small l^* values (also seen from the dashed line in Fig. 4b of ref. 1), making $T(L)$ much lower than the data, whereas the classical T values must always lie above any data from a localizing — or absorbing — sample. For more quantitative comparison, we slightly rescaled the angular axis of the GaAs cone (Fig. 1a). The agreement becomes striking if we introduce an absorption length $L_a = \sqrt{(l^* l_a/3)} \approx 8$ μm, or $l_a \approx 300$ μm for TiO_2 using classical diffusion theory. Note that identical results are obtained from numerical simulations. We conclude that kl^* is 5 ± 1 rather than 1.5, and that the shape of the GaAs cone can be explained by classical diffusion including absorption.

Next we analysed the transmission of the same sample[1]. As $l^* \gtrsim 0.5$ μm, the classical transmission without absorption lies above the experimental values for all cases. Figure 1b shows that the T data can be described by diffusion theory with absorption over the whole L range; l^* and l_a found by fitting are very close to values obtained from coherent-backscattering cones, emphasizing the consistency of our analysis. Finally, for the smallest particle size (~ 0.3 μm), an exponential decay with
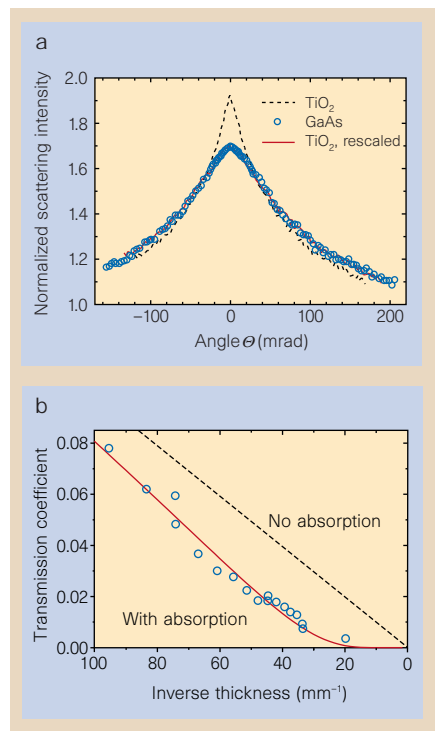
a,

b,

Figure 1 Optical properties of very turbid powders. **a,** Comparison of coherent backscattering cones for GaAs powder (Fig. 3b of ref. 1) and for pure TiO_2 (ref. 2). The red line represents data for TiO_2 that include absorption transformed according to $\Theta^2 \rightarrow \Theta^2 - \Theta_a^2$, where $\Theta_a = 1/(kL_a) = 21$ mrad, and rescaled by $\Theta \rightarrow 1.13 \times \Theta$. **b,** Plot of transmission T of GaAs powder (circles) of average particle size 1 μm against inverse sample thickness L^{-1} (Figs 4b and 5b of ref. 1). The red line is derived from diffusion theory with absorption $T(L) = (L_a/\gamma l^*) \sinh^2 (\gamma l^*/L_a)/\sinh(L/L_a)$, $\gamma \approx 5/3$, $l^* = 0.59$ μm, $L_a = 8.9$ μm. For the dotted line, $L_a \rightarrow \infty$.

decay length of ~ 4.3 μm was reported[1]. This is a reasonable L_a value, given the expected stronger absorption and smaller l^* of this sample.

In conclusion, we believe that the results of Wiersma et al. cannot be considered as unambiguous evidence for the existence of the critical regime, or Anderson localization, of light. Further investigation is needed to quantify the role of absorption.
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1. Wiersma, D. S., Bartolini, P., Lagendijk, A. & Righini, R. *Nature* **390,** 671–673 (1997).
2. Wiersma, D. S., van Albada, M. P., van Tiggelen, B. A. & Lagendijk, A. *Phys. Rev. Lett.* **74,** 4193–4196 (1995).

Wiersma et al. *reply* — Scheffold et al. have compared different data sets from our group and suggest that our evidence for localization is not conclusive and that the role of absorption should be characterized further. We believe that their analysis is misleading, and that our conclusions about localization are still valid.

Scheffold et al. compared our data on coherent backscattering from GaAs powders[1] with our previously published data[2] on coherent backscattering from TiO_2. From a comparison of the widths of the cones, they estimate the inverse of the scattering strength, kl^*, of our GaAs samples, where k is the wavevector of the light and l^* is the mean free path. However, the GaAs data were recorded using linearly polarized light, whereas the TiO_2 data were recorded with circularly polarized light[2]. This difference is fundamental, as linearly polarized light inherently gives a smaller enhancement factor (the top of the cone is lower) than circularly polarized light. To overlay our two data sets, Scheffold et al. scaled the y-axis of one of the data sets and shifted the zero of its y-axis. The results are misleading, however, because shifting the zero also changes the full width at half maximum of the cone, and so gives the wrong value of kl^*, because the width is inversely proportional to kl^*.

To illustrate the inconsistency of this approach, we repeated the procedure used by Scheffold et al., but keeping the TiO_2 instead of the GaAs data fixed, and scaling and shifting the y-axis of the GaAs data. The result indicated that the backscattering cone from GaAs is three times wider than that from TiO_2, which corresponds to a scattering strength of the GaAs samples of $kl^* = 1.7$, instead of 5.0. This shows that manipulating the y-axis leads to strongly varying and thereby inconsistent conclusions about the same experiment.

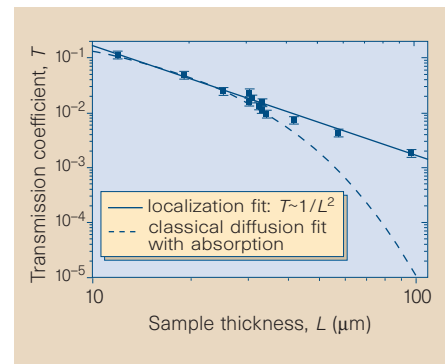A strong argument against absorption, for example from surface states, is that the

Figure 2 Comparison of scaling theory and classical diffusion using transmission coefficients of a GaAs sample. Scaling theory, solid line; classical diffusion with absorption, broken line. Average particle diameter is 1 μm, mean free path l^* is 0.59 μm, and absorption length L_a is 9.6 μm. Data show the L^{-2} behaviour characteristic of the localization transition, and cannot be fitted as classical diffusion with absorption.

shape of the bandgap does not change upon grinding (see the temperature measurements in Fig.1 in ref. 1). Additional evidence that excludes absorption is the observation that the top of the backscattering cone remains triangular while the surrounding region becomes round. This is exactly the behaviour expected at the localization transition, whereas in the case of absorption, the top of the cone would never be triangular. However, Scheffold et al. have replotted our data in Fig. 1a in such a way that this triangular shape is obscured by the use of larger symbols.

Scheffold et al. use classical diffusion theory with absorption to fit our transmission data (Fig. 1b). An absorption fit yields a χ^2 of 0.033, whereas our fit with scaling theory (that is, with the desired L^{-2} behaviour instead of exponential decay) yields a better value of 0.0053. Our independent, new transmission measurements using GaAs powders (Fig. 2) show L^{-2} behaviour over two orders of magnitude, confirming again the scaling behaviour at the localization transition and the absence of absorption.
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1. Wiersma, D. S., Bartolini, P., Lagendijk, A. & Righini, R. *Nature* **390,** 671–673 (1997).
2. Wiersma, D. S., van Albada, M. P., van Tiggelen, B. A. & Lagendijk, A. *Phys. Rev. Lett.* **74,** 4193–4196 (1995).