Tracking Artificial Satellites

Observations of artificial satellites can be used to provide information about two aspects of the Earth. They are affected by any irregularities in the Earth's gravitational field, and precise determination of their orbits since the first satellites were launched in 1957 has gradually resulted in a most detailed knowledge of gravitational variations from place to place. (Studies of the motion of natural satellites has similarly given some information about the gravitational fields of other planets. However, this knowledge has been greatly increased in those cases where spacecraft have passed close by, or even better, orbited the body. The discovery of the lunar mascons described on page 117 is a case in point.) Information can also be gained about conditions in the upper atmosphere, especially its density. The orbits of satellites are greatly affected by the density of the regions through which they are passing, particularly at perigee. Strong solar flares, by causing heating and expansion of the upper layers of the atmosphere, greatly increase their density and thus have a marked effect on satellite orbits. In the final stages of a satellite's lifetime, such changes can precipitate decay and re-entry into the atmosphere.

All that is required for these studies is a number of accurate positional determinations at known times. Naturally this is more easily said than done, but although special large cameras are used by some professional teams, visual observations are quite capable of yielding the required degree of accuracy. Timing usually presents few problems, and stop watches or the simultaneous recording of time signals and the observer's event markers are quite suitable. As with lunar occultations (page 109), telephone or radio time signals should be used.

The measurement of positions is rather more difficult and the precise means that are adopted will depend upon the equipment employed. The purpose is to obtain a satellite's right ascension and declination at a determined instant. Some instruments such as theodolites – not usually found in amateur hands – will give readings in altitude and azimuth, but these will, essentially, be converted into RA and Dec. when analysed.

In the early days of studies of artificial satellites, teams of observers used 'fixed' telescopes to establish a 'fence' of overlapping fields in the sky. It was then possible for the particular observer (or observers) who saw the satellite to obtain the time of its transit across a crosswire in the field. Nowadays it is more common to find individual observers with binoculars or similar small-aperture equipment. The method then consists of observing the satellite's path against the stellar background, and of choosing a pair of suitable reference stars and noting its position relative to them at a certain instant. The stars chosen should be readily identifiable, and given in a good atlas and catalogue. As the positional information regarding the fainter stars (below about 9th magnitude) is not very reliable, bright objects should be chosen whenever possible. If possible more than one observation should be obtained during the satellite's pass, but this may not be practicable on some occasions as the satellite may run into eclipse. From the positions and times (and additional information such as the observer's exact latitude, longitude and altitude) the orbit may be derived.

With so many objects in orbit, it is essential that the proper identity of the satellites should be known, and it is normal for 'Look Data' predictions to be prepared for each observer, giving information on where individual satellites may be seen. Some observers prepare such predictions for themselves – especially if they have computers – but the normal method is for a national centre to be responsible.

One of the earliest and brightest artifical satellites, Echo 1, is shown in this photograph taken looking towards the galactic centre.