★ STAR DUST

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VAN FLANDERN FINDS EVIDENCE OF MISSING PLANET

DR. VAN FLANDERN

It is not easy to explain the sudden, violent explosion of a planet. Yet, Dr. Thomas C. Van Flandern, research astronomer of the U. S. Naval Observatory, has recently developed startling evidence that so persuasively points to such an event that it is difficult to account for it in any other way. Dr. Van Flandern will present his findings to National Capital Astronomers at the February 7 meeting.

Recent dynamical calculations by M. W. Ovenden have demonstrated the existence of a 90-Earth-mass planet in the asteroid belt until 16 million years ago. These calculations have now been strikingly confirmed by the discovery that very-long-period comets apparently originated in the explosion of such a planet at that epoch. The evidence from comets is present in the distributions of each orbital element; but the most compelling evidence comes from a backwards integration of 60 well-observed very-long-period comets to their previous perihelion passage, which shows that most of these intersect at nearly the same point on the heliocentric celestial sphere. Taken in conjunction with the already existing evidence, these new results leave little room to doubt that a Saturn-sized planet did exist between the orbits of Mars and Jupiter 16 million years ago, and then violently exploded.

Born in Cleveland, Ohio, Thomas C. Van Flandern received his B.S. in mathematics from Xavier University in Cincinnati and his Ph.D. in astronomy from Yale University in 1969. A research astronomer at the U. S. Naval Observatory since February 1963, Dr. Van Flandern is principally concerned with celestial mechanics, especially lunar motion. He is a member of the International Astronomical Union, American Astronomical Society, American Geophysical Union, American Association for the Advancement of Science, Sigma Xi, and National Capital Astronomers.

FEBRUARY CALENDAR — *The public is welcome.*

Monday, February 2, 9, 16, 23, 7:30 PM — Telescope-making classes at the Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, 362-8872.

Friday, February 6, 13, 20, 27, 7:30 PM — Telescope-making classes at American University, McKinley Hall basement. Information: Jerry Schnall.

Saturday, February 7, 6:15 PM — Dinner with the speaker at O'Donnell's Sea Grill, 1221 E Street, NW. Reservations not necessary.

Saturday, February 7, 8:15 PM — NCA monthly meeting at the Department of Commerce Auditorium, 14th and E Streets, NW. Dr. Van Flandern speaks.

JANUARY LECTURE

Dr. William C. Erickson, professor of astronomy at the University of Maryland, described the University's Clark Lake, California radio observatory at the January meeting of National Capital Astronomers.

He began with an introductory radio astronomy film produced by the National Radio Astronomy Observatory at Green Bank, West Virginia.

The newly completed Clark Lake array is dedicated to the longest-wavelength portion of the astronomical spectrum, from about 20 m (15 MHz) to about 3 m (100 MHz). Dr. Erickson said relatively little recent astronomical work has been done at these wavelengths — the region in which Karl Jansky discovered extraterrestrial radio emission, and where Grote Reber alone pioneered radio astronomy for a decade (*Star Dust*, June 1975).

Jansky's discovery was not regarded seriously by either radio engineers or astronomers at the time. To the former the celestial noise represented only another source of interference with radio communications. The latter generally assumed that Jansky was merely detecting the thermal emission of objects that could be better observed optically; the intensity of such emission decreases with wavelength. Thus, understandably, Reber began his efforts at the shortest wavelengths within the state of the art. Discovering the *direct* wavelength-intensity relation, Reber demonstrated the non-thermal character of the emission, and radio astronomy was launched.

Because of the poor resolution attainable and the high background radiation from both nature and artifact, subsequent work moved toward the shorter wavelengths as improved detection techniques evolved.

The low-frequency mechanisms, e. g., spiraling magnetically trapped electrons on long orbits, or oscillations in plasma, are the subject of the Clark Lake studies. Information can be derived on the evolution of objects that radiate progressively lower frequencies as they expand. Pulsars, quasars, and radio galaxies all involve these low-frequency radiation mechanisms.

The Clark Lake array spans about 3 km on a dry salt flat surrounded by mountains that shield much of the man-made interference. The array comprises 480 elements in an east-west arm, 240 in a north-south arm, and a number of additional cross-polarized elements making a total of about 800. Mechanically fixed, the array is steered electrically by phasing banks of 15 elements each, 32 banks in the east-west arm, 16 in the north-south arm. Any aim point in the sky within the 100° field of the array can be selected within about 100μs, excluding controller response time. The controller, a General Automation SBC-12, controls phasing and also processes observational data, which are recorded on magnetic tape for reduction at the University of Maryland. The quick-pointing capability facilitates simultaneous observations on a rapid time sharing basis, either for separate projects or for comparisons. Resolution of the array is 3 minutes at 100 MHz, 15 minutes at 20 MHz. Effective collection area approximates that of a solid dish having a diameter of 60 m at 100 MHz, 300 m at 20 MHz.

Individual elements of the array are conical log-spirals, left-circularly polarized. Each consists of eight interwound wires, terminated at the base, fed at the apex in opposed triplets, leaving the intervening two inactive. A current sheet of width equal to the spacing is thus simulated, approximating a self-conjugate spiral. By connecting the inactive conductors, simultaneously disconnecting two adjacent ones, the pattern of the spiral can be rotated in 45° steps. The switching is accomplished by appropriately biasing diodes in each conductor at the apex of the element. Control bias voltage is supplied through about 150 miles of buried cables from the observatory building.

