Shung and Mahan Respond: In our opinion, Overhauser's comments[1] are not scientifically valid. A point-by-point rebuttal is presented below.

Jensen and Plummer[2] published photoemission measurements from sodium which contained unexpected peaks and which they proposed as evidence for charge-density waves in sodium.[3] We pointed out that nearly all of the experimental results could be explained by nearly-free-electron theory, and there was no real evidence for charge-density waves in sodium.[4] Overhauser objects to our conclusion.[1] Overhauser's first objection was to our method of inserting the damping of the electron motion. This damping causes broadening of the direct transitions which is a key aspect of our theory. The mean free paths are only 5 to 10 Å. An expression for the wave function of the electron $\psi(\mathbf{R})$ at the position $\mathbf{R}$ of the detector is[5]

$$\psi(\mathbf{R}) \sim \int d^3r\, G(\mathbf{R},\mathbf{r},E_f)\mathbf{p}\cdot\mathbf{A}\psi_i(\mathbf{r}).$$

The Green's function G describes how an electron of energy E_f inside the metal gets to the detector. We showed how to reduce the above expression to[5] the three-step model. The matrix element contains the factor of $\exp(-z/\lambda)$ due to the probability of the electron getting to the surface without scattering. The point is that one-body states are not exact eigenstates of the interactive many-electron system.

Overhauser's second comment is that we failed to use his form of the interband matrix element.[6] Our objections to that result are the following: The theory of Ref. 6 is designed to explain the structure at photon energies of 4 to 12 eV in metallic potassium (not sodium). However, the band-structure calculations of Ham[7] show empty d bands which are 4–8 eV above the Fermi energy. Direct transitions to these empty d bands should be an important part of the one-electron spectra and should explain the extra peak in the potassium absorption. His matrix element was proposed for potassium which has both empty d bands and an extra peak in the absorption spectra. Metallic sodium has neither, so that there is no reason to employ his matrix element for this metal.

The sign we used for V_{110} is the conventional one in the literature,[8] which is based upon numerous measurements of the Fermi surface.

Overhauser's final assertion is that our theory does not explain the "balcony" peaks. We are unsure of what he means by this phrase. Certainly our theory explains the peak in the photoemission for electrons near the Fermi energy for most photon energies shown in his Fig. 1. That was the main point of our Letter. However, there are some electron energy distributions at high photon energy which show two peaks, one near the direct transition and one near the Fermi energy.[2] Our theory does not explain this second peak near the Fermi energy. In fact, these extra peaks are a mystery and are not predicted by any theory. Overhauser claims that they are explained by his theory of charge-density waves. However, he has not published any calculations of energy distribution curves which show this peak, and so his claim is unsubstantiated.

Our final remark is to observe that sodium is not the same as potassium. The issue of charge- or spin-density waves in potassium has been controversial for a long time, with much recent discussion.[9-11] However, there is little evidence for such behavior in sodium.[9,12]

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