

**Dixon *et al.* Reply:** Chamberlin<sup>1</sup> has shown that a form derived from percolation theory<sup>2</sup> to fit data on spin glasses can also be used to fit dielectric-susceptibility data<sup>3</sup> on structural glasses. We would like to make two points.

(1) Except for the similarity in their names there has been scant evidence to connect the physics of spin glasses to that of structural glasses; thus, at first sight, there appears to be little foundation for the curve-fitting procedure of Chamberlin. We note here, however, that our experimental results do imply an unexpected connection between these two areas. From the form of the master curve for the susceptibility data we demonstrate below that the normalized width  $w$  of the susceptibility cannot become greater than a critical value which is approximately 3. This is reminiscent of what has been found<sup>4</sup> in spin glasses.

Our argument rests on two assumptions: (i) This curve is indeed *universal* and can be used even in the region close to the glass transition which is not experimentally accessible. Although we cannot possibly hope to reach the transition temperature, our scaling form is the best way to extrapolate into that regime. (ii) Above  $v_p$ , the peak frequency,  $\epsilon''$  should be a monotonically decreasing function of  $v$ . This is consistent with our expectation that the structure of the relaxation should have a single peak.

For large values of  $v/v_p$ , the slope on our master curve, which plots  $w^{-1} \log_{10}(\epsilon'' v_p / v \Delta \epsilon)$  vs  $w^{-1} (1 + w^{-1}) \log_{10}(v/v_p)$ , is close to  $-\frac{3}{4}$ . This implies that  $\epsilon''$  varies as  $v^s$  with the exponent  $s = 1 - \frac{3}{4} (1 + w^{-1})$ . The assumption that  $\epsilon''$  decreases monotonically in this region implies that  $s$  must be negative so that  $w < 3$ .

In simulations of spin-glass dynamics, when the relaxation is fitted by a modified stretched exponential function,  $\phi(t) = \phi_0 t^{-a} \exp[-(t/\tau)^\beta]$ , the exponent  $\beta$  approaches the value  $\frac{1}{3}$  at the transition temperature. Since for a stretched exponential curve  $\beta \cong w^{-1}$ , our result that  $w < 3$  is equivalent to the result in spin glasses that  $\beta > \frac{1}{3}$ . It is interesting to speculate that similar physics may give rise to the same phenomenon in glasses as in spin glasses.<sup>5</sup> Thus, an attempt, such as that of

Chamberlin, to describe the glass using concepts from spin-glass physics may not be unreasonable. Nevertheless, it is not obvious why a model based on percolation theory should be applicable to structural glasses.

(2) Although Chamberlin's functional form does fit the data, the significance of the procedure allowing us to scale all our data onto a single curve has not been addressed. We found that a universal curve is obtained by plotting the imaginary part of the susceptibility versus  $w^{-1} (1 + w^{-1}) \log_{10}(v/v_p)$ . Does this emerge as the natural variable in his functional form? Can one show analytically what relationship between his five parameters must be satisfied in order to achieve this scaling behavior?

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P. K. Dixon, L. Wu, and S. R. Nagel  
James Franck Institute and Department of Physics  
The University of Chicago  
Chicago, Illinois 60637

B. D. Williams and J. P. Carini  
Department of Physics  
Indiana University  
Bloomington, Indiana 47405

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<sup>1</sup>R. V. Chamberlin, preceding Comment, Phys. Rev. Lett. **66**, 959 (1991).

<sup>2</sup>R. V. Chamberlin and D. N. Haines, Phys. Rev. Lett. **65**, 2197 (1990).

<sup>3</sup>P. K. Dixon, L. Wu, S. R. Nagel, B. D. Williams, and J. P. Carini, Phys. Rev. Lett. **65**, 1108 (1990).

<sup>4</sup>A. T. Ogielski, Phys. Rev. B **32**, 7384 (1985).

<sup>5</sup>I. A. Campbell, J. M. Flesselles, R. Julien, and R. Botet, J. Phys. C **20**, L47 (1987). For a review, see also D. L. Stein and R. G. Palmer, in *Complex Systems, SFI Studies in Sciences of Complexity*, edited by D. L. Stein (Addison-Wesley, Reading, MA, 1989), p. 1.