Ancient observatories

from A. J. Meadows

WHETHER the study of the orientation of ancient monuments ranks as a science or a pseudo-science remains a matter for debate, but there can be no doubt that the topic is once again attracting a great deal of attention. Having formed a focus of interest in the latter years of the nineteenth century and early in the twentieth century, studies of orientation went into decline in the inter-war years: partly, perhaps, because of factors such as excessive emphasis on allegedly significant orientations in Nazi Germany, and partly because the different groups of people involved—mainly astronomers and archaeologists—had failed to agree on the reality and significance of the results.

The recent revival of interest in orientation studies has arisen mainly from new detailed surveys of megalithic sites in the UK, especially those carried out by professor Thom since his retirement from Oxford. He has used these measurements in two ways —to identify the astronomical events indicated by the orientations and to consider the actual layout and scale of the monuments. The consensus of opinion at a recent joint meeting of the Royal Society and the British Academy on ancient astronomy tended to be that the deductions concerning astronomical orientation had firmer bases than those relating to the existence of a standard measure of length in megalithic times. Certainly the former have excited the more discussion. For, unlike most archaeological discoveries which illuminate primarily material culture, they could give a direct, if partial, insight into the level of intellectual sophistication that had then been reached.

Astronomers have in general contributed to the recent growth of interest in studies of alignments more by theoretical speculation than by on-site surveying. Indeed, much of the controversy engendered by the claimed alignments has hinged on the alleged extravagances of some of these speculations (especially regarding the astronomical implications of Stonehenge). The crucial point behind both the speculations and the arguments hinges on the significance of any measured orientation. After all, astronomical objects have to rise and set somewhere on the horizon: could not the observed alignments be purely coincidental? How convincing an answer can be given to this question depends critically on the accuracy and uniqueness of the data collected.

A group from the Cambridge University Astronomical Society has now re-surveyed with increased accuracy three sites previously described by Thom (this issue of *Nature*, page 431). The most interesting of the three sites is that at Ballochroy in Argyllshire (which Thom has described as one of the most important he knows for observing the solstitial Sun). The new measurements not only support Thom's claim, they also produce a set of dates for the various orientations present that agree remarkably well among themselves, and convincingly suggest that the stones were erected for use around the date 1600 BC. But the other two sites surveyed—at Loch Seil and Loch Nell, both also in Argyllshire—provide much less satisfactory evidence. At Loch Seil, the suggested alignments seem to be non-existent, and at Loch Nell, although the alignments are clearly defined, they do not point to any obviously significant astronomical event.

The sceptic might reasonably comment that one interpretable site out of three suggests that chance may well play a part in producing apparently significant orientations. But chance would be unlikely to produce orientations that agree with respect to dating, as do those found at Ballochroy. Besides, disturbances must certainly have occurred at some sites during the past four millenia, disrupting alignments that were originally there, and making interpretations ambiguous. The interesting discrepancies are rather those, as at Loch Nell, where the intended alignment seems obvious, but the astronomical explanation does not; for this raises the question whether all, or even the majority of, megalithic monuments were really intended to serve as astronomical observatories. One comment is worth making on this: there is still a need to consider all astronomical bodies that might have attracted attention in megalithic times. So far, attention has concentrated mainly on the Sun, Moon and a few bright stars. However, the planets, especially Venus, were surely equally important in ancient astronomy. The problem, in terms of orientation studies, lies in distinguishing between solar and planetary positions on the horizon.

If we compare studies carried out in recent years with those occurring earlier in the century, the only apparent difference in practical terms is an increase in the accuracy and extent of the site surveys. Why then has the subject re-erupted into the news? I would guess that one reason is a new pervasive interest in the influence of astronomical (or astrological) ideas on the thinking of early man. This is reflected in recent discussions of the astronomical implications of myth, noticeably the detailed analysis in *Hamlet's Mill* by G. de Santillana and H. von Dechend. It appears, too, in the debate over very early archaeological material that, according to A. Marshack, indicates a primitive lunar notation. All these topics are controversial, but, in combination, they suggest the intriguing conclusion that man was numerate long before he was literate.

1973) have suggested that this is due to the stereospecificity of the binding site, which can select one enantiomer from a solution of 11-*cis*-retinal, and thus confer optical activity on the visible absorption. On the other hand, Johnston and Zand (*Biochemistry*, **12**, 4637; 1973) have shown that model aldimines of all-*trans*-retinal with some optically active amines show circular dichroism, so long as the amine has an aromatic group that can couple with the long-wavelength absorption band of the retinal. Thus the fact that rhodopsin shows circular dichroism in the visible region implies only that the chromophoric group is bound to an optically active amino acid, and that there are aromatic amino acids near the binding site: the retinal is not necessarily in a dissymmetric conformation.

Intact retina

Another physical method of great potential in probing the structures of coloured molecules in biological milieux is the resonance-enhanced Raman effect. In 1970, Rimai, Kilponen and Gill (*Biochem. biophys. Res. Commun.*, **41**, 492; 1970) showed that using this technique it is possible to study the chromophoric groups of rhodopsin molecules in the intact retina, and thus provided the first direct evidence that the retinal is bound in the form of an aldimine. The intense 488 nm exciting light used in these experiments bleached the rhodopsin, but it has since been shown that use of a 583 nm dye laser permits the recording of the Raman spectrum without undue bleaching, and so it could be established that the chromophoric group is probably in the 11-*cis* conformation (Lewis, Fager and Abrahamson, *J. Raman Spect.*, **1**, 465;