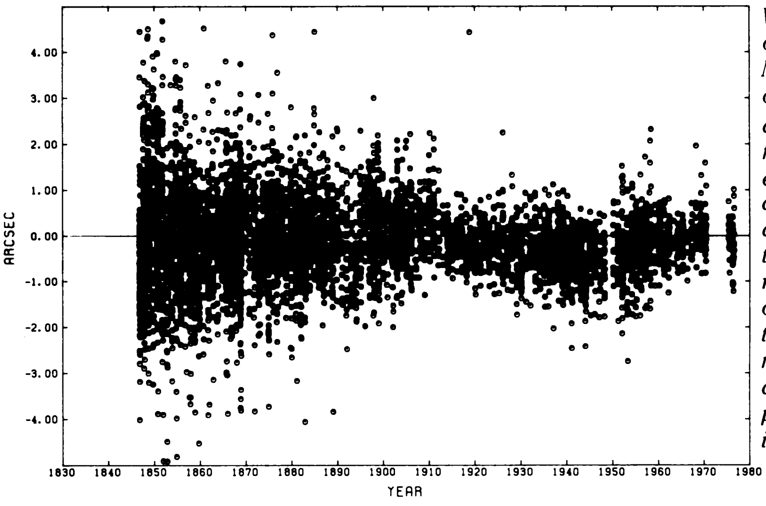
What's Bothering Neptune?



Variations over time in Neptune's observed declination from USNO ephemeris are in part due to systematic errors and other uncertainties, but may also indicate some perturbing influence.

The possibility that there may be a massive planet beyond the orbit of Neptune has been discussed by astronomers since the very year of Neptune's discovery, 1846. Neptune itself, in fact, was found from a prediction calculated on the basis of observed irregularities in the position of Uranus, the next planet in. Similar irregularities have been reported in Neptune's position, to such an extent that no regular orbit has been derived for Neptune that fits all the observations, and the planet Pluto was discovered in 1930 during a search for an object that could account for the reported Neptunian as well as Uranian perturbations. As has become increasingly clear in recent years, however, the mass of Pluto is far too low — perhaps by a factor of hundreds — to produce the cited effect.

The latest attempt to explain Neptune's seemingly perturbed orbital motion is being conducted by a group of astronomers at the U.S. Naval Observatory's Nautical Almanac Office in Washington, analyzing the 6,000-odd observations on record to see if they indeed indicate the presence of some yet-unknown influence.

Such an influence, the researchers emphasize, need not necessarily be a planet. In the nineteenth century, astronomers spent years searching for a planet inside the orbit of Mercury in hopes of explaining why the longitudes of Mercury's successive orbital close approaches to the sun got ahead of their calculated positions by a cumulative total of 43 arc-seconds per century. The answer turned out to be not a planet at all but an effect explained by relativity theory, which was simply unknown at the time.

Still, the Naval Observatory group feels, if one assumes that Neptune's "perturber" is indeed a planet, it is possible to draw some tentative preliminary conclusions about it. According to Robert S. Harrington and Thomas C. Van Flandern of USNO, a planet with two to five times the mass of the earth could produce the observed irregularities if it is currently at a distance of 50 to 100 astronomical units from the sun. (Earth's mean solar distance is 1 A.U.; Neptune's is about 30.) The object's orbit could also be significantly inclined from the plane of the ecliptic.

One potential aid to the researchers could be the recent discovery that the pioneering astronomer Galileo may have unwittingly observed Neptune in 1612 and 1613, more than 230 years before its discovery (SN: 10/11/80, p. 231). The evidence is Galileo's own notes, in which he recorded the presence of an object where modern star catalogs indicate that there would have been no star bright enough for him to have seen it; he also noted that on two observing nights, the object was in different positions relative to a now-established "fixed" star, presumably indicating the object's unstarlike motion. Neptune would have been near the line of sight to Jupiter (the target of Galileo's observations) on those nights, and the astronomer's sketch of the two planets seems to indicate a 1-arc-minute difference from Neptune's calculated position on that night. The precision of his drawing is not known, although, notes Van Flandern, Jupiter's apparent diameter would also have been about an arc-minute, and Galileo's representation of Neptune's position seems to differ from the calculated one by about the diameter of Jupiter's disk in the sketch.

