Colliding planets

The planet Neptune and its satellite Triton may collide with each other in the not too distant astronomical future according to a prediction by Thomas B. McCord of Cal Tech. McCord calculated the history and future of the Neptunian system and concluded that collison (or possibly the breakup of Triton into Saturnian style rings) will occur within 10 to 100 million years. This and other results of the calculation were published in the September issue of The *Astronomical Journal* [71, 585 (1966)].

The Neptunian system is of interest to celestial mechanicians because of Triton's retrograde orbit. Neptune's axial rotation is, like most other motions in the solar system, direct, and with the planet spinning counterclockwise and the satellite revolving clockwise, interesting combinations of angular momentum may be expected. Furthermore, the second satellite of Neptune, Nereid, has an orbit with unusually high eccentricity (0.76). Since most solar-system orbits are nearly circular, it would seem that Nereid underwent a highly perturbing experience, possibly because of Triton, at some time in the distant past.

Neptune suffers diurnal tides drawn out by Triton's attraction. These tides lag behind the line of centers of primary and satellite because Neptune is neither perfectly elastic nor perfectly fluid and needs time to respond to the distorting forces. The resulting drag causes transfer of angular momentum between the two bodies. Neptune also raises tides on Triton. If Triton's axial rotation period is sychronous with its orbital period (as seems reasonable to assume), the tidal bulge on Triton will stay in the same place on the satellite. Angular momentum will therefore not be transferred by this part of the interaction. On the other hand if Triton's orbit is eccentric (its eccentricity is known to be less than 0.1), the tides will pump up and down since the magnitude of tidal forces is strongly dependent on distance. Again there will be a lag because of imperfect elasticity, and this lagging pumping tide will dissipate energy from the system in analogy to an oscillating system with friction.

The angular-momentum transfer over time produces something like a winding-up effect: Triton draws closer to Neptune and eventually will either collide with the planet or break up under Neptune's distorting forces. A backward calculation of Triton's orbit shows it drawing away from Neptune and becoming more and more eccentric the further back in time one goes. At a certain time in the past, Triton's orbit would have lain in the region transited by Nereid (Nereid's orbit lies in the area between 60 and 440 Neptune radii from the planet). At this time, according to the calculations, the interaction between the two satellites could have caused Nereid's unusual eccentricity. As time goes further back, Triton's orbit evolves into a parabolic form. McCord suggests that in the beginning of the solar system Triton was thus captured by Neptune into the retrograde orbit and has been getting closer ever since. —DET

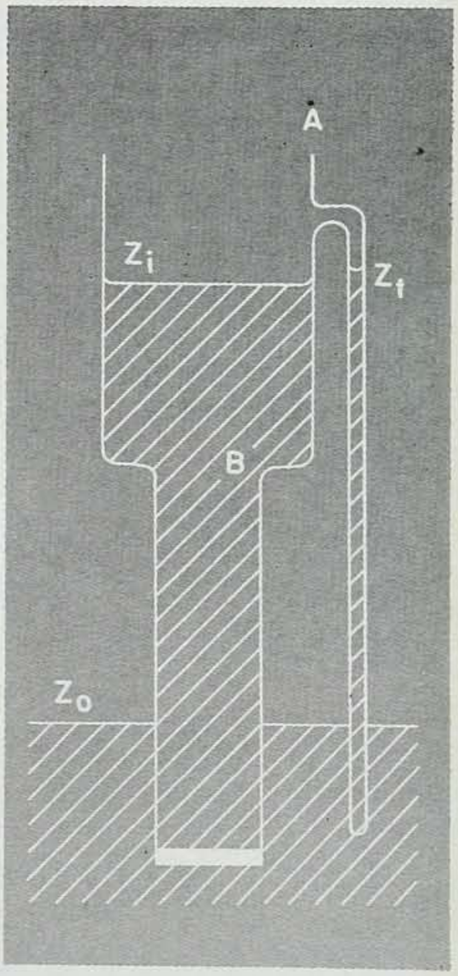
CERN bubble chamber

"Gargamelle," one of two large bubble chambers to be used at CERN is being developed by the Ecole Polytechnique and the Orsay and Saclay laboratories in France. Gargamelle, who in her previous incarnation was Gargantua's mother, will now be a cylindrical chamber 4.8 meters long and 1.9 meters in diameter containing a heavy liquid such as freon in a useful volume of 10 cubic meters. The chamber is expected to be ready for installation at CERN by the beginning of 1969.

