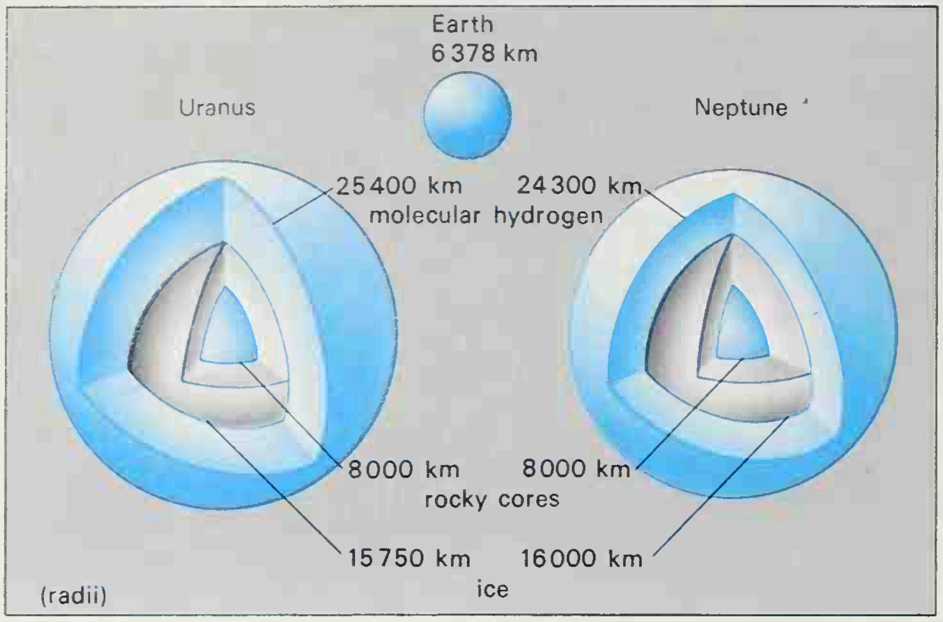

Fig. 5·19
Comparative sizes of Uranus, Neptune and the Earth. The sizes of the internal layers for the two gas giants are only tentative.

a 'horseshoe' orbit where it alternately approaches and recedes from the larger body.

Investigation of the Saturnian system has provided a great deal of insight into the characteristics of bodies which are composed largely of ice, and which probably bear a considerable resemblance to some of the primitive planetesimals and to some of the minor planets. The study of the dynamics of the rings and of some of the minor satellites remains poorly understood, but certain aspects may become clearer when Voyager examines Uranus, a different kind of system.

Uranus and Neptune

Although small in comparison with Jupiter and Saturn, the next two planets are still very large bodies, and the four planets are sometimes known as the 'gas giants'. Uranus and Neptune are very similar in size (equatorial diameters of 50 800 km and 48 600 km respectively) and mass, with Neptune being about 15 per cent more massive than Uranus (Table 5·17). Their characteristics are so similar that they may be conveniently discussed together. The densities of both planets are low and they probably have identical internal structures, with rocky cores surrounded by layers of ice and molecular hydrogen (Fig. 5·19). Unlike Jupiter and Saturn, they have measured temperatures which agree with those calculated for their distances from the Sun, 57 K and 45 K approximately, indicating that they have no major internal sources of heat.

Rotation

There is considerable doubt about the rotation periods of both planets. The cloud layers, which might give an indication of the correct periods, show no distinct features at all and spectroscopic measurements have given apparently contradictory answers. For a long time, periods of $10_h\ 50_m$ and $15_h\ 48_m$ have been quoted for Uranus and Neptune respectively but recent results suggest that these may have to be revised to approximately 16_h and 18_h.

Uranus is unique among the planets in that its equatorial plane (as shown by the orbits of the satellites) is almost perpendicular to the orbital plane. The axis has apparently been tilted by an angle of about 98°, so that, strictly speaking, the rotation and the orbits of the satellites are retrograde. The cause of this is completely unknown, but it has been suggested that the impact of a very large body could have been responsible. The effect of the axial inclination is that for very long periods of time (Uranus has an orbital period of about 84 years) the poles will face towards the Sun, and calculations indicate that over an orbital period they actually receive more solar radiation than the equator.

Atmospheres

Spectroscopic examination has shown the presence of only two gases in the atmospheres of these planets, methane and molecular hydrogen, although both ammonia and helium are also expected to be present, with ammonia ice forming the principal cloud particles. Neptune has recently been found to show unexpected changes of brightness at infrared wavelengths, and these are thought possibly to be due to alteration in the amount of high clouds, which may be composed of particles of frozen methane or argon.

Although with the apparent detection of radio bursts there had been some suggestion that Uranus had a magnetosphere, this remained uncertain. The discovery that the planet is unusually bright at various ultraviolet wavelengths now suggests that there is some auroral activity, and that most of the radiation comes from excited hydrogen atoms. The only likely mechanism for such excitation is the acceleration of charged particles in a magnetic field, which therefore seems likely to exist on Uranus. The planet's peculiar axial orientation should lead to some unusual features in its magnetotail, and these may be detectable when Voyager 2 encounters the planet in 1986.

Satellites

Uranus has five fairly small satellites, while Neptune has two or possibly three, one of which, Triton, is exceptionally large and has a retrograde orbit very close to the planet. Details of the orbits and possible sizes are given in Table 5·18, although it should be mentioned that the diameters are only rough estimates based upon the apparent magnitudes.

In 1977, observation of the occultation of a star by Uranus led to the discovery that within the orbit of Miranda, the innermost satellite, there were five narrow 'rings'. Subsequent observations, including further occultations, have established that there are actually nine rings located between about 42 000 km and 51 000 km from the centre of the planet. At least two of the rings, and possibly three, appear to be double, or have some form of complicated structure. However, they are all very narrow (unlike e.g. Saturn's rings) with the widest being no more than about 60 km. There are some suggestions that a minor satellite body has been detected in association with one of the rings. Such satellites have been proposed as one means of ensuring the dynamical