sociated with a given plane group. For certain reflexions the contribution of the heavy atom becomes nil; the distribution is then determined by the lighter atoms, and becomes $(\bar{1})N(Z)$ (for the plane groups considered) if these atoms are arranged at random and have similar atomic scattering factors.

Table 1 indicates the distributions obtained when the heavy atom is placed in any special position in the oblique, rectangular and square plane groups; the special positions include those with no variable parameters (the fixed positions of Collin) and mirror planes, which have one fixed and one variable parameter. Hexagonal plane groups are omitted from Table 1 because the special positions with one variable parameter appear to be represented by new types of distribution whilst those with fixed parameters are represented by variants of (max.)$N(Z)$ which cannot be tabulated in compact form. The method of deriving the results given in Table 1 is illustrated by taking as an example the plane group *pmg* to which reference has already been made.

### Plane group *pmg*

(i) *Heavy atom at general position* $(x, y)$

The geometrical structure factor is $4 \cos 2\pi hx . \cos 2\pi ky$, when $h$ is even, and $-4 \sin 2\pi hx . \sin 2\pi ky$ when $h$ is odd; both types of reflexions will therefore have the intensity distribution $(CC)N(Z)$ (Hargreaves, 1955).

(ii) *Heavy atom at special position* $(\frac{1}{4}, y)$ *on m*

The geometrical structure factor reduces to $\pm 4 \cos 2\pi ky$ when $h$ is even, and $\pm 4 \sin 2\pi ky$ when $h$ is odd; the intensity distribution for both types of reflexions is now $(C)N(Z)$ (Hargreaves, 1955).

(iii) *Heavy atom at special position* $(0, 0)$ *or* $(0, \frac{1}{2})$ *on* 2

When $h$ is even the geometrical structure factor becomes unity and the corresponding intensity distribution is (max.)$N(Z)$ (Hargreaves, 1955). When $h$ is odd the geometrical structure factor becomes zero; the heavy atom then makes no contribution to the reflexions and the intensity distribution, determined by the lighter atoms, is $(\bar{1})N(Z)$ (Wilson, 1949; Howells *et al.*, 1950).

The distributions listed in Table 1 are strictly valid only when the atoms in special positions are sufficiently heavy to dominate completely the remaining lighter atoms; but even when the atoms in special positions are only moderately heavy, Table 1 should still be useful in indicating the general nature of the deviations to be expected from the $(1)N(Z)$ or $(\bar{1})N(Z)$ distributions. Table 1 may be used both as an aid in determining crystal symmetry and (in some cases) for distinguishing between different possible special positions.

### References

Collin, R. L. (1955). *Acta Cryst.* **8**, 499.

Hargreaves, A. (1955). *Acta Cryst.* **8**, 12.

Howells, E. R., Phillips, D. C. & Rogers, D. (1950). *Acta Cryst.* **3**, 210.

Wilson, A. J. C. (1949). *Acta Cryst.* **2**, 318.

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*Acta Cryst.* (1956). **9**, 192

## Note on the crystal structure of sodium dichromate dihydrate.

By J. A. Campbell, *Oberlin College, Oberlin, Ohio, U.S.A.*

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Studies of the adsorption spectra of aqueous solutions of chromates and dichromates in connection with the equilibria found therein have shown that the spectra of dichromate and acid chromate ions are similar, and close to those of the solid dichromates. This raises the point as to whether certain solid dichromates contain acid chromate ions rather than dichromate ions. Inspection of the structure of sodium dichromate dihydrate, formula $Na_2Cr_2O_7 . 2H_2O$, was undertaken in an attempt to settle the question for a particular crystal where the alternatives were possible. (It could have the formula $Na_2(HCrO_4)_2 . H_2O$.)

Rotation photographs about all three axes and Weissenberg photographs about two axes ($a$ and $b$) were taken. The crystals, grown from water solution at room temperature, were monoclinic with unit-cell dimensions:

$$a = 6{\cdot}05,\ b = 10{\cdot}5,\ c = 12{\cdot}6\ \text{Å},\ \beta = 94{\cdot}9^\circ .$$

These cell dimensions, a density of 2·52 g.cm.$^{-3}$, and a formula weight of 298 g./mole gave $n = 4{\cdot}06$. Analysis of the photographs showed systematic absences for $0k0$ when $k = 2n$, indicating a space group of either $P2_1$ or $P2_1/m$. The crystal showed no piezoelectricity, and the response to the liquid-air test for pyroelectricity was doubtful. Wilson's method indicated the crystal to be centric, so that the space group must be $P2_1/m$.

Patterson diagrams were prepared from the two Weissenbergs. Analysis indicated that the chromiums were paired and located in the mirror planes. No detailed analysis has been, or will be, made. A Cr–Cr distance of about 3·2 Å and a Cr–O–Cr angle of about 120° are possible. The additional work necessary to complete the structure does not seem justified from my own point of view, since no structures with independent chromiums, i.e. $HCrO_4^-$ groups, were discovered which satisfied the data.

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