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PIONIC 4F-3D XRAYS FROM ^{208}PB and ^{209}BI

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Energies and widths of pionic x-rays are in general well described by an optical model description of the pion-nucleus interaction, with agreement between theory and experiment generally at the few percent level. Recently Konijn et al[1], have extended 4f-3d the x-ray measurements to Ta, Re, Pt, Au, Bi, and have found that the shifts and widths are approximately a factor 2-3 smaller than predicted. At TRIUMF we have undertaken a more extensive study of the ^{208}Pb and ^{209}Bi x-ray by exploiting the low-momentum pion beam and a BGO Compton suppressor to obtain higher statistics and somewhat lower backgrounds than previous workers. Fig. 1 shows the photon spectrum in the region of the Pb 4-3 x-ray consisting of approximately 35% of the total data analysed. Two models for the background shape, linear and exponentially decreasing were used in the fitting, and the quality of the data has permitted a more thorough evaluation of the sytematic uncertainties than was possible in earlier work. The chi-square obtained in our best fit was 1.03 per degree of freedom, and the peak-to-background amplitude obtained was 1:2. The fit in the region of the ^{209}Bi 4-3 x-ray is shown in Fig. 2. In this case the number of contamination gammas from pion absorption is higher, and the background is consequently less well-determined. The peak-to-background ratio is only 1:3.5, still better than the 1:7 ratio obtained in the previous experiment. Again the systematic errors are dominant, expecially the possible structure in the background. The ratio of the intensities of the 4-3 and 5-4 x-rays depends principally on the 4f strong interaction width. The measured intensity ratios of 9.6%±1.9% in Pb and 9.4±2.1 in Bi are consistent with the calculated value of 12±1%. The ratio scales roughly with the 4-3 width, and provides further evidence against narrow values. We have compared these results with optical model calculations using the parameters of Kunselman et al.[2], and Batty et al[3]. The xBi results are in good agreement with the model, which is not surprising considering the large systematic uncertainties. The Pb energy shift and width are 10% and 20% lower than the calculations, still within two standard deviations. Thus our data offers no evidence of anomalously narrow linewidths for the 4-3 x-rays.

Transition	Energy Error		EM	Shift	Width		Area
	keV	stat sys	keV	keV	keV	stat sys	
Pb 4-3	1274.7±.6±	1.0	1251.2	23.5	47.4 ± 2.6 ±	4.5	16200
Pb 5-4	575.44±.02±.05		573.80	1.64	1.30±.03±.08		270000
Bi 4-3	1312.0±1.8±3.0		1282.40	30.4	71.2±8.4±21		15000
Bi 5-4	589.90±.05±.04		588.13	1.77	1.49+.02±.04		284000

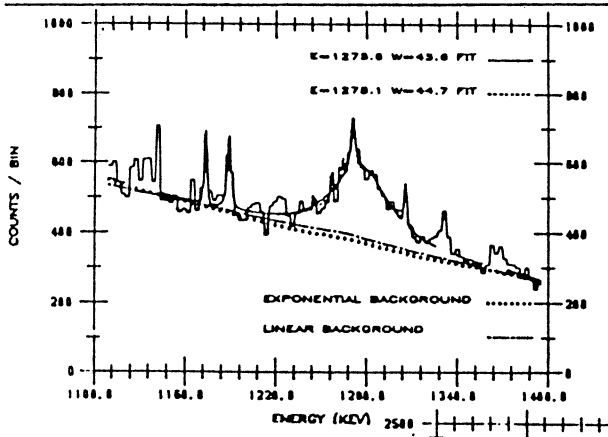

Fig. 1. Fits to the 208Pb 4-3 x-ray. The data has been rebinned to 2.8 keV/bin. The different fits models shown were used in the evaluation of the systamatics uncertainties. Gaps in the fit lines denotes regions omitted from the fit.

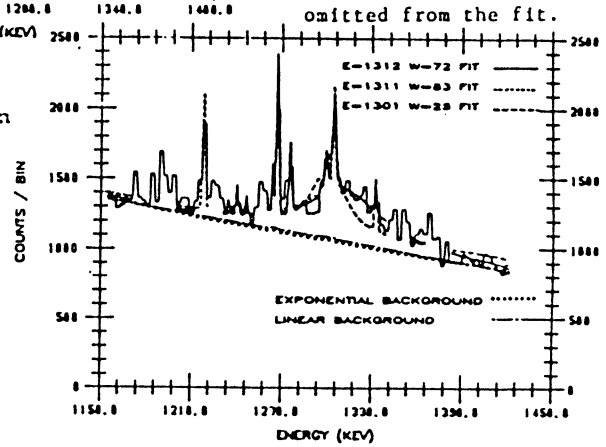

Fig. 2. Fits to the ^{209}Bi 4-3 x-ray. The presentation is the same as Fig. 1. Also included is a fit with the position and width fixed at its previously reported value.

1. J. Konijn et al, Nucl. Phys. A326 (1979) 401; J.F.M. d'van Enschut et al, Phys. Lett. 136B (1984) 24.
2. A.R. Kunselman et al, Nucl. Phys. A405 (1983) 627. potential (1)
3. C.J. Batty et al, Nucl. Phys. A322 (1979) 445, potential (c)

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