It is not yet possible to say definitely whether the damage seen is predominantly due to interstitial atoms or vacancies, or if both kinds of defect are involved. However, interstitials are thought to be more mobile at least up to 1,000° C., and the general behaviour does not seem to correspond to that of vacancies as described by Amelinckx and Delavignette[3], so that it may be assumed provisionally that the effects constitute a direct observation of the behaviour of interstitial clusters.

General studies of neutron-irradiated graphite (see, for example, Simmons[6]) have already suggested the formation of highly stable complexes by the annealing of low-temperature damage, and more detailed studies will now be possible. The rapid disappearance of defects above 1,500° C. corresponds well with the final annealing of electrical effects observed in unpublished work by Eatherly.

We wish to thank Messrs. J. H. W. Simmons and R. S. Barnes for their interest and encouragement.

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GEOPHYSICS

Auroral Observations at Halley Bay, Antarctica, during 1959

In accordance with the recommendations of the Special Committee on Antarctic Research the programme of auroral observation conducted during the International Geophysical Year at Halley Bay, Antarctica, was continued into 1959. The Halley Bay Base, established by the Royal Society International Geophysical Year Expedition and now administered by the Falkland Islands Dependencies Survey, is situated in geomagnetic latitude 66° S., and both visual and all-sky camera records are now available for the four years 1956–59. A detailed analysis of the results of the first three years observations has appeared elsewhere[1], and it is interesting to compare these results with those obtained during 1959.

Of particular interest is the apparent change in the position of the southern auroral zone over the course of the four years which includes the period of sunspot maximum in 1957. Previously[2] the position of a 'quiet arc zone' has been defined in terms of the median value and interquartile range of the latitudinal distribution of quiet arcs. Such a distribution has now been obtained using the results of the 1959 observations; the positions of the quiet arc zone for the four consecutive years are given in Table 1.

Table 1

Year	1956	1957	1958	1959
Median latitude (°S. geomagnetic)	70·8	71·8	71·9	71·0
Interquartile range	±1·3	±1·0	±1·0	±1·1

Paton[3] has recently suggested that there may be a simple geometrical connexion between the position of the quiet arc zones in the two hemispheres and the 'horns' of the Van Allen belts of geomagnetically trapped radiation. The changes in the character of these belts during the period July 1958–August 1959[4] are certainly in keeping with this proposal.

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METALLURGY

Theory of the Deformation and Fracture of Body-centred Cubic Transition Metals

Experiments on a number of body-centred cubic transition metals[1] have shown that, above the ductile–brittle transition temperature, the yield stress, σ_y, varies with the average grain diameter, $2d$, according to the relation:

$$\sigma_y = \sigma_i + k_y d^{-1/2} \quad (1)$$

Below the transition temperature, the brittle fracture stress, σ_f, is related to the grain size by the similar relation:

$$\sigma_f = \sigma_i + k_f d^{-1/2} \quad (2)$$

Cottrell[2] has developed a theory of the ductile–brittle transition in terms of the parameters σ_i and k_y. According to the model adopted by Cottrell, σ_i is a lattice friction stress which contains a temperature-dependent part tentatively attributed to the Peierls–Nabarro stress of the lattice. The grain size parameter, k_y, is related to the stress, σ_d, required to unpin a dislocation from its impurity atmosphere and is given by the equation:

$$k_y = \sigma_d l^{*1/2} \quad (3)$$

where l^* is the average distance from a grain boundary to the nearest dislocation source. In developing his theory Cottrell found that for a specimen to be brittle the criterion:

$$(\sigma_i d^{1/2} + k_y)k_y \geqslant [\beta\mu\gamma \quad (4)$$

must be satisfied. Here β is a constant which is nearly unity, for uniaxial tension, μ is the rigidity modulus, and γ the effective surface energy for fracture. The relations between the brittle fracture stress, the stress for ductile cleavage fracture, $\sigma_{f'}$, and the grain size which he obtained were:

$$\sigma_f(\sigma_f - \sigma_i)d = \beta\mu\gamma \quad (5)$$

and

$$\sigma_{f'} = \frac{\beta\mu\gamma}{k_y}\, d^{-1/2} \quad (6)$$

These equations appeared, at the time that the theory was formulated, to agree with most of the available experimental results, although no adequate results existed to test equation (6). Equation (5) is not significantly different from equation (2) over the ranges of grain size and temperature so far studied.

Recent experimental work in this laboratory and elsewhere has revealed several inadequacies in the theory of which three will be considered. First, a