the Alfvén radius and the spin period of the accreting star. This model implies fields of about 10^9 gauss, with an Alfvén radius of about 100 km above the surface of the neutron star surface. The implied spin period of the star is about 10 ms.

One phenomenon that is now being investigated is the *red noise*. The power spectra show a general decline with frequency, with a narrow rise at the QPO frequency. The red noise comes and goes; it may be present with or without the QPO, and the QPO may be present with or without the red noise. Investigators are searching for secondary spikes, but to date no two simultaneous frequencies have been reported, despite the hints of their possibility from the Cyg X-1 data. One limitation of the use of X-ray satellites is the telemetry data rates. The power spectrum and the time history of the flux data cannot be transmitted simultaneously through the limited bandwidth.

Apart from the observational aspects, there is a fundamental problem with the current models: Most postulate a magnetosphere to obtain QPO values that match the data, typically 5×10^9 gauss, which is small for a neutron star. A magnetosphere of this strength would funnel accreting matter to the magnetic poles as in accreting binary pulsars -- but QPO's have not yet been observed to

OCCULTATION EXPEDITIONS PLANNED

Dr. David Dunham is organizing observers for the following occultations. For further information call Dave at 585-0989.

UT	Place	Vis Mag	Pcnt Sunlit	Cusp Angle	Min Aper
Grazing Lunar:					
10-07-85 08:06	Somerset, PA	6.4	48	10N	5 cm
10-07-85 10:41	Pittsburg, PA	6.5	47	2S	5 cm
10-09-85 07:04	Ceresville, MD	8.1	28	10N	10 cm
10-10-85 08:36	Beaver Creek, MD	7.9	7.9	7N	8 cm
10-24-85 00:25	Marysville, OH	4.2	81	7S	5 cm
Asteroidal:					
10-31-85 10:56	Bahamas	Star Mag 8.9	Delta Mag 4.0	Name (159) Aemilia	8 cm
Cometary:					
10-19-85 06:24	No. South America	Star Mag 11.6	Comet Halley		15 cm
10-21-85 10:25	Mexico	12.0	Halley		15 cm

NCA WELCOMES NEW MEMBERS

Robert I. Franklin 8715 First Ave, Apt 1207D Silver Spring, MD 20910	Herbert J. Mulqueen Route 1, Box 665. Warsaw, VA 22572
Donald A. Larson 6900 West Ave. Chevy Chase, MD 20815	Julio and Donna Santos 5920 Bayshire Rd. Springfield, VA 22152
Frank and Pamela McAlister 10910 Knights Bridge Ct. Reston, VA 22090	Jackson and Suzanne Winter-Rose 3832 Calvert St., NW Washington, DC 20007

***** RESERVE YOUR PLACE FOR THE HALLEY TOURS! *****

The checks are arriving! Don't miss the opportunity to go with us to the Southern Hemisphere for Halley's Comet and to explore some of the most fascinating parts of the world. Many extras for lifetime memories -- Choose your tour from the September *Star Dust*, or call NCA, (301) 320-3621 for still other possibilities. These are truly super tours provided in conjunction with one of the most experienced and thorough astronomical tour operators, *World of Oz*. Your check for \$250 per person now, payable to *NCA Travel*, will reserve your place. Indicate which tour on your check and mail to NCA, 5120 Newport Avenue, Bethesda, MD 20816. *Don't wait until 2061!*

NASM SKY LECTURE, H-ALPHA SUN VIEWING

NCA's Geoffrey Chester will present the Monthly Sky Lecture, *A Comet Makes a Comeback*, in the Planetarium of the National Air and Space Museum, at 9:00 a.m. on Saturday, October 5. Following the lecture, weather permitting, he and Stan Cawelti will offer safe, telescopic hydrogen-alpha viewing of the Sun on the deck east of the building.

pulse at the spin rate.

It is difficult to detect the spin rates of rapidly rotating neutron stars in binary systems. Because light transits the diameter of the binary system in a few milliseconds to a few seconds, the pulse rate is doppler-broadened by the orbital motion; the orbits are not well enough known to permit correction.

Simulations have shown that techniques using trial grids and long integration times can be useful, but there are no concrete results using real data. As time passes, upper limits are progressively reduced as unsuccessful attempts to detect the spin accumulate. This offers no support to theories that explain the QPO as an interaction of accreting matter with a magnetic field.

One explanation developed by Dr. Wood for not detecting the spin period invokes a strong gravitational-lens effect near the surface of the neutron star. The effect would bring over the horizon radiation from points hidden by the star. This reduces the amplitude of the pulse, because the area of accretion on the neutron star which is the pulse source is never effectively occulted. Because the pulse is not completely eliminated, this model suggests that continuing searches at greater sensitivities would be useful.

Dr. Wood concluded by speculating on possible experiments to detect gravity waves which are predicted to emanate from spinning neutron stars.
Mark Trueblood

EXCERPTS FROM THE IAU CIRCULARS

1. July - Auriere, Cordoni, and Koch-Miramond observed variability in object AC 211 with a UBV photometer on the 2-m Pic du Midi telescope, indicating that this object is the source of X-rays from the globular cluster M 15.

2. August 19 - Brosch and Mendelson, Wise Observatory, observed an 80-second occultation of a 12.8-magnitude star by Pluto. The star disappeared completely for only 14 sec, indicating the possible presence of an atmosphere on Pluto.

