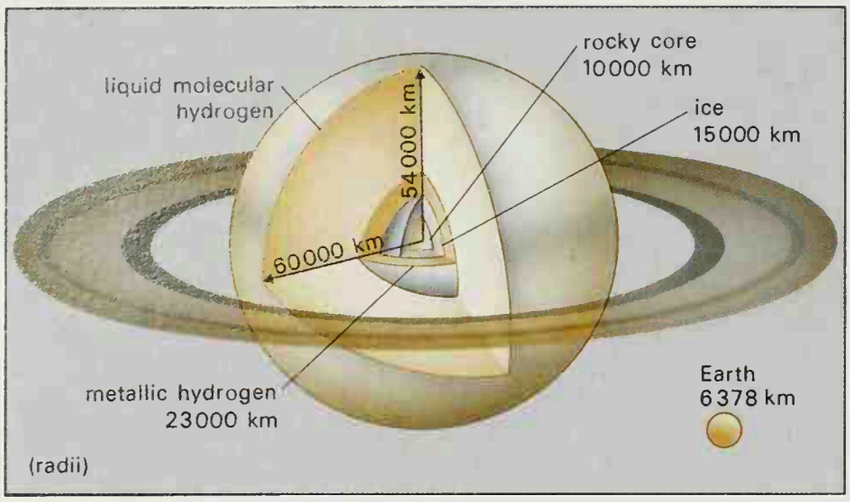


Fig. 5·18
Comparative sizes of Saturn and the Earth. Unlike Jupiter, Saturn probably has a layer of ice surrounding the rocky core.

Table 5·15 **Saturn-Earth comparative data**

	Saturn	Earth
equatorial diameter (km)	120 660	12 756
sidereal period of axial rotation	10_h40_m	$23_h\ 56_m\ 04_s$
inclination to orbit	26° 44′	23°27′
density (kg per m^3)	706	5 517
mass (Earth = 1)	743·6	1·0000
surface gravity (Earth = 1)	1·159	1·0000
escape velocity (km per s)	36·26	11·2
albedo	0·76	0·36

mean Sun-Saturn distance 9·5388437 au

them. One, Titan, is a planetary-sized body in its own right, and is the only satellite in the Solar System with a dense atmosphere. The next six satellites, in descending order of size, do not show the extreme diversity of Jupiter's Galilean satellites, but they do possess some remarkable features, and can conveniently be discussed in pairs of similar sizes.

Titan

Although methane had been detected from Earth as early as 1944, the atmosphere of Titan has proved to be truly extraordinary, with more compounds being discovered than on Saturn itself. Most surprisingly, nitrogen forms the bulk of the atmosphere, and this is even more massive than the Earth's, with a surface pressure of 1·6 atmospheres. There are thin haze layers in the outer atmosphere, but the surface is completely hidden beneath a dense blanket of photochemically produced clouds about 200-300 km above the solid surface. It is quite probable that large complex organic molecules are being formed from the compounds present, and that they aggregate to form 'smog' particles which sink down to the surface.

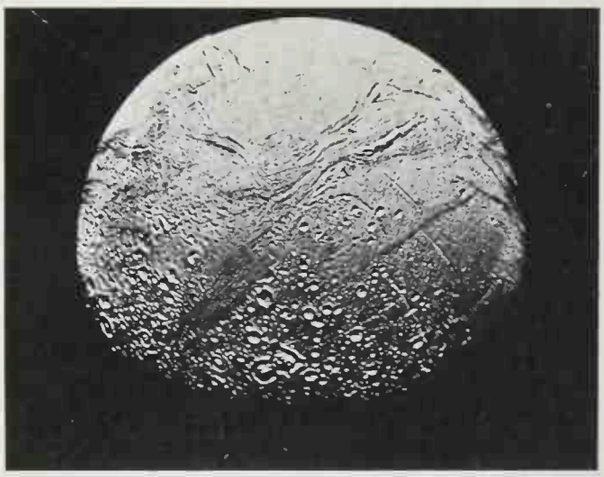
As with Ganymede and Callisto, Titan's density of about 1 900 kg per m^3 suggests a composition of about half water ice and half silicate material, which is probably differentiated into a rocky core and a surface ice layer about 100 km thick. Conditions at the surface must be remarkable. The temperature is about 95 K, and is almost certainly raised by some form of greenhouse effect. This temperature is close to the temperature at which methane is either solid or liquid, so that methane clouds in a nitrogen/methane atmosphere may be raining methane down on to a surface covered with methane ice! Quite apart from this, complex organic molecules must precipitate out on to the surface, possibly in sufficient quantity to have formed a layer 100 m thick over the lifetime of the satellite.

The atmospheric conditions on Titan are so unusual, and its chemistry must be so similar in many ways to that of the primitive Earth, that the satellite is probably a more important target for future space probes than Saturn itself. The techniques used in such a mission would have to resemble those employed in examining Venus with its thick atmosphere, or in the forthcoming Galileo probe to Jupiter.

Mimas and Enceladus

The two large satellites closest to Saturn, Mimas and Enceladus, are both icy bodies. Mimas, however, is fairly strongly cratered, and has one enormous crater (named Herschel) which is about 130 km in diameter, as much as 10 km deep, and with walls rising 5 km above surface level. A high central peak was created by the rebound from the impact, which probably came very close to disrupting completely the 400 km diameter satellite.

Enceladus is very different, with an exceptionally high albedo of well over 90 per cent. Although some parts of the surface have a moderately high density of craters, other portions are relatively smooth, suggesting that some process has been acting to rejuvenate the surface. Water 'volcanism' has been proposed, and it has even been suggested that this has been the source of the material forming the E Ring. But such a small body as Enceladus could not be expected to have, or to retain, any internal heat, so it must be assumed that some form of gravitational tides are acting to heat the interior. It is as yet uncertain, but it is possible that Dione may act in this way, in the form of an orbital resonance, just as Europa acts upon Io in the Jovian system.



Far right:
The smoother portions of the surface of Enceladus appear to indicate that some 'resurfacing' of the icy crust has taken place, perhaps by water 'volcanism'.

Tethys and Dione

Both Tethys and Dione are slightly larger than 1 000 km in diameter and are quite heavily cratered. Tethys has one large impact scar, Odysseus, which