to the rocket axis, giving end-over-end tumbling. Since the observed 'flash period' always increased slightly with increasing flight range of observation, the rotation was retrograde with respect to the west-to-east transits observed and, therefore, clockwise as viewed from the north.

Such rotation would be most sensitive to accelerating 'windmill' behaviour, generated by the cross-wind, when the satellite passed northwards through perigee in the relatively dense and fast circulating tropical atmosphere. This condition would apply from late July 1958 onwards, and the effect is likely to have increased considerably when the altitude decreased shortly before fall-in.

Each feature of the rotation thus appears to be accounted for, perhaps more convincingly than in terms of meteorite impact, material ablation or even forces of electrical or magnetic origin. It may be that only very long, light-weight objects such as cylindrical balloons and empty rocket cases will show this type of response.

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RADIOPHYSICS

Possibility of detecting Ionospheric Drifts from the Occurrence of Spread *F* Echoes at Low Latitudes

DURING the course of an investigation concerning the geographical extent of the scattered and diffuse echoes frequently observed during the night hours at high and low magnetic latitudes (spread *F*) an interesting phenomenon was observed. Times of occurrence of spread *F* echoes on ionospheric soundings taken every 15 min. during September and October 1957 at four stations in Peru (Talara, Chiclayo, Chimbote and Huancayo—average separation about 350 km., magnetic dip from 2° to 13°) strongly suggested that the patches of irregularities thought to be producing the spread *F* were often observed successively at each of the four stations. For example, an occurrence of spread *F* might be observed to begin at, say, 0015 hr. at Talara, the north-westernmost station, at 0045 at Chiclayo, at 0100 at Chimbote and at 0145 at Huancayo, the south-easternmost station. This tendency was particularly marked for the relatively short occurrences (less than about 2 hr. in duration) that were commonly observed during the latter half of the night. As the stations were located approximately along a straight line, it is not possible to deduce unambiguously the magnitude and direction of the suggested drift. It has been shown, however, that the geographic north–south component of the night *F* region drift is usually small at these latitudes[1]. Therefore, on the assumption that the drift was wholly in the magnetic east–west direction, magnitudes of the geographic east–west component of the apparent drifts indicated by the spread *F* occurrences during September and October have been estimated. A mean apparent drift velocity of 135 m./s. towards the east was obtained for period 0000–0400 hr. Skinner, Hope and Wright, using the Mitra technique at another equatorial location (Ibadan) during the same period, observed a mean east–west component of *F* region drift of about 110 m./s. towards the east[2]. The degree of agreement suggests that drifts, either of the patches of irregularities giving rise to the spread *F* echoes or of the disturbance producing the irregularities, may play an important part in the occurrence of spread *F* at low latitudes.

A more comprehensive study of spread *F* occurrences along the Peruvian chain of stations during the International Geophysical Year period, including a full interstation correlation analysis, is now being completed and will be published elsewhere.

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PHYSICS

Thermal Expansion at Low Temperatures

CONSIDERABLE experimental data have been published[1] on the heat capacity C of solids, extending to temperatures which are very low in relation to their characteristic temperature θ; data are available in the temperature region $T \sim \theta/100$, where the Debye continuum model may be expected to apply and where for metals the electronic contribution is important. Complementary information regarding the thermal expansion coefficient, α, is desirable as it would throw additional light on the lattice dynamics of solids, particularly the anharmonic nature[2] of the interatomic forces as evidenced by the Grüneisen parameter $\gamma = 3\alpha\chi V/C$ (χ = incompressibility, V = volume). Also any data obtained about an electronic expansion coefficient, α_e, in metals should provide useful information about their band structures.

Unfortunately, most methods of measuring the expansion, whether by X-rays[3], interferometry[4] or capacitance[5], have not been sufficiently sensitive to trace its variation much below $\theta/10$. However, there are now available techniques for the accurate comparison of small capacitances which allow movements as small as 10^{-9} cm. to be detected, and these may be used to determine expansion coefficients down to $T \sim \theta/100$. Such techniques depend on the use of three-terminal capacitors in which the capacity to be measured is a mechanically well-defined gap between two of the terminals (or conducting surfaces) and the third terminal is a conductor which acts both as a guard ring and as a shield surrounding the other two. This unknown capacitance is then compared with a reference capacitance in a four-arm bridge of which the two other arms are tightly coupled inductive arms; ground-lead capacitances do not appear in the balance equations but merely affect the bridge sensitivity. Some recent developments in precise capacitance measurement have been described by Thompson[6] and their application to measuring thermal expansion will be described elsewhere[7]. The measurements described here on the thermal