Hagen and Griessen Reply: Although Chaddah and Bhagwat\textsuperscript{1} point out rightly in their Comment that the relaxation rate of the magnetization $M$ of a superconductor depends on the field profile inside the sample at time $t = 0$, we show here that their argument is based on a wrong expression for $M = M(t)$.

In several publications\textsuperscript{2-4} we have shown, on the basis of Monte Carlo simulations as well as of an exact solution of a four-pinning-region model, that over approximately 90\% of the relaxation

$$M(t) = M(t = 0) \left[ 1 - \frac{kt}{E(T)} \ln \left( 1 + \frac{t}{\tau} \right) \right], \quad (1)$$

if (i) the sample is homogeneous, in the sense that all pinning centers are described by the same activation energy $E(T)$, and (ii) the field has initially completely penetrated the sample so as to establish a critical state. These two conditions guarantee that everywhere the current density $j$ is equal to the critical current $j_c$ at $t = 0$. For $t \gg \tau$ (as is the case in all experiments carried out so far) Eq. (1) reduces to Eq. (1) in the Comment.

In Eq. (3), Chaddah and Bhagwat\textsuperscript{1} assume without derivation that the same logarithmic time dependence is valid for the case where the field has not penetrated the sample completely at $t = 0$, i.e., when $H < H^*$. We show here that this assumption which has also been made by many other authors (see, e.g., Refs. 5–9) is, in fact, not justified.

For this we consider a slab of thickness $2a$ and infinite dimensions in the $y$ and $z$ directions in a magnetic field $H$ applied along the $z$ axis. At $t = 0$, $|j| = j_c$ in a surface sheet $x_0 < |x| < a$, and $j = 0$ in the central part, $|x| \leq x_0$, of the sample. Using the same Monte Carlo simulation as in Refs. 3 and 10 we obtain the relaxation curves shown in Fig. 1 for various cases of fully and partially field-penetrated samples. For the partially penetrated samples, $M(t)$ does not obviously vary linearly with $\ln t$ and the relaxation rate $dM/d\ln t$ is not uniquely defined; i.e., $A(H)$ in Eq. (3) of Chaddah and Bhagwat is, in fact, strongly time dependent. An analytic expression for $A(H, T, t)$ will be published elsewhere.\textsuperscript{10} It is important to point out that convex $M$ vs $\ln t$ curves in partially penetrated Bi$_2$Sr$_2$CaCu$_2$O$_8$ single crystals have been observed by Shi, Xu, and Umezawa\textsuperscript{8} (e.g., at 8 K in a field of 0.1 T).

In conclusion, we do not believe that a maximum in $d\ln M/d\ln t$ can satisfactorily be explained with the arguments put forward by the authors. It is, however, obvious that relaxation processes in partially field-penetrated samples have to be taken into account for a correct description of flux creep at low fields and temperatures.

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\textsuperscript{3}C. W. Hagen, R. Griessen, and E. Salomons, Physica (Amsterdam) \textbf{157C}, 199 (1989).


\textsuperscript{6}P. Chaddah and G. Ravikumar, Physica (Amsterdam) \textbf{162-164C}, 347 (1989), and references therein.


\textsuperscript{8}Donglu Shi, Ming Xu, and A. Umezawa (to be published).


\textsuperscript{10}R. Griessen, J. G. Lensink, T. A. M. Schröder, and B. Dam, Cryogenics (to be published).