

X-Ray Emission from Crab Nebula

Group	Energy range (keV)	% of source luminosity	Date of observation
NRL	0.8-4	5	13 Mar. 1969
Columbia	5-20	6.5 ± 5	7 Mar. 1969
Rice	>30	7 ± 2	4 June 1967
MIT	1.5-10	9	27 Apr. 1969
Goddard	2-10	15 ± 3	16 Mar. 1968

ular rather than stellar. Their result cast doubt for a while that the Crab contained a neutron star. However, the NRL group notes in their latest report, their earlier observation could not have detected a 5% stellar contribution.

The new NRL experiment also showed that NP 0532 was emitting two pulses, a main one and an interpulse occurring 12 millisecond later, similar to the behavior already found both in the optical and radio regions.

Meanwhile a Columbia group (Roger Angel, Robert Novick, Paul van den Bout, Martin Weisskopf and Richard Wolff) was analyzing Crab x-ray data from a flight launched six days earlier than the NRL rocket. The Columbia group was searching for x-ray polarization from the nebula. The Crab is known to emit strongly polarized radiation in the visible and radio regions; if x-ray polarization were found, too, it would be strong evidence that the Crab x-ray emission results from synchrotron radiation. When the Columbia experimenters heard of the NRL result, they examined their data for pulsing and found (International Astronomical Union circular no. 2142) pulsing with a peak value (6.5 ± 2.7)% of the average source luminosity. Further analysis suggests a value of (6.5 ± 5)%.

A group at Rice University (Robert Haymes, G. J. Fishman and F. R. Harnden Jr), analyzing balloon-flight data from 4 June 1967, also confirmed the pulsing (circular no. 2143). Comparing the 1967 x-ray period with 1969 optical data, the Rice group calculated linear slowdown rate over a 575-day interval as 36.51 ± 0.02 nanosecond/day.

A collaboration (Hale Bradt, Saul Rappaport and W. Mayer of MIT, Ed Nather, Brian Warner and Malcolm MacFarlane of McDonald Observatory, Texas, and Jerome Kristian of Mt Palomar) looked at the pulsar with a rocket-launched x-ray detector, the 200-inch Palomar telescope and the 36-inch McDonald telescope (*Nature*, 24 May). They confirmed the earlier

observations and demonstrated that the pulsar blinks at both x-ray and optical wavelengths simultaneously, within 1 millisecond.

Analyzing 1968 rocket data, a team from Goddard Space Flight Center (Elihu Boldt, Upendra Desai, Stephen Holt, Peter Serlemitsos and Robert Silverberg) confirmed pulsing. Their luminosity value is substantially higher than the other observations.

Crystal Acts Like a Two-Dimensional Antiferromagnet

A single crystal of K_2NiF_4 acts like a two-dimensional antiferromagnet above a critical temperature $T_n = 97.1$ K, according to a recent experiment at Brookhaven. At the critical temperature the crystal undergoes an extremely sharp phase transition to long-range order in three dimensions. Then below that temperature the magnetization varies as $(T - T_n)^\beta$ where $\beta = 0.15$, again suggesting that the magnetic behavior is two dimensional.

Robert Birgeneau (Bell Labs and Brookhaven), Howard Guggenheim (Bell) and Gen Shirane (Brookhaven) reported their results in *Phys. Rev. Letters* 22, 720 (1969). The group believes that theirs is the first observation of two-dimensional scattering in a magnetic system.

The experimenters expected that K_2NiF_4 would show such behavior, Birgeneau told us, because its structure favors strong interactions within crystal planes and no interactions between nearest-neighbor planes. Nearest-neighbor nickel ions that are within the plane possess molecular orbitals that point directly at each other, thus producing a huge exchange interaction. Also, the crystal was known to be antiferromagnetic, its spins lining up antiparallel.

To do the experiment, the group bombarded the single crystal with monochromatic neutrons from the Brookhaven High-Flux Reactor, and they observed scattering as a function of angle as the temperature was lowered. As the temperature neared the critical

point, the spins in a given plane lined up head to tail over very long crystal-line distance: Spins were almost perfectly correlated over lengths up to 500 nanometers. These enormous spin globules showed no awareness of the spins in another plane until the critical point was reached.

The data show that within the plane in two dimensions, you have normal critical scattering peaks. On the other hand, if you scan through the crystal planes, the scattering cross section is essentially independent of momentum in the direction perpendicular to the plane. So you observe, instead, a "critical ridge."

As the critical point is approached, the correlation length grows, Birgeneau said. Once the crystal has nearly perfect long-range order, with globules containing more than a million spins, the net coupling between the crystal planes apparently commences to matter. Just at the critical point, when the system is about to become completely ordered, it simultaneously orders in three dimensions.

Below the critical point, the K_2NiF_4 system again acts two dimensionally. Many critical-point experiments on three-dimensional systems have shown magnetization to vary as $(T - T_c)^\beta$ with $\beta = 0.33$ to 0.4. In 1944 Lars Onsager, using the two-dimensional Ising model, had predicted $\beta = 1/8$. The Brookhaven result is $\beta = 0.15$, which is about 1/7. This equation fits the data over the complete temperature range the group studied, from 97.0 to 5.0 K.

—GBL

Berkeley Group Reports Discovery of Element 104

A Berkeley group says it has positively identified two isotopes of element 104, $^{104}X^{257}$ and $^{104}X^{259}$. Speaking at the American Chemical Society's Mendeleev Centennial Symposium, Albert Ghiorso said that they also think they have found $^{104}X^{258}$, but are not yet sure. The group was unable to observe $^{104}X^{260}$, which Georgi N. Flerov and his collaborators at the Joint Institute for Nuclear Research, Dubna had reported in 1964 (and named kurchatovium).

