Table 5·13 **Satellites of Jupiter**

number	name	distance (km)	sidereal period (d)	inclination	eccentricity	diameter (km)	magnitude
XIV	Adrastea**	128 000	0·295	0·0	·0	40	17
XVI	Metis**	128 000	0·295	0·0	·0	40	17
V	Amalthea	180 900	0·489	0·4	·003	270 × 170 × 150	14·1
XV	Thebe	221 000	0·670	0·0	·0	80	16
I	Io	421 700	1·769	0·0	·0	3632	5·0
II	Europa	671 000	3·551	0·0	·0001	3126	5·3
III	Ganymede	1 070 400	7·155	0·2	·001	5276	4·6
IV	Callisto	1 882 600	16·689	0·2	·007	4820	5·6
XIII	Leda	11 110 000	240	26·7	·146	10	20
VI	Himalia	11 470 000	251	27·6	·158	180	14·7
X	Lysithea	11 710 000	260	29·0	·130	20	18·6
VII	Elara	11 740 000	260	24·8	·207	80	16·0
XII	Ananke	20 700 000	617	147	·17	20	18·8
XI	Carme	22 350 000	692	164	·21	30	18·1
VIII	Pasiphae	23 300 000	735	145	·38	40	18·8
IX	Sinope	23 700 000	758	153	·28	30	18·3

Much of the information for the smaller satellites is uncertain, in particular the diameters, which are subject to errors of 5–10%. The eccentricity of satellites I, II and III is variable.
** Yet to receive official confirmation.

covered in a reddish material – possibly derived from Io. Even less is known about the remaining objects except for their orbits, and details about these have yet to be fully confirmed in the cases of Adrastea, Metis and Thebe. The satellites lying beyond the four large Galileans fall into two groups, and although their origin is obscure it has been suggested that they might have originated from the break-up of two larger bodies. In the case of the outer group, which has retrograde motion, they are very likely to be captured minor planets.

Saturn

The most spectacular object in the Solar System as seen through a telescope is probably Saturn with its magnificent system of rings. Apart from these, however, Saturn shows many similarities with Jupiter (Table 5·15),and is a very sizeable planet with an equatorial diameter of 120 000 km (nearly nine-and-a-half times that of the Earth). It is particularly remarkable for its very low density of only 706 kg per m^3, less than that of any other known planetary or satellite body, which indicates that, like Jupiter, it is primarily composed of hydrogen and helium. It, too, is expected to have a core of silicate materials, relatively larger than Jupiter's, surrounded by layers of metallic and molecular hydrogen. This core probably has a diameter of about 20 000 km and contains some 3–4 Earth masses, while it may be surrounded by a 5 000-km-thick layer of ice. Unlike Jupiter, the layer of metallic hydrogen is probably fairly small at about 8 000 km thick and the major portion of the planet is formed of liquid molecular hydrogen (Fig. 5·18).

Observations show that Saturn, like Jupiter, has an internal source of heat, and that the amount of energy is relatively more important, being about two to three times the radiation received from the Sun. The original heat of accretion is thought not to be sufficient to account for this and it is proposed that an additional source is the separation of helium from the hydrogen-helium mixture in the interior. Helium is probably 'condensing' and 'raining' down towards the centre, releasing heat as it does so.

Saturn has an even greater polar flattening than Jupiter (about 10 per cent compared with 6 per cent) and the polar diameter is about 108 600 km. The atmospheric rotation period was rather difficult to establish as the markings visible from Earth were never so distinct as on Jupiter. The generally accepted period is 10_h14_m (System I) with greater speeds towards the poles. Voyager experiments detected radio bursts at very long wavelengths which were shown to have a period of 10_h40_m, this now being accepted as the sidereal period of the planet (System III).

As with the other planets known to possess metallic cores and have rapid rotation rates (Jupiter and the Earth), a planetary magnetic field is generated in the interior. Before the Pioneer 11 and Voyager missions nothing certain was known about Saturn's magnetic field, but it has now been established that it is intermediate in strength between those of Jupiter and the Earth. It was something of a surprise when the geomagnetic axis was found almost to coincide with the rotational axis – they deviate by only 0·7 degree – as one theory for the generation of planetary magnetism required a much greater divergence. Just as Io is the primary source of the charged particles and atoms within the Jovian magnetosphere (with perhaps some contribution from Europa), so Titan provides most of the material in Saturn's system, with some gas also possibly derived from the inner satellites Enceladus, Tethys and Dione.

Titan orbits near the position of the magnetopause, although apparently it is usually inside it. It contributes large amounts of nitrogen from its atmosphere, as well as methane, which is broken down and provides the basic source for the large hydrogen torus found to encompass the orbits of Titan and Rhea.

All the satellites within the radiation belt affect the population of charged particles at their respective distances, but Titan in particular causes strong magnetic and plasma effects behind it. The number of charged particles drops dramatically at the edge of the rings, which essentially sweep up all particles within that radius.