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S.C. Roy [a], Lynn Kissel [b] and R. H. Pratt [c]

[a] Department of Physics, Bose Institute, Calcutta, India,
[b] Computational Physics Group Lawrence Livermore National Laboratory,Livermore, CA.
[c]Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA

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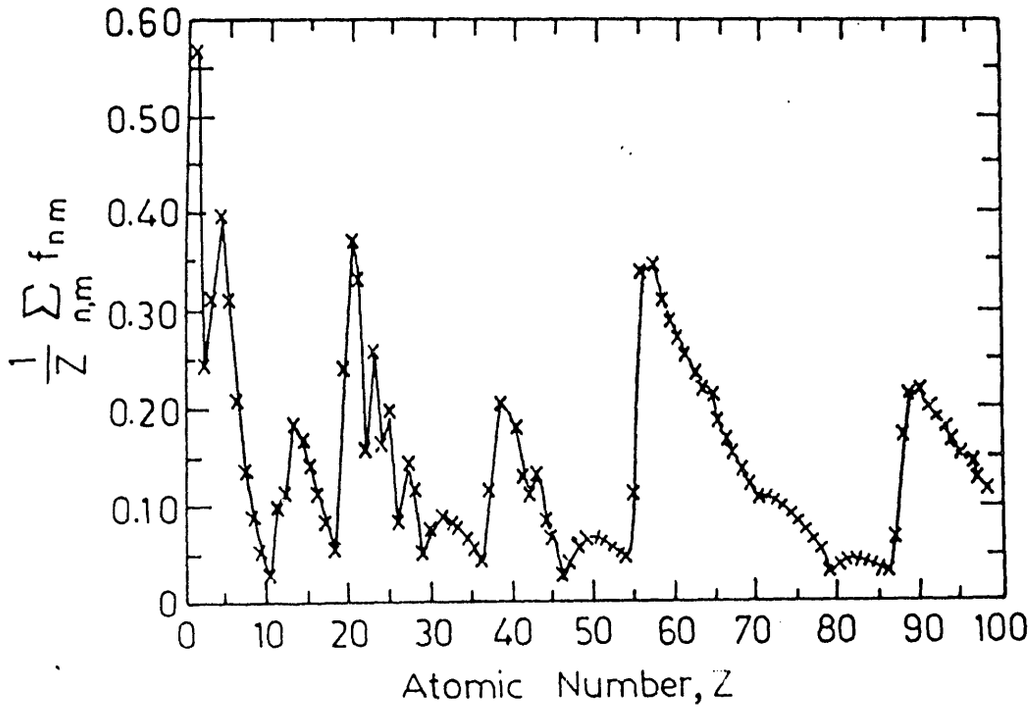
ANOMALOUS SCATTERING CALCULATION OF X- AND GAMMA RAYS

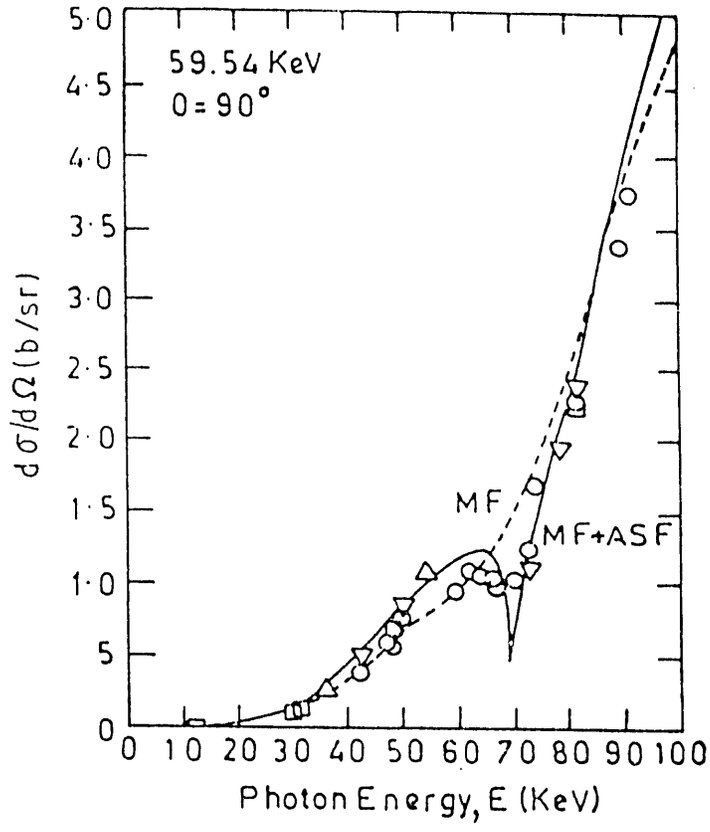
S.C. Roy[a], Lynn Kissel[b] and R. H. Pratt[c]

a) Dept. of Physics, Bose Institute, Calcutta 700009, India
b) Computational Physics Group, L-59, Lawrence Livermore National Laboratory, Livermore, CA 94550, U.S.A.
c) Dept. of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260, U.S.A.

Anomalous scattering of x-and gamma rays is a subject of continued interest. It has been realized recently that the anomalous scattering factors derived using dispersion relations are either incomplete or incorrectly calculated [1]. Here we discuss the present status of anomalous scattering calculations, using state-of-the-art numerical S-matrix calculations[2] in obtaining Rayleigh scattering amplitudes. Anomalous scattering factors tabulated by Cromer and Liberman[3] and Henke et.al.[4] are widely used. All calculations connect real part of the scattering amplitude with the imaginary part. The imaginary part, in turn, is related to the photo absorption corss sections through the optical theorem. In many calculations only photoelectric cross sections are used, neglecting substraction of bound pair production cross sections, and neglecting the contributions from bound-bound transitions. These contributions are significant in some elements as may be observed in Fig. 1. Using S-matrix values of Rayleigh amplitudes, the limit at high energy has also been evaluated, differing somewhat from form factor predictions. Use of this corrected high energy limit improves ageement with experimental results [5].



Approximate calculations, utilizing modified form factors in conjunction with corrected angle-independent anomalous scattering factors, generate Rayleigh scattering cross sections comparable with those obtained using state-of-the-art S-matrix calculations. Fig.2 presents a typical example of this agreement. Such approximate Rayleigh scattering amplitudes deviate from the S-matrix calculations for large momentum transfers in heavy elements. The anomalous factors at high energy are larger in such elements, and angle independence is an approximation. (For forward scattering the approach in principle is exact). Experimental and theoretical (S-matrix) information may be utilized to study the angular dependence of the anomalous scattering factors.



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