Sarma *et al.* Reply: In our Letter[1] we presented experimental data to establish that (1) the Auger satellite in the $L_2M_{45}M_{45}$ transition region of Cu and Zn cannot primarily be due to a preceding Coster-Kronig (CK) Auger transition, as has been believed until now; and (2) the photon energy dependences of the satellite intensities suggest a breakdown of the sudden approximation over a wide energy range. Fuggle and Sawatzky (FS) in the preceding Comment[2] have suggested an interpretation for the extra satellite intensity not explainable in conventional terms. They also argue that our data[1] do not suggest a breakdown of the sudden approximation. We discuss these two major points first before turning to the other minor points raised in the Comment.

FS suggest that the substantial satellite intensities in the $L_2M_{45}M_{45}$ transitions are due to a spectator hole in the initial state generated via a shakeup and/or shakeoff transition accompanying the photoemission. This possibility was already discussed by us.[1] However, FS do not realize that the probability of shakeup and/or shakeoff transitions in the photoemission step is in itself *not* enough to quantitatively explain the extra intensities of the Auger $L_2M_{45}M_{45}$ satellites in Cu and Zn.[1,3] Thus, their statements do not add any new understanding that was not discussed earlier.[1] A proper explanation[3] must establish the reason for the anomalously large satellite intensities below the L_1 thresholds (Fig. 1). In this context, it has to be realized[3] that the energetics of various interactions are such that the main L_2-hole state can decay via the CK process, but the L_2M_{45}-hole state cannot. This leads to a very large apparent enhancement of the Auger $L_2M_{45}M_{45}$ satellite relative intensity arising from the initial photoemission shakeup and/or shakeoff processes. With this new interpretation and the various transition probabilities, we now can quantitatively explain[3] satellites in the Cu and Zn $L_{23}M_{45}M_{45}$ spectra. From our analysis,[3] we find that while a large portion of the satellite intensity in the Cu $L_3M_{45}M_{45}$ is from the CK process, the majority of the satellite intensities in the Cu $L_2M_{45}M_{45}$ and Zn $L_{23}M_{45}M_{45}$ are due to the shakeup and shakeoff processes with the shakeoff process dominating.

FS claim that our data show "a major increase of the Auger satellite intensity over a photon energy range of $\sim$10 eV," and thus, our data do not establish the breakdown of the sudden approximation. This is misleading and a gross misrepresentation of our data by FS which clearly show for the case of Zn $L_{23}M_{45}M_{45}$ Auger satellite intensity a continuous and prominent increase (with no sign of saturation) up to *more than 100 eV* above the threshold (inset, Fig. 1). Our recent data on Cu $L_2M_{45}M_{45}$ (Fig. 1) also show a similar constantly pronounced dependence on the photon energy. Thus, our data establish a very extensive breakdown of the sudden approximation for elemental solid Cu and Zn photoemission. We note that the reference to the evidence of breakdown of sudden approximation made by FS showed only a marginal effect.

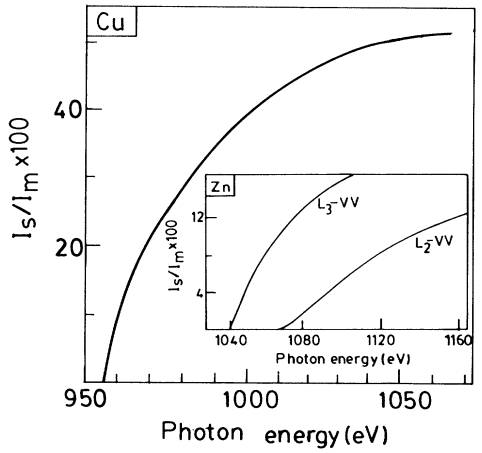

FIG. 1. The variation of the ratio of the satellite and main peak intensities, I_s/I_m, as a function of the photon energy used for the core-hole excitation, in the case of the Cu $L_2M_{45}M_{45}$ transition. Inset: Same variations (from Ref. 1) for the cases of Zn $L_3M_{45}M_{45}$ and $L_2M_{45}M_{45}$ transitions. The core threshold energies are approximately 952 eV (Cu L_2), 1116 eV (Zn L_3), and 1143 eV (Zn L_2).

FS refer to our claim that the L_2- and L_3-$M_{45}M_{45}$ spectral line shapes should be similar if the extra $3d$ hole is created *in the final state.* FS have not recognized that there is nothing wrong with this claim and that two spectral line shapes can be quite dissimilar *only if* the extra $3d$ hole exists from *the initial state.* Furthermore, FS refer to reports of incomplete relaxation in Auger spectroscopy that have only shown very small (a few percent) effects experimentally, contrary to our data which exhibit *pronounced* effects.

D. D. Sarma,[(1)] C. Carbone,[(2)] P. Sen,[(2)] R. Cimino,[(2)] and W. Gudat[(2)]

[(1)]Solid State and Structural Chemistry Unit
Indian Institute of Science
Bangalore-560 012, India

[(2)]Institut für Festkörperforschung
Kernforschungsanlage
D-5170 Jülich 1, Federal Republic of Germany

Received 29 November 1990
PACS numbers: 79.60.Cn, 71.28.+d, 71.45.Gm

[1]D. D. Sarma *et al.*, Phys. Rev. Lett. **63**, 656 (1989).

[2]J. C. Fuggle and G. A. Sawatzky, preceding Comment, Phys. Rev. Lett. **66**, 966 (1991).

[3]D. D. Sarma *et al.* (unpublished).