The atmosphere

The atmospheric composition is roughly the same as that of Jupiter, but the overlying hydrogen haze is very much thicker, so that the planet appears comparatively featureless. Sufficient details have been observed, however, for it to be determined that the overall structure is very similar to Jupiter's, with strongly zonal flow at low latitudes and greater convective activity towards the poles. The equatorial wind speeds are exceptionally great, reaching 500 m per second (nearly 1 500 km per hour). To the north and south of this eastward jet stream, easterly and westerly flows alternate in a very regular fashion. There was a particularly turbulent westerly jet at about 47° north at the time of the Voyager 2 encounter.

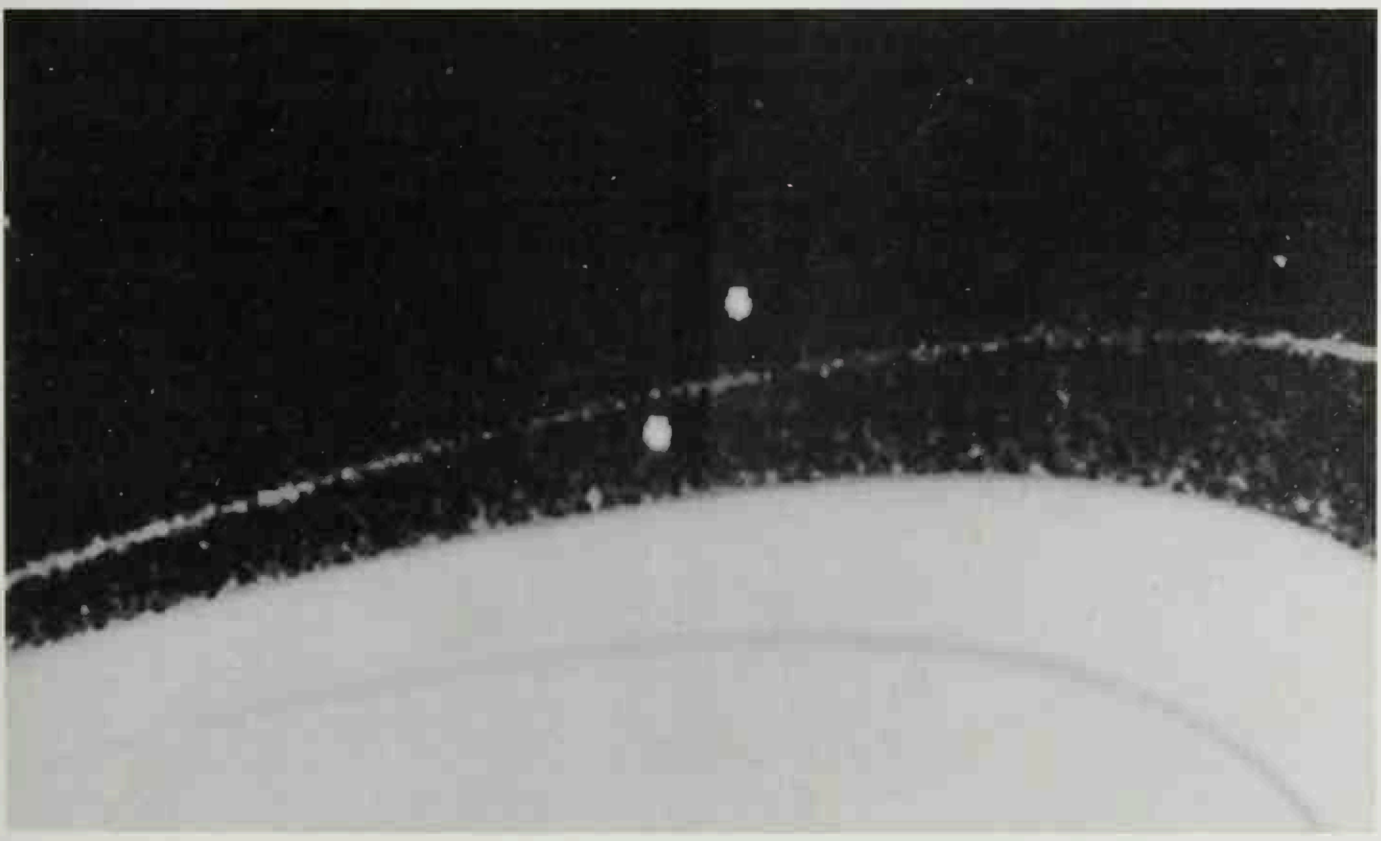
Below the hydrogen haze the highest clouds are again ammonia cirrus, with a temperature of about 95 K at the top of the troposphere, where the pressure is about 0·07 atmosphere. Unlike Jupiter, breaks in the cloud cover appear to be very rare indeed on Saturn – if they occur at all. There is actually quite a number of features within the ammonia clouds, however, the largest being oval spots quite similar to those on Jupiter but very much smaller. Like the Great Red Spot and the white ovals on Jupiter, they are high-pressure areas which can certainly persist for about a year or more. Smaller-scale features may only last for a few days. There is probably little seasonal variation on Saturn, despite its axial tilt of nearly 27°, due to the large mass of the atmosphere.

Saturn also experiences aurorae at high latitudes where energetic particles from the magnetosphere are precipitated into the upper atmosphere. Radio discharges similar to those produced by lightning were initially thought to be associated in some way with the ring system, but are now believed to be truly the result of lightning discharges in the atmosphere.

The rings

Saturn's ring system, impressive even from Earth, has been shown by the Voyager missions to be of quite amazing complexity. The details of the main features are given in Table 5·14. It should be realized that there are really no distinct boundaries between the main rings, although the Cassini Division comes closest to being so. There are instead definite changes in the density of particles found at a given distance from the planet. The three main rings, A, B and C, have been known for a long time, the last being sometimes known as the Crêpe Ring on account of its tenuous appearance. Although discovery of the D Ring from Earth has been announced in the past, it does not really correspond with the features found on the Voyager images.

The whole system of rings consists of many thousands of individual ringlets, and doubtless with higher resolution even more would be shown. Understanding the dynamics of all these ringlets is a major problem, and there are probably several factors which contribute, or which may predominate in particular regions of the whole system. It was long thought that the major divisions were caused by gravitational resonances with certain of the satellites outside the rings, particularly Mimas; however, except in the case of the Cassini Division – or more especially the Huygens Gap – this cannot account for the system's complexity. Current theories favour the idea that much of the structure is governed by density waves somewhat similar to those suggested to control the distribution of matter in spiral galaxies. The distribution of ringlets certainly changes with time, although it is expected that the overall structure will probably be reasonably constant. Many of the individual ringlets are eccentric, with the centre of Saturn at one focus of the ellipse, and it is suspected, although unconfirmed, that they may be controlled either by a single satellite or by a pair of 'shepherd'



Opposite:
A Voyager 2 picture showing the thin F Ring and its two 'shepherd' satellites, and part of the much wider A Ring in the foreground. The two satellites confine the F Ring to its narrow band, while another satellite (not shown) orbits the very edge of the A ring.