ASTRONOMY

Titan's Atmosphere

Saturn's largest moon found to be surrounded by methane and possibly ammonia. Discovery may have indirect bearing on the origin of the solar system.

➤ THE ATMOSPHERE of the planet Saturn's largest satellite, Titan, consists of methane or marsh gas and possibly ammonia, Prof. G. P. Kuiper, of the McDonald Observatory of the Universities of Chicago and Texas, has discovered as the result of successfully photographing its spectra. Titan thus becomes the only moon in the solar system known to have an observable atmosphere.

This information is being transmitted by the Harvard clearing house to astronomers all over the world, as it has an important bearing on problems concerning the atmospheres of all planets and their moons as well as on the origin of the solar system.

Several decades ago, observations indicated that Titan, which is larger than the earth's moon in both size and mass, had an atmosphere, but the difficulty of getting satisfactory spectra prevented study of the constitution of such an atmosphere, if it really existed.

Now Dr. Kuiper's observations prove the existence of the atmosphere and show that it must have abundant quantities of methane, which is usually called marsh gas and is composed of one atom of carbon combined with four of hydrogen. Its atomic weight is about 16, while that of ammonia, composed of one molecule of nitrogen and three of hydrogen, is about 17. It is the relative heaviness of the atoms of these gases, when compared with hydrogen and helium, which enable them to cling to a moon of rather small surface gravity.

Of all the moons in the solar system —earth's one, Mars' two, Jupiter's eleven, Saturn's nine, Uranus' five, and Neptune's one—Titan would probably be most likely to retain an atmosphere. As Sir James Jeans pointed out over 20 years ago, the kinetic theory of gases demands that in a free atmosphere the lighter gases move most rapidly in order to carry their share of the equally distributed energy. Thus, hydrogen and helium, the lightest gases, move the fastest, and they are the first to begin to escape from a planet's atmosphere after it is formed. In the earth's case, the hydrogen has been retained mostly in combination with other elements, as with oxygen to form water, whereas oxygen, of atomic weight 32 in molecular form, and nitrogen, of atomic weight 28, have been retained in their molecular form as the main constituents of the atmosphere.

However, it has been the earth's gravitational pull which has prevented their escape, for they, too, move rapidly about. The heat of the sun increases the rate of their motion, so that more particles of all gases escape from the daytime side of the earth than from the night side. In the case of the moon, the atmosphere was probably thin in the first place, and the resulting intense heating of the surface by day must have long since caused almost all gases to escape. The moon's surface gravity is only 16% that of the earth, so its control over all but the very heaviest gases has never been sufficient for it to retain an atmosphere of observable amount. It might be expected that Titan, which has a surface gravity only 14% of the earth's, might have lost all trace of air, also. But Jeans points out the tremendous difference in the distance from the sun. Saturn is nearly ten times as far from the sun as is the earth. So the solar radiation received by our moon is 100 times as great as that received by Titan. Consequently, the temperature of Titan is very low, probably some 250 degrees below zero Fahrenheit, whereas on the moon, by day, 250 degrees above zero can be reached. On Titan, as well as on the planet Saturn itself, everything but methane must be frozen to the surface, whereas on the moon, even water has been boiled away. It is believed that clouds of ammonia droplets or particles are suspended in the methane atmosphere of Saturn, and this same arrangement may account for Dr. Kuiper's having found possible evidence of ammonia in the spectrum of the satellite itself.

Titan is Saturn's brightest satellite, and averages some 760,000 miles distant from the planet itself, requiring about 16 days to revolve around it once. Titan is about 2,600 miles in diameter and nearly two times the mass of the moon; it is exceeded in size only by two satellites of Jupiter, both of which are larger than the planet Mercury. However, they have comparatively low surface gravities, and no definite observations of atmospheres around them have been reported at present. Titan takes its place as the only moon in the solar system known to have an observable atmosphere.

Of great significance to astronomers is the fact that Titan's atmosphere appears to be similar to that of Saturn itself. This may indicate a common origin for the two bodies and also a similar constitution. However, Titan has a density about three and one-half times that of water, whereas Saturn itself is lighter than water, the only planet for which that is true. Saturn's low density is explained by assuming it to be composed largely of hydrogen. Atmospheres of methane and ammonia for both Jupiter and Saturn add to the evidence supporting this belief, and the finding of an atmosphere containing large amounts of hydrogen around Titan is further evidence along the same lines.

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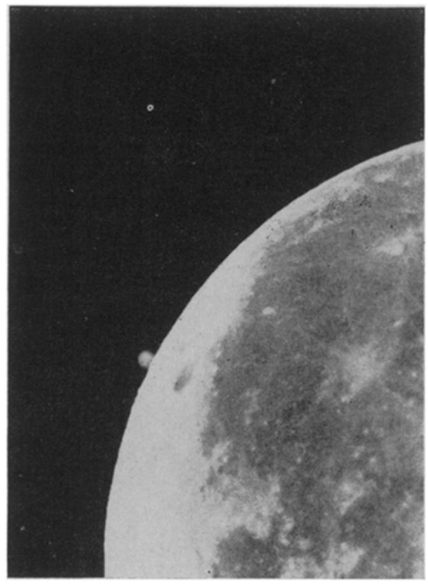

DWARFED—In this photograph of the beginning of the Jan. 13 occultation of Jupiter by the moon, the planet appears to be much smaller than the moon, though actually it is more than 40 times as large. The picture was taken by the Camera Station of the Amateur Astronomers Association of the American Museum of Natural History.