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Reconciling Particle-Beam and Optical Stopping-Power Measurements in Silicon[1] WILLIAM KARSTENS, St. Michael's College, E. J. SHILES, Retired, DAVID Y SMITH, University of Vermont and Argonne National laboratory — A swift, charged particle passing through matter loses energy to electronic excitations *via* the electro-magnetic transients experienced by atoms along its path. Bethe related this process to the matter's frequency-dependent dielectric function $\varepsilon(\hbar\omega)$ through the energy-loss function, Im[-1/$\varepsilon(\hbar\omega)$]. The matter's response may be summarized by a single parameter, the mean excitation energy, or I value, that combines the optical excitation spectrum and excitation probability. Formally, ln I is the mean of ln $\hbar\omega$ weighted by the energy-loss function. This provides an independent optical check on particle energy-loss experiments. However, a persistent disagreement is found for silicon: direct particle-beam studies yield $173.5<I<176$ eV, but a fit to the stopping-power of 36 elements suggests 165 eV. An independent determination from optical data in 1986 gave 174 eV supporting the higher values. However, recent x-ray measurements disclosed short comings in the 1986 optical data: 1. Measurements by Ershov and Lukirskii underestimated the L-edge strength, and 2. A power-law extrapolation overestimated the K-edge strength. We have updated these data and find $I = 162$ eV, suggesting that silicon's recommended I value should be reconsidered. While this 5% change in I value changes the stopping power by only 1%, it is significant for precision measurements with Si detectors.

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