If the sketch is trustworthy — one of many assumptions involved in the painstaking quest — it more than doubles the timespan over which Neptune's positions have been recorded. Furthermore, it expresses the position of Neptune with reference primarily to Jupiter rather than to the surrounding stars, whose precisely determined locations in nineteenth-century star catalogs pose problems in analyzing about half of the post-discovery Neptune observations. To be on the safe side, the Naval Observatory group is carrying out its analysis both with and without the Galileo sightings.

Two star-referenced Neptune observations by Lalande in 1795 also show positional discrepancies, says Van Flandern, who gives them credibility because the indicated reference stars are shown with positional "errors" only 20 to 25 percent as large as Neptune's. Other astronomical observations from the seventeenth and early eighteenth centuries, meanwhile, are also being combed to see if they too included the yet-undiscovered Neptune. Much of the analysis, however, involves simply "cleaning up" the early post-discovery sightings, correcting for star-catalog uncertainties and systematic errors. The search — whether it turns out to have been for an unknown planet or some heretofore unconsidered influence — is not easy. □

A specter haunting physics

Fractional electric charge is the spook that simply will not go away. It is now almost four years since William Fairbank of Stanford University announced to a packed room at an American Physical Society meeting that he and his associates, Arthur F. Hebard, George S. LaRue and, more recently, James D. Phillips, were finding evidence that electric charge exists in fractions of about one-third of the charge of the electron (SN: 4/30/77, p. 276). It had been an accepted fact of twentieth century physics that electric charge comes only at integral multiples of that quantum, the charge of the electron, which is the minimum amount of charge any object was supposed to be able to have. Fairbank announced to the most recent meeting of the American Physical Society, held in New York this week, that the evidence for fractional charge continues to mount. He and his associates are now convinced that fractional electric charge exists, and they are publishing a statement to that effect in a paper recently submitted to THE PHYSICAL REVIEW.

The experiment measures the charge on little balls of superconducting niobium. The advantage of having them superconducting is that they can be levitated in a magnetic field to counteract gravity. They are thus loaded between two large flat metal plates, which act as electrodes. If there is any charge on the balls they will move from their equilibrium position toward the electrodes of opposite sign. At the beginning, the balls are bombarded with electrons and positrons, which bear unit charge, negative and positive respectively, to neutralize them. When this neutralization procedure is exhausted, the experiment measures any residual charge, which at this point would have to be in fractions of a unit.

Surprisingly, the experimenters find more and more balls, which, as far as they can tell, have charge in one-third of a unit. The latest count is nine of $+1/3$, five of $-1/3$, out of 39 balls tested. The others tested neutral. The figures are up from just one ball when the experimenters first started to talk on the record about the results of their work.

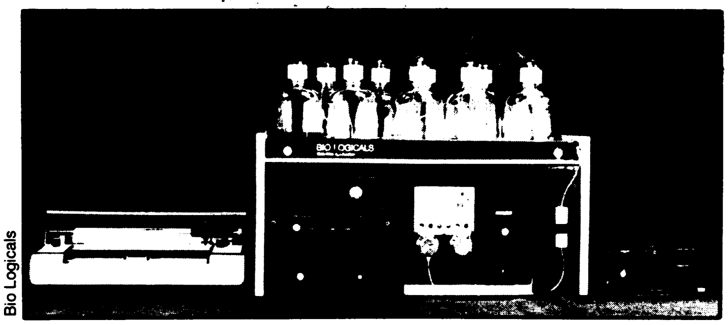
As Fairbank points out, this result would have gone over much better 15 years ago than it does today. At that time there was an expectation that charges of $1/3$ the electron charge might be observable in nature. The theorists of particle physics had just postulated the existence of the quarks, the basic constituents out of which most of the particles known to physics could be built. Quarks have to have charge in $1/3$ and $2/3$ amounts. People began to look for quarks experimentally. Failure to find free quarks in a number of experiments led theorists to think of good reasons why quarks must always be confined inside the structures they build and never exist as free particles. These reasons are now at the basis of the theory and must be defended for fear of the work that would have to be redone if this theory that explains so much should come apart.

