radio astronomy notes

Gathered at the dedication of the E. O. Hulburt Center for Space Research of the Naval Research Laboratory in Washington, D. C.

SOLAR SYSTEM ASTRONOMY

Size of earth's orbit measured

The mean disance to the sun, called the astronomical unit, is a fundamental measuring stick in the solar system. It was once known only from angular measurements of the position of extraterrestrial bodies.

Recently interplanetary radar systems have been used to measure accurately the distances to Venus and Mercury directly, but these disagreed sharply with the older measurements.

Now Stephen H. Knowles of NRL has used radio waves to determine the astronomical unit, charting how the hydrogen absorption of the waves shifted as the earth made one revolution around the sun. The frequency change recorded is directly proportional to the earth's orbital velocity and this, in turn, is proportional to the orbital size.

The NRL equipment measured the apparent frequency of two cold hydrogen clouds in front of the supernova remnant Taurus A, the Crab Nebula. The clouds absorb radio waves over a very narrow frequency band near 21 centimeters.

The year's measurements indicate that the astronomical unit is 149,588,000 kilometers, plus or minus 10,000 kilometers, which agrees with radar experiments and is more accurate by a factor of 10 than previous optical measurements.

LUNAR ASTRONOMY

The lunar bulge

Although the moon has been known to have a large gravitational bulge aimed at earth, whether or not this anomaly is associated with a real geometrical bulge remained undertermined until now.

The size of the geometrical bulge is found from the difference between the mean limb radius and the sub-earth radius of the moon. The limb radius is determined from occultation measurements of stars; the sub-earth radius, previously difficult to measure accurately, can now be found by radar.

The mean value of the sub-earth radius is 1,737,930 meters, plus or minus 150; the radius to limb (optical) is 1,738,070, also plus or minus 150.

The difference of minus 140 meters, with a possible error of 200 meters above or below that value, means that the side of the moon facing earth may have a depression but very likely does not have a large bulge.

The lack of a sub-earth bulge, when combined with the known large dynamical bulge, implies that the density of the material at the front side of the moon must be higher than the density of the back side. This may be associated with the lack of craters on that side.

Dr. Allan Shapiro of NRL believes that the known depression of the maria relative to the mountainous areas may be due to the sinking of the heavier maria into the interior, with corresponding floating of the less dense mountains.

Dr. Shapiro concludes that, if a geometrical bulge exists, it is probably located on the back side of the moon.

IONOSPHERIC PHYSICS

Origin of the nighttime ionosphere

During the past decade research has provided a fairly detailed understanding of the production of the daytime ionosphere, but the reasons for the persistence of the nighttime ionosphere have not been clear. Without a nocturnal source of ionizing radiation, the ionosphere would be expected to disappear within an hour or so after sunset.

Nevertheless, it persists with a density of several percent of the daytime strength throughout the night. Now scientists at NRL have settled the origin of the nighttime ionosphere to the extent that the responsible radiations, Lyman beta and singly ionized helium, from the sun have been observed directly.

The successful search for nocturnal radiation was made by a set of very sensitive extreme ultraviolet detectors flown on an Aerobee rocket. The ultraviolet Lyman beta was found responsible for the ionosphere in one layer, the helium radiation in another, by Dr. C. Y. Johnson and four co-workers.

ASTROPHYSICS

New model of sun

The sun is hotter at its center—21 million degrees C. compared to 16 million degrees—and less dense—30 grams per cubic centimeter compared to 160 grams—than conventional models call for, according to the calculations of Dr. Carl Rouse at NRL.

In Dr. Rouse's model, the sun burns on the carbon cycle, producing 99 percent of the solar luminosity by that method, and only one percent by the proton-proton cycle.

In the carbon cycle, the fusion of hydrogen to helium occurs indirectly through the production and decay of various forms of carbon, nitrogen and oxygen, which act as catalysts, and neutrino production occurs from decays of nitrogen 13 and oxygen 15.

In the proton-proton cycle, energy is released during the fusion of four hydrogen nuclei to form one helium nucleus, with beryllium 7 and boron 8 being the final products. Neutrinos detected on earth would come from the decay of boron 8. The predicted flux of neutrinos from this process is greater than in the carbon-carbon cycle.

Dr. Rouse's calculated model agrees with observations; it particularly accounts for the non-detection of solar neutrinos in the cleaning fluid placed a mile underground in South Dakota by Dr. Raymond Davis Jr. and his co-workers at Brookhaven National Laboratory (SN: 9/30/67, p. 332).