Weitz et al. Respond: Wilcoxon, Martin, and Schaefer claim that fractal gold aggregates exhibit multiple scattering, primarily because they observe changes upon dilution. However, their observation is actually caused by restructuring of the very tenuous fractal clusters induced by the shear incurred upon dilution. The restructuring results in an increase in the apparent power law of the scattering.^{1,2} That the restructuring indeed causes the observed change is proven by the results shown in Fig. 1. The scattering from undiluted diffusion-limited aggregates is linear on a logarithmic scale, with the slope giving the fractal dimension of $d_f \approx 1.84$ [Fig. 1(a)]. Data from a sample diluted a factor of 10 by running water slowly down the side of the cuvette are shown in Fig. 1(b). The scattering is still linear and the slope is unchanged. However, inverting the diluted sample two times, as might be done to mix the added water, induces sufficient shear to restructure the aggregates, changing the slope of the scattering [Fig. 1(c)], and reproducing the results of Wilcoxon, Martin, and Schaefer. Conclusive proof that this change is due to restructuring is shown by two additional experiments. Gently mixing the undiluted sample results in restructuring and a similar change in the slope of the scattering [Fig. 1(d)]. Finally, diluting the unaggregated colloid, then aggregating, thus avoiding all shear on the aggregates, results [Fig. 1(e)] in scattering identical to the unsheared sample. This proves conclusively that the observations of Wilcoxon, Martin, and Schaefer arise from shear-induced restructuring and not multiple scattering.

In our colloids, we find that there are sample-tosample variations in the measured slope of roughly ± 0.1 about the mean of 1.78 and variations of about ± 0.05 when the measurements are repeated on the same sample. Nevertheless, we find no significant trend in the average of well over fifty measurements when the wavelength is changed over the stated range. Data obtained with $\lambda = 633$ nm [Fig. 1(f)] have an identical slope to those obtained with $\lambda = 488$ nm [Fig. 1(a)]. It is crucial, however, to use clusters large enough to avoid any incipient finite-size effects at the smallest q, obtained with $\lambda = 633$ nm, as this would cause an apparent decrease in the slope at this wavelength.

The large extinction reported, as well as the variation of the absolute scattering intensity with incident wavelength, reflect the well-known optical resonance possessed by the gold colloids. The large extinction is mainly due to absorption, rather than scattering. The depolarized scattering is consistent with the short-range, chainlike, nearest-neighbor correlations in the aggregates, which cause an anisotropy in the polarizability of the particles.³ There are no long-range spatial correla-



FIG. 1. Scattering from gold aggregates. (a) Full concentration, unsheared; (b) diluted, unsheared; (c) diluted, sheared; (d) undiluted, sheared; (e) diluted before aggregation, unsheared; and (f) undiluted and unsheared with $\lambda = 633$ nm. All other curves were obtained with $\lambda = 488$ nm and all dilutions were a factor of 10. The slopes of the linear curves vary between 1.75 and 1.86. The scattering curves are not corrected for absolute intensity and are arbitrarily offset for clarity. Only shearing, and not dilution, changes the slope of the scattering, which proves conclusively that there is no multiple scattering.

tions of this anisotropy as the intensity of the depolarized scattering is independent of q. Nevertheless, the slope of the polarized scattering is unaffected by multiple scattering and accurately reflects the fractal dimension of the aggregates.

To conclude, we find no evidence whatsoever to support the claim of Wilcoxon, Martin, and Schaefer that the fractal gold aggregates exhibit significant multiple scattering. Furthermore, all the results reported to date support our original claim of two distinct fractal dimensions for the aggregates, depending on the aggregation kinetics.

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