The 45° rotation provides any desired phase within 22.5°, or 1/16 wavelength — a precision which would require a reflector of 1/32-wave accuracy.

Each element is supported by a central pipe 7.8 m tall, from the top of which eight plastic support ropes diverge to anchor stakes in the ground. Each conductor is fastened to the support ropes at each intersection as it spirals downward. Approximately one-third million clips had to be crimped. The

EXPEDITIONS BEING ORGANIZED

The lunar occultation group, led by Walter Nissen, is planning a number of expeditions to graze paths which will pass near Washington during the first half of 1976. In addition to experienced observers, volunteers are needed for a variety of work — equipment checkout and deployment, star catalog searches, keypunching, field assistance, operation of tape recorders and shortwave receivers, transportation (most of these will be within 50 to 100 miles), and other general teamwork. Equipment is also needed, such as telescopes, shortwave receivers, tape recorders. Call Walter Nissen, O: 737-0431, H: 528-6671.

SURPRISE PLANNED

We are working on a special surprise for NCA members and their immediate families for Friday evening, May 7. Please mark your calendar and watch *Star Dust* for further information.

NAVAL OBSERVATORY VISIT POLICY REVISED

Arrangements for public visits to the U. S. Naval Observatory have been broadly changed. Visitors are accepted any working day between 10 AM and 3 PM. Visitor nights will be designated. No reservations will be necessary, but passes will be issued at the gate. For details, call (202) 254-4569, or write Visitor Information, Naval Observatory, Washington, DC 20390. The NCA pass arrangement is not affected by these changes.

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control and signal cables are fed through the pipe to the top, where the eight switching diodes are located. 6,400 diodes were soldered in. Winding the elements took three years.

Separate preamplifiers are provided for each bank of 15 elements. From these the signals are transmitted to the observatory through 50 miles of coaxial cable.

To preserve purely left-circular polarization it is necessary to eliminate the small vestigial right-circular response of the array, which would introduce ellipticity and side lobes. The solution was to make the individual signal cables of random lengths and individually phase-compensate each at the receiver for left-circular polarization, thus randomizing the right-circular components. To randomize the cable lengths he repeatedly opened the Los Angeles telephone directory and cut the cables according to whatever numbers appeared. Hopefully there is no bias in the Los Angeles telephone-numbering system.

Because the slope of the intensity-wavelength relation of the galactic background exceeds the dynamic range of the receiver, the signals are slope-filtered upon arrival at the observatory building. Further amplification is followed by conversion to 170 MHz i.f. amplification, then conversion to 10 MHz adjustable-bandwidth i.f. amplification. To frequency-sweep the spectrum, it is only necessary to sweep the first local oscillator. The control computer correlates and digitizes the outputs once per second and writes on magnetic tape.

Performance correlates well with design. From early test scans of the spectrum Dr. Erickson identified many sources of interference — TV, FM, CB, and others, even in the radio astronomy bands. Interesting results are already emerging from this powerful new tool, however. Starting with Cas A, the strongest source, he found that the secular decrease of 1.3 percent per year was not constant; the strength was increasing. Skeptical workers at Cambridge recently confirmed his finding. He has found a strong, but puzzlingly variable correlation between extragalactic X-rays and low-frequency radio emissions, and has made a few pulsar measurements at long wavelengths. He has also found a radio correlation with solar X-rays, and is able to study coronal holes at low frequencies.

Dr. Erickson hopes to extend the system to permit cross-correlation of all banks of elements, thus to produce a simultaneous 1024-beam raster of an area of sky, e.g., the Sun and corona, or sidereal objects. rm

EXCERPTS FROM THE IAU CIRCULARS

1. December 5 — H. Wroblewski, University of Chile, discovered a fast-moving object of 12th magnitude in Monoceros on plates taken at the Cerro El Roble station.

2. December 27 — C. Kowal, Hale Observatories, discovered fast-moving object 1975 YA of 12th magnitude in Camelopardalis on plates taken at Palomar. Orbital elements by B. G. Marsden indicate that the object is a member of the Apollo group having a high inclination.

3. January 5 — Bolton and Gulliver, David Dunlap Observatory, observed considerable short-term variability in the metallic shell lines of the spectrum of o Andromedae. Observations since 1975 August showed the development of a strong shell as seen in the hydrogen lines.

4. January 7 — E. Helin, California Institute of Technology, discovered a fast-moving object (1976 AA) of 13th magnitude in Gemini on exposures made with the 46-cm Palomar Schmidt. Marsden's orbital elements show that this object has an orbit smaller than that of the Earth, with an aphelion distance of 1.15 AU and a period of 0.95 year.

FOR SALE

Six-inch F/7.5 Cave mirror. Needs recoating, but usable as is. Make offer. William S. Durham, 6430 Edsall Road, Apartment 304, Alexandria, Virginia 22312.

CORRECTION TO ASTRONOMICAL LEAGUE RELEASE

The address given in the League's December 26 general convention release for registration and further information should read: George H. Maurer, RD *3*, Box 140, Coopersburg, Pennsylvania 18036.

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