In the Berkeley experiments, $^{98}Cf^{249}$ was bombarded with carbon ions from the HILAC device. The experimenters, to identify isotopes 257 and 259, first directly observed their alpha decay to nobelium, measuring the alpha-decay energy. Then they measured the de-

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cay half lives of the nobelium daughters. The group was able to make thousands of the new atoms. The Dubna experimenters had only a few dozen events believed to be fissions of ^{260}No , with an activity of 0.3 sec.

The Berkeley group consisted of Giorso, Matti Nurmia, James Harris, Kari and Pirkko Eskola.

CERN-Serpukhov Collaboration Yields Data on Particle Yields

Results from the first collaboration between Soviet and CERN experimenters at the Serpukhov 76-GeV synchrotron were reported in *Phys. Letters* 29B, 48 (1969). Never before have Western and Soviet scientists collaborated on the same instrument with both groups supplying part of the apparatus.

The measurements give particle yields at the newly attainable Serpukhov energies and will be useful in predicting intensities of secondary particle beams. The measurements also helped to test detectors at high energy.

No new structure was found from long-lived particles with mass up to 2.2 GeV to a level of 10^{-6} times the pion fluxes at 40 and 50 GeV/c. Anti-deuteron production was smaller than 10^{-7} times the pion production.

Indiana U. Builds 200-MeV Sector-Focused Cyclotron

Indiana University is building a 200-MeV open-sector (sector-focused) cyclotron, which will be the largest of its type in the US. The largest open-sector cyclotron in the world will be in Zurich, where a 540-MeV device will be used as a meson factory. The Indiana machine can accelerate other ions to an energy of $240 Q^2/M$ (in MeV), where Q is the charge of the ion and M is mass in a.m.u.

In its initial configuration the facility will have three stages: a dc stage with output energy up to 600 keV, a small cyclotron stage with median-plane injection and an energy gain of about 30, and a final cyclotron stage with an energy gain of 10 (for heavy ions) to 14 (maximal-energy protons).

The small cyclotron, now being constructed at a temporary location, is a 1/3 (linear dimension) model of many aspects of the final stage. The cyclotron stages will have a wide energy

range and will accept a large range of charge-to-mass ratio.

Similar to spiral-ridge cyclotrons, which achieve focusing with spirals, open-sector cyclotrons achieve focusing with magnetic hills and valleys. In the Indiana design, four pie-shaped C magnets are arranged in a ring. The hills and valleys correspond to high field and zero field. Maximal orbit diameter is 6.6 meters. Because the machine has no central region, central-region problems are eliminated. Sector-focused cyclotrons, unlike fm cyclotrons, are cw and give much higher intensity and beam quality than the fm devices.

The building to house the Indiana facility is in final design stages and is expected to be finished in fall, 1970. Then the final cyclotron stage can be assembled. Total cost of the installation is expected to be \$9.6 million.

Redefinition of Temperature, Volt and Gravity Standards

Last fall the International Committee of Weights and Measures met in Sèvres, France, and announced changes in their definitions of the practical temperature scale, the interna-

tional volt and the basic reference for the acceleration due to gravity.

Most of the fixed points on the International Practical Temperature Scale have been assigned new values, and the new scale extends down to 13.8 K, instead of the 90.18-K limit of the 1948 scale. Differences between the 1948 and 1968 scales range from 0.022 kelvins at 173 K to 9 kelvins at 4200 K. Reprints containing details of the new scale are available from the National Bureau of Standards.

The standard volt of the International Bureau of Weights and Measures has been reduced by 11 parts per million, to bring this "practical" volt closer to the volt as defined from the basic mass, length and time units. In the US the change means that the standard volt of the NBS will be reduced by 8.4 parts per million, because the US and international units have drifted apart since the last calibration.

The acceleration due to gravity at Potsdam, taken as the point of departure of the so-called "Potsdam System" of gravity measurements, has been reassessed as 9.81260 m/sec^2 , which represents a decrease of 15 parts per million.

IN BRIEF

A preliminary search for quarks at the Serpukhov 76-GeV synchrotron shows that if the quark has a 5-GeV mass, then its production cross section is less than 10^{-36} or 10^{-37} cm^2 , according to project leader Lansberg.

Very strong evidence for water on Mars has been obtained with spectra from the 82-inch McDonald Observatory telescope, and new observations have begun with the new 107-inch McDonald telescope. Observers were Ronald Schorn and C. B. Farmer (Jet Propulsion Laboratory) and Stephen Little (University of Texas).

The earth sporadically emits low-frequency (below 10 MHz) radio signals, according to observations with the first Radio Astronomy Explorer satellite. Robert Stone (speaking at the spring meeting of the US national committee of the International Union of Radio Science) said that signals from both Earth and Jupiter are sharply beamed, quite intense and occur sporadically.

Infrared observations reported in the

March issue of *Astrophys. J. Letters* by several groups suggest that interstellar grains may be made of silicates, according to Neville J. Woolf and E. P. Ney of the University of Minnesota.

No evidence for an undiscovered chamber in the Pyramid of Chephren, Giza, Egypt, has been found by Luis Alvarez and his collaborators. An array of spark chambers inside the chamber looked for an anomalous variation in cosmic-ray flux. Because the large lower zones on the pyramid's four sides have not yet been scanned, a missing chamber may yet be found.

A huge cloud chamber ($105 \times 105 \times 38 \text{ cm}$) surrounded by a magnet 5.5 meters in diameter will look for cosmic rays at the University of Chicago's High Altitude Cosmic Ray Observatory on Sacramento Peak, New Mexico. The chamber is filled with water vapor, alcohol and argon, and has already recorded 5000-GeV cosmic rays in Chicago tests. It will be used to investigate cosmic-ray secondaries. □