6·9 Mars radii. This makes observations of their orbits a good way of measuring the oblateness of the planet, and the result is that the equatorial radius of Mars seems to exceed the polar radius by about 17 km. The alternative method, simply to look at telescope images of the planets, results in an ellipticity of twice the dynamical value—an equatorial bulge of 40 ± 20 km. People think there is more to the discrepancy than the inaccuracies in the geometric method suggest.

From considerations of celestial mechanics, Dr Wilkins favours the view that Phobos and Deimos were formed in the envelope of some kind of proto-Mars. This accounts for the low eccentricities and inclinations of their orbits more easily than the capture theory. Future studies of the satellites should concentrate on better orbital data, which ought to throw more light on Mars itself, and on observations from space probes to search for clues as to their origin and evolution. The ultimate success would be to soft-land a transmitter on Phobos—the orbital data it would produce should end the suspicion that Phobos is slowly spiralling in.

Recent radar measurements along the martian equator have shown elevation differences of up to 15 km (see *Nature*, **223**, 562; 1969), and Professor S. K. Runcorn (University of Newcastle) wondered whether this marked ellipticity of the equator might have something to do with the contradictory oblateness measurements. He went on to explain that if Mars, like the Earth, has a core of liquid heavy metals, then it must be a very small core. But there are grounds for supposing that there is some internal activity. There seem to be linear features on the surface which represent the response of the crust to deep processes, and convection could be responsible for maintaining the elevation differences.

Dr W. H. Pickering (Jet Propulsion Laboratory, California) described the new information which Mariners 6 and 7 had provided. He said that the data are consistent with the carbon dioxide hypothesis for the polar cap. It is true that the temperature is a fraction higher than it ought to have been, but this is easily explained as the effect of several bare patches on the cap. Clearly the frozen layer is not deep. Assuming a carbon dioxide atmosphere, the surface pressure deduced from S-band occultation data is consistent with variations in elevation of the surface of about 10 km. The television photographs show fewer craters with central peaks compared with the Moon, and no rilles.

No differences in albedo were detected when the Mariners crossed the dark markings, but Dr Pickering said that the television circuits included an automatic gain control system designed to average out large scale intensity changes while at the same time accentuating small scale features such as craters. The effect can be allowed for, and when this is done we may know more about the dark markings. The orbits of the Mariners were closer to what might be expected from the dynamical value of the oblateness than the geometric value, but Dr Pickering said this ought to be taken with a pinch of salt because of non-gravitational perturbations on the spacecraft. He added that one of the martian satellites has been found on one of the pictures, but it is only a couple of picture elements. There are no plans to take particular notice of the satellites during the 1971 missions.

The question of internal activity was taken up by Dr G. Fielder (University of London Observatory), who said that some craters had polygonal rather than circular outlines, which he attributed to an underlying tectonic structure. This could affect the shape of craters whether they are formed by internal processes or by meteoric impact. The small depth to diameter ratios which some craters have is not necessarily a sign of erosion because there are similar craters on the Moon which are comparatively young and crisp. More needs to be known about the martian environment, and in particular the size of the fine dust which is believed to be present. Applying Stokes' law to the motion of the yellow clouds, Dr Fielder said that particle size seemed to be about 25 μm, similar to the sizes of dust on the Moon, which suggests that the dust might be impact debris.

ASTRONOMY

How Quasars Evolve

from our Cosmology Correspondent

An analysis of optical plates obtained with the 48 inch Schmidt telescope at Palomar Mountain and studied by A. Braccesi and L. Formiggini of the National Radio Astronomy Laboratory in Bologna suggests that the time scale of the optical evolution of quasi-stellar objects is consistent with the time scale of radio evolution derived from sources in the 3C catalogue. Braccesi and Formiggini have measured the magnitudes and colours of 300 ultraviolet-excess objects, determining which of these are QSOs by their combined ultraviolet and infrared excesses (*Astronomy and Astrophysics*, **3**, 364; 1969).

The $\log N$–$\log S$ relation plotted from these selected sources will then have a slope rather less than the true slope for QSOs, because some white dwarf stars are inevitably picked out by this technique, and the Italian astronomers estimate that 15 to 30 per cent of the ultraviolet-excess objects down to a magnitude of $B = 19{\cdot}4$ (using the four colour $UBVI$ system) are white dwarfs. Allowing for this, the corrected slope for QSOs is $-1{\cdot}80$, very different from earlier results (for example, Sandage (*Astrophys. J.*, **141**, 1560; 1965) found a slope of $-0{\cdot}95$), but the early results are well known to be inaccurate. This steep slope implies cosmological evolution of the sources—either they were more common, or brighter, or both in the distant past.

Braccesi and Formiggini feel that the slope they have found agrees with an evolution which goes as $(1+z)^5$, where z is the redshift, because although Schmidt in 1968 (*Astrophys. J.*, **151**, 393) found rather greater slopes for large z, the predominant sources in the current sample have smaller z. The observations would therefore agree with the evolutionary time scale found by Schmidt, which he had derived primarily from radio sources in the 3C catalogue. The proposal of the Italian team to carry out a comprehensive radio survey of the same sources which they have now studied optically should result in an unequivocal determination of the link between radio and optical evolution in QSOs, but the results already obtained will in themselves prove useful to the cosmologists, narrowing down once again the possible model universes that might be directly relevant to our own.