

different features may be observed during a single, fairly short observational session. This leads to a very valuable method of determining the position of a feature by timing its passage across the central meridian, from which its longitude may be derived.

Although the four Galilean satellites can be seen with only limited optical aid, somewhat larger equipment is required to observe the various forms of satellite phenomena which arise from their small orbital inclinations to the equatorial plane of Jupiter. As a result of the similar orbital inclinations of Jupiter and the Earth, transits of the satellites and their shadows across the planet's disk, eclipses of the satellites by the shadow-cone of the planet and occultations of the satellites by Jupiter itself are regularly visible from the Earth. Apart from being interesting to observe, a comparison of the actual times of their occurrence with those predicted is important for an understanding of the gravitational interaction of the satellites and the planet.

Saturn with its system of rings is an awe-inspiring sight even through quite a small telescope (except when the rings are presented edge-on to the Earth, as happens every 15 years). However, a large aperture is really required for detailed observation of the planet, which generally shows less distinct phenomena than Jupiter. Long-lived features are only very rarely seen – and cause appropriate excitement when they do appear – so that routine amateur work concentrates upon the estimation of the relative intensities of the rings and the rather faint belts and zones. When any distinct details can be seen the method of Central Meridian transits can be applied (as for Jupiter). Phenomena involving Saturn's satellites are rare when compared with Jupiter's, as they can be observed only during the five successive apparitions that occur when the Earth is passing through the plane of the rings. In general, passage through the ring-plane is eagerly awaited by observers, as they also make observations of the visibility of the rings themselves as they fade towards disappearance and subsequently reappear. Around

this period bright 'knots' may sometimes be seen in the rings, and these probably represent clumping of the ring particles or undulations in the general surface.

The magnitudes of Saturn's satellites are poorly known and estimates may therefore be attempted by amateurs. Variations in brightness (and apparent colour) are detectable, and these are dependent upon the positions of the satellites in their orbits (as would be expected with synchronized rotation). However, this work is very difficult to carry out on account of the considerable interference from the glare of the planet itself, and, as in the case of minor planets and comets, the lack of suitable comparison stars. It is usual with this kind of work to take one satellite as the standard against which the others may be compared, even though it is itself almost certainly variable. With so many problems, a proper photometer – preferably photoelectric – is really required.

The remaining planets – Uranus, Neptune and Pluto – can be located using progressively larger telescopes, Uranus being visible as a faint point of light in binoculars, and Pluto needing about 300mm aperture. A telescope of this size shows Uranus as a disk, but no detail can be seen and none of the three planets offers much for most amateurs.

General photography of the planets is difficult because of the small sizes of the disks. Nevertheless some amateurs, especially those with fairly large-aperture equipment, have achieved excellent results, even though these cannot compare for detail with visual observations. The main requirements are patience, perseverance and a telescope with a long focal length. Some success has been achieved by the use of the multiple-image technique, where a series of exposures, obtained over a short period of time on a single occasion, are combined in the darkroom to produce a single image with enhanced detail. However, this method and those requiring hypersensitized film are only applied by the most advanced amateurs.

A remarkable photograph showing several of the satellites of Saturn, taken by K. Kaila, Finland. The image of Saturn itself is, of course, greatly overexposed; its brightness makes photography of the satellites extremely difficult.

