although at titers many orders of magnitude lower than that shown by monoclonals to other cell surface determinants that readily stimulate antibody production (for example, H-2, Thy-1, Ly antigens)¹⁶.

In conclusion then, it appears that the differentiation of testis from the bipoten-

tial gonad, the key step that leads to the development of the male phenotype, is controlled by an interaction between autosomal genes and genes on the sex chromosome. Whether sex specific antigens are involved, and if so, how, is still a matter of speculation. □

mixed with a small amount of water frost.

Stretching the capabilities of the size determination measurement to the outer Solar System, Morrison, Cruikshank and Brown have placed significant upper limits on the sizes of Triton, the major satellite of Neptune, and of Pluto. The results are consistent with icy objects of sub-lunar size, and with the hypothesis that the two objects are physically similar. The possibility that Triton is the largest planetary satellite can now be excluded as it is certainly smaller than the giant satellites Ganymede, Callisto and Titan. An improvement of only a factor of two in the quality of the IR measurements is likely to lead to positive detections, and hence definitive size measurements, for both Triton and Pluto.

The scientific value and cost-effectiveness of these Solar System studies are self-evident, and it is gratifying that NASA has reversed its earlier decision to stop funding for the Infrared Telescope Facility. The importance of IR astronomy for targets outside the Solar System is also gradually being realized in the study of star formation, galactic nuclei and many other dusty interstellar environments. It is to be hoped that the facility will long continue to exploit the special advantages of Mauna Kea, where, as well as University of Hawaii telescopes, there are now two international observatories in operation; the Canada-France-Hawaii Telescope (CFHT) and the United Kingdom Infrared Telescope (UKIRT). More telescopes are planned for the future, including the SERC Millimetre Wave Telescope. □

Distant planetary satellites more accurately measured

from Ian Gatley

A BASIC step in the exploration of the Solar System is the determination of the sizes of planets, satellites and asteroids. Most of these objects are far too small for direct-imaging techniques from ground-based telescopes, but the cost of spacecraft makes size determinations from the ground extremely desirable. Fortunately, a simple and elegant method which combines the results of optical and IR observations is available, and two papers in this issue of *Nature* give new results for four of the uranian satellites (Uranus is to be visited by Voyager 2 in 1986), Neptune's largest satellite Triton and the most distant planet, Pluto.

The principle is this. Sunlight falling on the target is either absorbed or reflected; the energy absorbed is subsequently re-radiated in the thermal IR. Visual photometry measures the reflected component of the solar radiation and IR radiometry measures the absorbed component and the sum of these is equal to the total incident energy. One can therefore solve simultaneously for the albedo (reflectivity) and the size of the object under study (Morrison *Icarus* 19, 1; 1973).

The principle is simple but its application is not, for two reasons: the IR signals are weak, and the atmosphere transmits poorly at the relevant IR wavelengths (around 20 μm) because of the presence of water vapour. These problems can be overcome by the use of a large IR telescope on a high dry site, such as the newly commissioned 3 metre NASA Infrared Telescope Facility on the 14,000 foot summit of Mauna Kea in Hawaii. This telescope was constructed primarily for the study of the Solar System, and its early results in this area are fascinating.

R. Hamilton Brown, Dale Cruikshank and David Morrison have measured the diameters and albedos of four satellites of Uranus — Ariel, Umbriel, Titania and Oberon, and find lower albedos and larger diameters than previous, less reliable estimates. Having made accurate size measurements, these workers now stress the importance of experiments to deter-

mine masses, for knowledge of the densities of the satellites will provide important insights into the origin and subsequent evolution of the uranian system. The albedo measurements give information on the surface composition of the satellites. Ariel, Umbriel, Titania and Oberon all have sizes similar to the large icy saturnian satellites, particularly Rhea, but they have significantly lower albedos, more like those found for Hyperion. It is noteworthy that Voyager images of Hyperion show it to be a reddish colour, suggestive of surface impurities.

Recently, further progress on surface composition has come from IR spectroscopy. Observations of Hyperion by Cruikshank and Brown (*Icarus* 50, 82; 1982) have revealed the presence of water ice bands, which differ in detail from those seen on Rhea. Measurements of the dark side of Iapetus by L. Lebofsky, M. Feierberg and A. Tokunaga (*Icarus* 49, 382; 1982) show an absorption feature thought to result from a hydrated silicate

100 years ago

POLLUTION OF THE ATMOSPHERE

THERE was a letter in *Nature* some time since, calling attention to the pollution of the atmosphere by the burning of coal; and it was calculated that in the year 1900, all animal life would cease, from the amount of carbonic dioxide; but the author had overlooked the fact that the rain is continually cleansing the atmosphere of this, and the fall of this rain on the ground, and the combination of this with various salts; besides the oceans alone would absorb their own bulk at normal pressure, but at an increased pressure of, say half a mile deep, would dissolve more than we are likely to need for hundreds of years.

But there are other products of combustion, or rather of incomplete combustion, that are not brought down in this manner by rain, as hydrogen and the hydrocarbons, chiefly marsh-gas and ethylene.

Since the year 1854 (as near as I can estimate) there has been burnt 10,000 million tons of coal; and if we say (in its consumption by household grates, leakage by gas-pipes, etc.) 1-100th escapes, then 100 million tons of hydrogen and hydrocarbons are floating in the

atmosphere or 1-10,000,000 part in bulk; if we say the average proportion of hydrogen to be .45, and of marsh gas .35, and of ethylene .4, we have .84 per cent of gases that are lighter than air, and it is more than probable that the law of diffusion of gases, as demonstrated with jars, does not apply to the atmosphere. The cases are not parallel: in the air we have unconfined space, pressure, and temperature diminishing infinitely, conditions favourable to the lighter and the gas with the greater amount of specific heat rising and maintaining its elevation, especially as we know that in large halls carbonic dioxide is found in larger quantities on the floor. According to Prof. Tyndall's researches, hydrogen, marsh gas, and ethylene have the property in a very high degree of absorbing and radiating heat, and so much so that a very small proportion, of only one thousandth part, had very great effect. From this we will have a marked influence on the climate of the world. The mountainous regions will be colder, the Arctic regions will be colder, the tropics will be warmer, and throughout the world the nights will be colder, and the days warmer. In the Temperate Zone winter will be colder, and generally differences will be greater, winds, storms, rainfall greater.

H. A. PHILLIPS

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Ian Gatley is at the UK Infrared Telescope Unit of the Royal Observatory, Edinburgh, in Hilo, Hawaii 96720.