of T_D, it can still be quite accurate in regions of very large pseudospin alignment. For example, in fitting (4.2) to the data of Fig. 4, we found that if Δ_0 were adjusted to make the $\Delta(\sigma)$ curves fall to 9 cm^{-1} at $\sigma = 0$, then the slopes at high stresses were always too large. Instead, we have fitted the equation to the high stress region as shown in Fig. 5 by fixing Δ_0 at 27 cm^{-1} and varying σ_0: the resulting value of σ_0 is given in Table 1. As will be seen, the deviations in this fit can be accounted for in terms of short range order.

Table 1. *Summary of experimental results for* σ_0 *and* Δ_∞ *determined by several methods.* $\Delta(\sigma)$ *indicates a fit of the stress equation* (I.4.22) *to the experimental stress results of Section* 2. $\sigma_c(H_c)$ *indicates a fit to the pseudospin flop phase boundary formulae of the previous paper* (I). *e indicates a fit to the X-ray and neutron diffraction data of Will*[19] *and Forsyth and Sampson*[20]

Sample	Temp.	Method	σ_0 (kg/mm^2)	Δ_∞ (cm^{-1})
$DyVO_4$	77·4 K	$\Delta(\sigma)$	79 ± 2	7·5 ± 0·5
	20·4–14·1	$\Delta(\sigma)$	66 ± 2	9·0 ± 0·5
	4·2	$\Delta(\sigma)$	61 ± 4	—
	4·2–1·4	$\sigma_c(H_c)$	69 ± 7	—
	4·2	*e*	64 ± 6	—
YVO_4 : Dy	77·4	$\Delta(\sigma)$	60 ± 1	4·85 ± 0·1
	20·4	$\Delta(\sigma)$	55 ± 1	5·05 ± 0·1

The data at 77K shown in Fig. 6, may be fitted to the high temperature limit of (4.2):

$$\Delta = \sqrt{{\Delta_\infty}^2 + \left(\frac{1}{\frac{1}{\Delta_0} - \frac{1}{2kT}}\right)^2 \left(\frac{\sigma}{\sigma_0}\right)^2} \qquad (4.3)$$

The values for Δ_∞ and σ_0, recorded in Table 1, have shifted considerably from their values in the low temperature range. Similar results are found from the data on the lightly doped samples, shown in Fig. 7. The effect of dilution is to introduce a factor ξ, defined as the fraction of Jahn–Teller active ions, in the stress equation (4.2):

$$\frac{\sigma}{\sigma_0} = \sqrt{\frac{\Delta^2 - {\Delta_\infty}^2}{\Delta^2}} \left(\frac{\Delta}{\Delta_0} - \xi \tanh \frac{\Delta}{2kT}\right) \qquad (4.4)$$

where the definitions of σ_0 and Δ_0 are unchanged. T_D and the observed zero temperature splitting now vary linearly with ξ. In the limit $\xi \to 0$,

$$\Delta = \sqrt{{\Delta_\infty}^2 + {\Delta_0}^2 \left(\frac{\sigma}{\sigma_0}\right)^2}. \qquad (4.5)$$

This equation has been fitted to the data of Fig. 7, assuming $\Delta_0 = 27$ cm^{-1}, and the results for Δ_∞ and σ_0, shown in Table 1, are remarkably similar to those of the concentrated material, indicating that in fact the internal force constants are also very similar. The fact that Δ_∞ and σ_0 behave in the same way with temperature as in the concentrated material suggests that by 77 K a significant amount of thermal expansion due to anharmonic forces is present in both crystals and that therefore the discrepancies in Δ_∞ and σ_0 are not necessarily due to any failure of the molecular field equations.

The line shifts as a function of stress at 4·2K can be used to deduce the splitting if a correction for the centre of gravity shifts due to Γ_1^+ distortion is made. Equation (4.2) predicts a linear dependence of splitting on stress, which is in fact observed in the data of Fig. 8. σ_0, given in Table 1, is in excellent agreement with the value obtained at 14·1 to 20·4 K, especially considering the 5 per cent error arising from the uncertainty in the centre of gravity correction.

