Age and origin of the Moon

There are various dating techniques which may be used on lunar samples and these have shown that the majority of the rocks are very old indeed. The highland materials, for example, commonly have ages of $4{\cdot}3$–$4{\cdot}0 \times 10^9$ years and the very oldest rock has been dated at $4{\cdot}6 \times 10^9$ years, very close to the age estimated for the Solar System itself. The mare basalts on the other hand have ages of $3{\cdot}8$–$3{\cdot}1 \times 10^9$ years and are thus much younger than the highlands, although still comparable in age to the very oldest rocks known on Earth ($3{\cdot}8 \times 10^9$ years). No significantly younger rocks are known to exist on the Moon.

By counting the number of craters on identical areas, the relative ages of different surface materials may be determined. As we are now able to date some of these materials exactly from the samples which have been obtained, it is possible to estimate the rate at which craters have been formed. It seems that on the Moon the flux of meteoroids declined rapidly until about $3{\cdot}0 \times 10^9$ years ago, since when it has remained at approximately the same level and is now similar to the number and size of meteoroids which are known to enter the Earth's atmosphere.

It is thought that the Moon (like all the planets) was formed in a very short time from smaller bodies a few hundred kilometres in diameter, which are known as planetesimals. In the intense early bombardment, the heat of the impacts caused the whole surface to become molten down to about 200 km. From this molten layer the crustal (highland) rocks formed, and these continued to be cratered after they became rigid. At a later date, the interior heated up due to radioactivity of the materials and the mare lavas escaped to the surface, filling some of the large basins which remained. The interior of the Moon gradually cooled until now only the very centre retains any heat. Being without a molten interior today, the Moon does not possess any significant magnetic field. There are, however, traces of very early magnetism, but this might have originated outside the Moon itself.

Right:
Mariner 10 photograph of part of the surface of Mercury. The prominent lobate scarp which runs diagonally across the picture is actually considerably longer, only about 300 km being shown here.

Mercury

Mercury has never been an easy object to observe from the Earth because of its closeness to the Sun. It never reaches an elongation greater than about 27° 45′, and it is also very small with a diameter of 4 878 km, thus presenting a disc never more than 11 arc sec. across. Only a few vague markings are visible with even the largest telescopes. It was long supposed that its axial rotation was the same as its orbital period of 88 days, so that one hemisphere permanently faced the Sun, leading to very high temperatures on that side while the other was very cold. In 1965, using radar echoes, it was discovered that the rotation period was approximately 59 days, suggesting that tidal interaction with the Sun has caused 2 orbital periods to equal exactly 3 axial rotations. This effect, known as **spin-orbit coupling**, has resulted in a rotation period of 58·65 days. The spacecraft Mariner 10, to which we owe practically all modern knowledge about the planet, was placed into a similar resonant orbit, making its second and third encounters with the planet 2 and 4 Mercurian 'years' (3 and 6 rotations) after its initial approach. Some

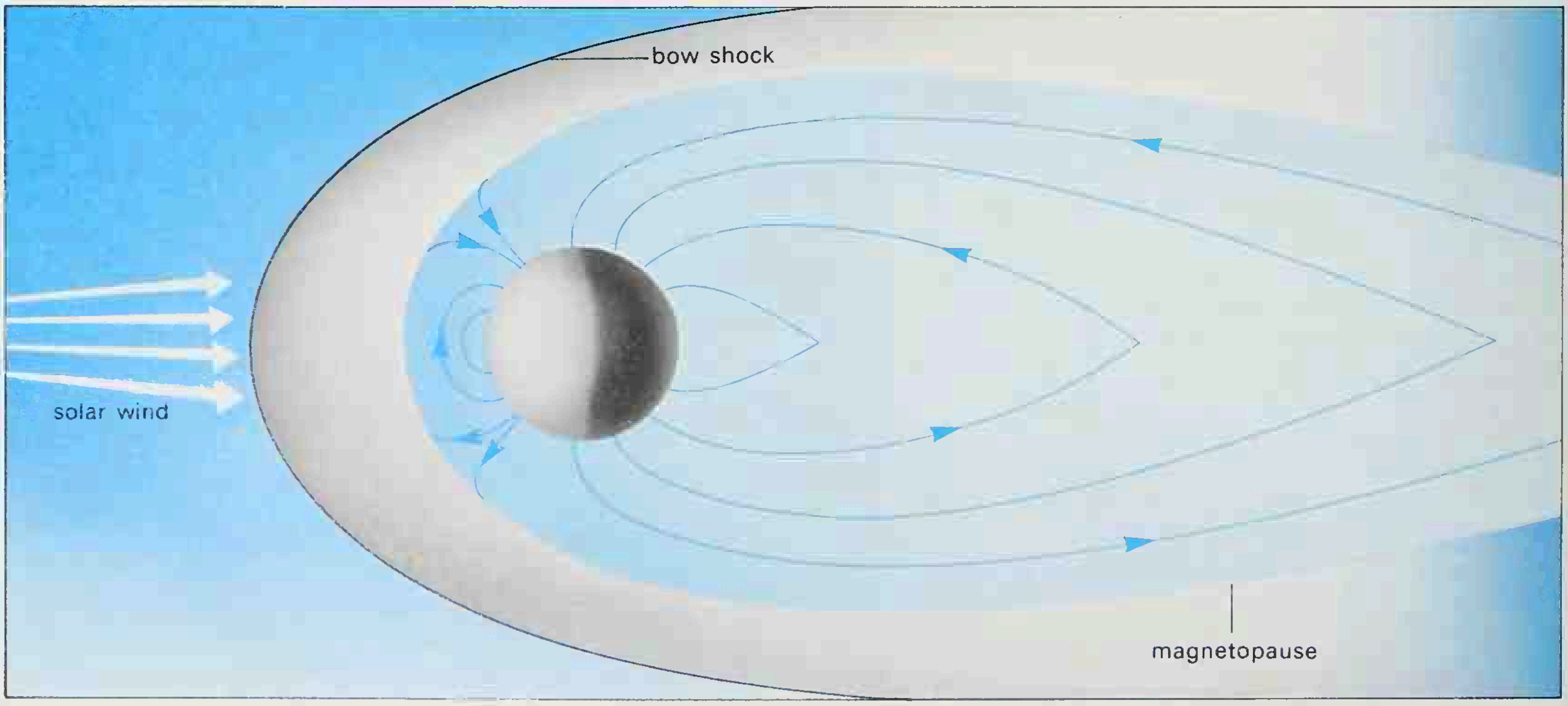

Fig. 5·10
Mercury's magnetic field and magnetosphere. It is assumed that the planet's rotational and magnetic axes are identical, and at right-angles to the orbital plane.