study. It has proved to be a world of superlatives: it is by far the largest of the planets with an equatorial diameter of 142 796 km (11·2 times that of the Earth); it is more massive than all of the other planets put together (318 times the Earth's mass); it has the shortest rotation period; it has a vast magnetic field and is a powerful source of radio waves. In keeping with its importance it has at least seventeen satellites and exerts great influence on the orbits of the minor planets and comets by its gravitational perturbations. However, despite its apparent size, it is small when compared with the Sun which has a mass 1 047 times that of Jupiter. Table 5·11 gives some of the details of this planet and its orbit.

Table 5·11 **Jupiter-Earth comparative data**

	Jupiter	**Earth**
equatorial diameter (km)	142 796	12 756
sidereal period of axial rotation	$9_h55_m30_s$	$23_h56_m04_s$
inclination to orbit	3° 04′	23° 27′
density (kg per m^3)	1 330	5 517
mass (Earth = 1)	1318·7	1·0000
surface gravity (Earth = 1)	2·643	1·0000
escape velocity (km per s)	60·22	11·2
albedo	0·73	0·36
mean Sun-Jupiter distance 5·2028039 au		

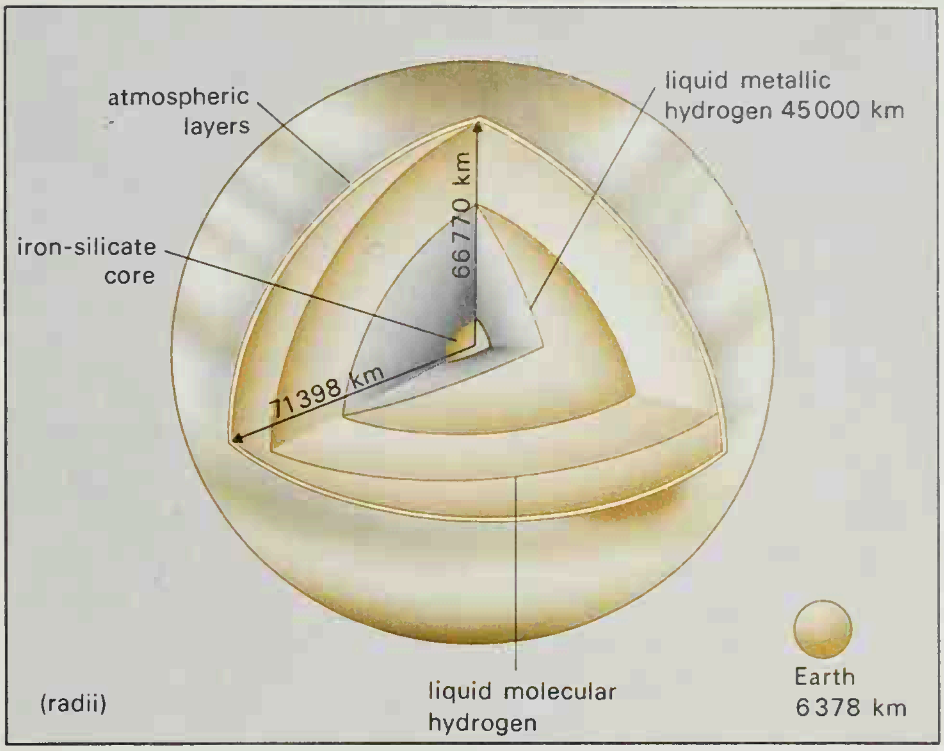

Fig. 5·15: Comparative sizes of Jupiter and the Earth. The size of Jupiter's probable rocky core is uncertain. The thickness of the planet's atmospheric layers is about 1 000 km.

Interior

Jupiter's density is only 1 330 kg per m^3 (less than a quarter of the Earth's) and this indicates that it is almost entirely composed of very light elements, notably hydrogen and helium. On theoretical grounds it is expected that the ratio of these two elements should be about the same as that found in the Sun, and this has been confirmed by the Pioneer and Voyager spacecraft measurements. A minor amount (perhaps 10–20 Earth masses) of heavier elements should be present, and this may be expected to be concentrated into a small iron-silicate core, although the presence of such a core is not evident either from study of the orbits of its satellites or spacecraft tracking. Tracking has, however, shown that the body of Jupiter is in fact liquid, and this is in agreement with calculations of the planet's internal temperature, which is expected to reach 20 000–30 000 K at the centre. This heat is the remains of that produced by release of gravitational energy when the planet originally formed. The combined effect of the temperature and the immense internal pressure is that hydrogen will be liquid throughout the planet. In an outer layer the hydrogen is in the molecular (H_2) form, but at about 40 000–50 000 km from the centre the molecules are separated into individual atoms (H), causing the material to become an electrical conductor and it is described as being in the **metallic state**. Figure 5·15 indicates the probable internal structure of the planet.

Observation of Jupiter's radio emission has established that the rotation period of the body of the planet is $9_h55_m29{\cdot}75_s$. (This is known as the System III rotation period to distinguish it from the other two periods which are found from atmospheric features and which will be mentioned later.)

As a result of this rapid rotation, the liquid state and the low overall density, the globe is flattened by about 6 per cent with the polar diameter being 133 540 km.

Atmosphere

Above the liquid molecular hydrogen layer there is a thick and complex atmosphere and it is clouds within this which are responsible for all the visible features. The most immediately obvious are a series of light-coloured zones and dark belts which encircle the planet parallel to the equator. Apart from the banded structure, however, there is a wealth of streaks, irregular patches, ovals and spots of all kinds, as well as the famous Great Red Spot, which is about 25 000 km long by 10 000 km wide and roughly equal in area to the whole of the Earth's surface. Observations from Earth showed that markings within the approximately 20°-wide equatorial zone have a rotation period of $9_h50_m30_s$ (System I), whereas areas to the north and south of this rotate in $9_h55_m41_s$ (System II), much closer to the period of the interior. Voyager images showed that this difference is largely due to the very strong eastwards flow within the equatorial zone, which may reach velocities as high as 150 m per second. The whole atmospheric circulation at low and middle latitudes is strongly zonal with both eastwards and westwards currents at various latitudes. Considerable local turbulence and small-scale features occur with the strong wind shear which is present in the regions between the opposing currents. It is now known that the colours of the various belts and zones are very variable, but the dominant winds are remarkably constant, having been traced from Earth-based observations made over many decades, and including a very substantial contribution from amateur astronomers.