To interpret the data of Figs. 10 and 11 on the pseudospin flop boundary, we assumed that the true thermodynamic phase boundary lay half way between the two hysteresis points. At such low stresses that the sample remains in the field-favoured distortion even when the field is reduced to zero, we assumed that the low field point of the hysteresis lies

at 'negative' values so that the phase boundary is taken to pass through the origin. With this interpretation, the theoretical curve (I.4.14) is in good agreement with the observed results at 4·2 K. But at 1·4 K the predicted phase boundary (I.4.19) is linear down to zero stress, whereas the data is not, although the trend is in the right direction, as can be seen in Fig. 11. We interpret these deviations at 1·4 K as arising from incomplete magnetic ordering or the existence of a not perfectly Ising g-value, both of which would tend to "round out the corner" at low stresses.

σ_0 may be extracted from the data by evaluating the slope of the asymptote at fields above 10 kG where the magnetization is saturated. The result is shown in Table 1 and has a 10 per cent error arising from the difficulty of drawing a reliable slope through the hysteresis points; nevertheless it is once again in remarkable agreement with other values. The field intercepts of the asymptotes have been predicted in (I.4.18) and (I.4.19). They can be evaluated in terms of the internal ferromagnetic and antiferromagnetic fields of $DyVO_4$, which are known from other measurements and calculations[7, 16], and are given in Table 2. Demagnetization factors for the crystal were estimated from the measured a, b and c dimensions on the crude assumption that it was ellipsoidal in shape. Comparison of the observed and predicted intercepts is given in Table 3.

The macroscopic distortion of $DyVO_4$ has been measured by X-ray and neutron diffraction at low temperatures. The earliest results by Sayetat *et al.*[18], on powdered samples are 30 per cent lower than later results on both powders[19] and single crystals[20]. We use these latter values to calculate σ_0 from the formula

$$e(T=0) = \sqrt{\Delta_0^2 - \Delta_\infty^2}/2\Omega\sigma_0 = 0{\cdot}505 \pm 0{\cdot}05\% \quad (4.6)$$

which may be derived from (I.3.10) and (I.3.13). The striking agreement between this value of σ_0 and the others of Table 1, which were determined at a wide variety of temperatures and by physically different kinds of experiments, leaves little doubt that the molecular field theory provides an accurate framework for understanding the basic behaviour of $DyVO_4$.

Table 2. Ferromagnetic and antiferromagnetic internal fields in $DyVO_4$ at $T = 0$, from [7, 16]

$DyVO_4$, $T \ll T_N$ Internal magnetic fields (kOe)				
	Lorentz	Dipole	Exchange	Total
Ferro-magnetic	4·6	0·92 ± 0·2	−1·9 ± 0·4	3·6 ± 0·6
Antiferro-magnetic	0	6·9 ± 0·2	0·9 ± 0·5	7·8 ± 0·7

Table 3. Comparison of predicted and observed field intercepts, in kOe, of the asymptotes of the pseudospin flop phase boundary in $DyVO_4$ at 4·2 and 1·4 K

$DyVO_4$, $T_N \gtrless T \ll T_D$				
	Pseudo-spin flop: field intercept of asymptote (kOe)			
Temp.	Intercept	Demagnetization correction	Total	Observed
4·2 K	$\left(\frac{2kT\ln 2}{g\beta} - \frac{1}{2}H_F\right) = 2{\cdot}8 \pm 0{\cdot}3$	2·3 ± 0·5	5·1 ± 0·8	7 ± 1
1·4 K	$\frac{1}{2}(H_{AF} - H_F) = 2{\cdot}1 \pm 0{\cdot}6$	2·3 ± 0·5	4·4 ± 1·2	5·5 ± 1