3. August - 23 - McCarthy, Strauss, and Spinrad observed a coma extending 1.5 from the nucleus of Comet Halley with a CCD on the Lick Observatory 3-m telescope. Spectra revealed the presence of strong CN, C₂, and C₃ emissions.

4. August - Bockelee-Morvan, Bourgois, Crovisier, and Gerard detected the presence of OH radical emission from Comet Halley at 1667 and 1665 MHz with the Nancy radiotelescope.

5. September - Lewin, van Paradijs, Jansen, van der Klis, Sztajno, and Trumper reported detecting low-frequency noise and possible quasiperiodic oscillations at 11 Hz in the bulge source GX 349+2. The data were obtained in 1984 September with EXOSAT. Robert N. Bolster

NAVAL OBSERVATORY SCHEDULES OPEN HOUSE, STARTS HALLEY HOTLINE.

On Saturday, 19 October from 10:00 am to 4:00 pm the U.S. Naval Observatory will be open to the public. NCA will participate with displays, demonstrations, and, weather permitting, safe solar observation with the NCA Clark refractor housed at the Observatory, and with portable instruments. Enter the Observatory at the main gate, 34th Street and Massachusetts Avenue, NW.

For taped information on the regular public tours, call 653-1543. For the Halley Hotline, call 653-0258.

FOR SALE

Tasco Model 10K 80-mm refractor. 120-mm fl. Equatorial mount with clock drive, setting circles, manual slow-motion controls, tripod, finder, dewcap, rack-and-pinion focusing, 2-X Barlow, 3 eyepieces, star diagonal, erector, green filter, solar projection screen, wood carrying case and original packaging. Good condition. \$400. Lee Finlayson, (301) 589-3054.

Odyssey Comacoat 10-inch F/4.5. Finder, Oculars. Good condition. Negotiable. Kip Poremba, 6015 Roxbury Avenue, Springfield, VA 22152. (703) 569-5484.

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FIRST CLASS

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ASTRONAUT BARTOE TO DISCUSS SHUTTLE SCIENCE



DR. BARTOE

The 5 October meeting of National Capital Astronomers will hear Shuttle Astronaut Dr. John-David F. Bartoe discuss his scientific observations from Spacelab 2.

The mission comprised 13 investigations in seven disciplines: solar physics, atmospheric physics, plasma physics, high-energy physics, infrared astronomy, technology research, and life sciences. Several instruments observed some phenomena jointly using different techniques.

The solar physics instruments investigated the photosphere-to-corona energy-transfer mechanism. The plasma physics instruments probed the ionospheric plasma in which the shuttle orbit was immersed, with both an electron beam and thruster engine exhaust, while a sub-satellite measured magnetic and electric fields, particle distributions, and plasma composition, density, and temperature. Three astronomical telescopes on board have extended infrared, X-ray, and cosmic-ray observations

into new regimes. The infrared telescope bandwidth extended to 4 microns for both diffuse and discrete sources. The X-ray telescope observed extended sources, particularly clusters of galaxies, in the 2- to 20-keV range. Cosmic rays with energies up to 4 TeV were recorded.

The experiments were conducted by a coordinated effort between the payload specialists on board and the principal investigators' team at the Houston Control Center.

John-David F. Bartoe received his B.S. in 1966 from Lehigh University, Bethlehem, Pennsylvania, his M.S. in 1973 and Ph.D. in 1975 from Georgetown University, Washington, DC. He has been employed at the U.S. Naval Research Laboratory since 1966, where he has been Co-Investigator and/or Project Scientist on numerous NRL programs, including the Skylab Apollo Telescope Mount experiments, Skylab Calibration Rockets, High-Resolution Telescope and Spectrograph (HRTS) Rocket Experiment, Spacelab 2 HRTS Experiment, Solar ultraviolet Spectral Irradiance Monitor (SUSIM) Experiment on OSS 1, Spacelab 2, and EOM Missions, and the SUSIM Experiment on the Upper-Atmosphere Research Satellite. He was Payload Specialist on board the Spacelab 2 Mission on the Space Shuttle.

OCTOBER CALENDAR -- The public is welcome.

Tuesday, October 1, 8, 15, 22, 29, 7:30 pm -- Telescope-making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, MW. Information: Jerry Schnall, 361-8872.

Friday, October 3, 11, 18, 25, 7:30 pm -- Telescope-making classes at American University, McKinley Hall basement. Information: Jerry Schnall, 361-8872.

Friday, October 11, 18, 25, 8:00 pm -- NCA 14-inch telescope open nights with Bob Bolster, 6007 Ridgeview Drive, south of Alexandria off Franconia Road between Telegraph Road and Rose Hill Drive. Call Bob at 960-9126.

Saturday, October 5, 6:00 pm -- Dinner with the speaker at the Ding How Restaurant, 1221 E Street, NW. Reservations unnecessary.

Saturday, October 5, 8:15 pm -- NCA monthly meeting at the U.S. Department of Commerce Auditorium, 14th Street and Constitution Avenue, NW. Dr. Bartoe will speak.

Saturday, October 12, 7:30 pm -- *Exploring the Sky*, presented jointly by NCA and the National Park Service. Glover Road south of Military Road, NW, near Rock Creek Nature Center. Planetarium if cloudy. Information: Dr. John Lohman, 820-4194.

Saturday, October 19, 10:00 am to 4:00 pm -- Open House at the U.S. Naval Observatory, with NCA participation.

Saturday, October 19, 8:00 pm -- Annual Public Seminar: *How to Select, Use, and Care for a Telescope*. U.S. Department of Commerce, Conference Room D.