Gargamelle's magnet, which will produce a field of 19 kG at the center of the chamber will have its pole faces placed directly against the body of the chamber so that the liquid inside will take up the whole interpolar space. The poles will contain 750 tons of steel to which 80 tons of copper coils cooled by water at 25 atm will be added. The coils, 45.8 mm square, will carry a current of 10 000 amperes at 600 volts. Placed vertically, they will provide a horizontal field that will lie along the diameter of the cylinder when the chamber is set up horizontally. Photography will take place along the axis of the field. The size of the chamber will make it especially useful for studies of neutrinos and other weakly interacting particles.

A superfluid potentiometer

Physicists who work on superfluidity have often "lost their cool" arguing over the meaning or even the existence of certain new effects. Controversy arose because measurements were frequently rough and inconclusive. Now a simple but powerful new technique for studying processes that affect superfluid film flow has been developed, which uses level sensing to probe the chemical potential along flowing liquid He II film. The work, reported in the 7 November issue of *Phys. Rev. Letters,* was done by William E. Keller and Edward F. Hammel



SUPERFLUID FILM-FLOW BEAKER. Differences in chemical potential between z_i and z_0 (related to gravitational head) cause helium film to flow over beaker edge.

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of Los Alamos Scientific Laboratory, who acted on a suggestion made by Brian D. Josephson of the University of Illinois.

To measure chemical potential, μ_f, along the path of the film, several different devices were built; one such beaker arrangement is shown in the figure. Superfluid helium flows over the beaker rim, where the liquid level is z_i inside the beaker and z_o outside. The side tube has much smaller radius than that of the beaker, so adjustments of the liquid level z_t in the tube by film flow occur much faster than changes in z_i and z_o. The chemical potentials per atom of the bulk liquids inside and outside, μ_i and μ_o, are related to the gravitational head by $\mu_i - \mu_o = mg(z_i - z_o)$. This difference in chemical potentials provides the driving force for film flow. Keller and Hammel, taking advantage of several new theoretical developments, find that z_t measures μ_f (relative to μ_i or μ_o) at the tube orifice.

With this simple level-sensing technique, Keller and Hammel measure height as a function of time and then plot profiles of chemical potential along the flow path, inside and outside the beaker. Measuring inflows ($z_i < z_o$) and outflows ($z_i > z_o$) for a variety of beaker shapes, they find that dissipation in the flowing film can either occur very locally or over extended regions, depending on the experimental setup. —GBL

Franklin Institute

We recently attended the dedication of a new building to house the Franklin Institute Research Laboratories. The 105 000-square-foot facility is across the street from the institute's famous science museum, in central Philadelphia. The institute, which also performs research at the Bartol Research Foundation in nearby Swarthmore and the Center for Naval Analyses in Washington, D. C., has a professional staff of 810. The new $5-million building houses 300 scientists and other staff.

The laboratories' chemistry division has been working in the chemistry and physics of organic solids, polymerization, quantum chemistry and ways of desalinizing ocean water. Projects in the materials science division include: identifying and characterizing structure, purifying and fabricating materials, and studying specific properties and the effect of structure on these properties. Three years ago institute scientists made very pure single crystals of beryllium and were interested to find that unlike the usual brittle metal, these were quite ductile. Last year they found that semiconducting lead telluride has a superconducting transition at about 5°K, a much more convenient temperature for device applications than had previously been found with semiconductors.

At the annual Franklin Institute Medal Day ceremony held later the same day (19 October), medals were given (see PHYSICS TODAY, November, page 95) for such diverse activities as research in polymers (Herman F. Mark), radiation shielding (Everitt P. Blizard, posthumously) and development of monolithic circuits (Jack S. Kilby and Robert N. Noyce). The institute's highest honor, the Franklin Medal, went to Britton Chance, of the University of Pennsylvania.

Synchrotron for Smithsonian

The world's first high-energy synchrotron is being moved from the University of California campus at Berkeley to the Smithsonian Institution's Museum of Science and Technology in Washington, D.C., where it will form an exhibit in the new Hall of Nuclear Science. The machine, which first operated in 1948, has been shut down since 1960.

Construction of the synchrotron began in 1945 not long after Edwin M. McMillan, now director of the Lawrence Radiation Laboratory, and the late Vladimir I. Veksler independently put forth the theory of phase stability, which made synchronous particle accelerators possible. On 16 December 1948 it yielded its first beam of 340-MeV electrons.

One of the machine's historic investigations was on photoproduction of mesons, which led ultimately to the discovery of the neutral pi meson, the first particle to be discovered by accelerator techniques. Theory had suggested that sufficiently energetic gamma rays might generate mesons. The Berkeley synchrotron was the first ac-