Fairbank's audiences are perhaps smaller than years ago, but they are just as respectful and, if anything, more concerned. People are heard wishing this troublesome experiment would go away somewhere. □

Space Telescope institute

A year ago, the National Aeronautics and Space Administration decided to establish a separate organization to run the activities of the earth-orbiting Space Telescope, expected to be carried aloft by the space shuttle in early 1985 (SN: 1/19/80, p. 39). Now the Association of Universities for Research in Astronomy (AURA) has been awarded a five-year, $24 million contract to organize and operate the Space Telescope Science Institute, with three five-year options to cover the instrument's anticipated 15-year lifetime. The institute, initially directed by University of Wisconsin astronomer Arthur D. Code, will be located at Johns Hopkins University's Baltimore, Md., campus, from which it will be linked to the telescope's control center at the nearby NASA Goddard Space Flight Center. □

Gene machine: Automated DNA synthesis



Bio Logicals

Gene machine automatically pumps chemicals through a column of particles that bind the growing chains. The operator need only specify the nucleic acid sequence.

Linking the four building blocks of genetic material into synthetic sequences in the laboratory has been a skilled craft. An organic chemist working with several technicians spends months synthesizing step by carefully planned step a few micrograms of a simple gene segment. Now computerized systems for automatic DNA synthesis are about to turn that craft into an industry.

At a press conference Jan. 22 Bio Logicals, a small Toronto biotechnology firm, introduced a gene synthesizing machine that it will market for $19,500. At least three and possibly five companies will soon have computerized gene-synthesizing systems on the market, according to BioEngineering News, and together they are expected to sell up to 400 units per year. Bio Logicals president Robert Bender says, "The DNA/RNA synthesizer is just the beginning of a sophisticated new technology that will make genetic engineering a true industrial process."

The gene assembly area in the Bio Logicals machine is a column of solid particles. The gene components (nucleotide bases), and chemical reagents and solvents flow through the column. A computer directs openings and closings of valves between reservoir bottles and the solid support column. It takes the machine 45 minutes to add each nucleotide to the growing chain; the cycle has six steps that include chemically protecting and exposing appropriate parts of the chain.

Bender says that the machine has already been used to synthesize strings of 20 nucleotides, but the developers do not yet know the limit of the machine's capability.

There is already one "microprocessor-controlled polynucleotide synthesizer" marketed by Vega Biochemicals in Tucson, Ariz., but Bio Logicals claims that its new machine is faster, at half the price. "We have a new synthetic chemistry and have packaged it in such a way that the machine can be operated by a non-chemist," Bender told Science News. "It is simple enough to be operated by any intelligent person with 30 minutes' training," he says.

The prospect of simply creating their own DNA sequences appeals to biologists. According to BioEngineeing News other polynucleotides have been purchased for as much as $10,000 per microgram. The strings of nucleotides are most often used to locate a desired gene in a cell. A radioactively labeled DNA segment will bind to a corresponding sequence on a chromosome. The segments also can be linked together to form a totally synthetic gene. In the future, such segments may also be used as new regulatory regions to allow scientists to better control the activity of a gene in a cell. □

New HHS rules for research on humans

The Department of Health and Human Services has released new rules concerning protection of human participants in scientific research. The rules appear in the Jan. 26, 1981 Federal Register and will go into effect on July 27, 1981. HHS estimates the rules will exempt 50 to 80 percent of all research projects subject to review, primarily in the social and behavioral areas. The department is the largest single source of research money in the United States, especially for medical and behavioral studies, and the rules apply to all of the research it funds.

The new rules represent an attempt to reduce the paperwork needed to review research that presents little or no risk. A first draft of the rules was published in August 1979, and more than 500 comments were received — many from social scientists and historians who feared the rules would require them to get permission from a review board before using information about persons mentioned in public documents.

As a condition for receiving federal funds, institutions must still set up local review panels called Institutional Review Boards to protect human subjects from undue risk or invasion of privacy by researchers, but the following five categories of study are now exempt from review board approval:

- educational research, especially for comparing different types of instruction,
- research on educational testing when subjects remain anonymous,
- research using only surveys or interviews, except when subjects can be identified,