these energies,[3] it is possible to state whether a particular mesonic x-ray lies above or below the "K edge" of a given filter element and thus place an upper or lower limit on the energy of that transition. Calculated mesonic x-ray energies in this energy range are only slightly affected by readily evaluated nuclear size corrections; other effects,[4] except for the vacuum polarization, are considered negligible. A large number of such transitions have been studied to date. The observed pulse-height spectra contain components of degraded radiation arising from Compton scattering in the meson target and surrounding material and fluorescent radiation from the filter. Thus the upper energy part of the pulse-height distribution is emphasized in the interpretation of the data.

At present, the results of most interest in the determination of the μ^- meson mass and of vacuum polarization effects are the following. For the $2P-1S$ transition in carbon, $Z=77$, 78, 79 filters all behave similarly indicating "K edges" above the mesonic x-ray energy while $Z=74$ has its "K edge" well below the mesonic energy. The $Z=77$ filter indicates that the transition energy is below 76.123 kev. The most significant result was that the phosphorus $3D-2P$ transition energy lies above the $Z=81$ and 82 absorption edges and below the $Z=83$ edge. Corresponding to the $Z=82$ absorption edge we emphasize that the photon energy in this case is greater than 88.065 kev. The $4F-3D$ transition in silicon indicates that the transition energy is above the $Z=47$ and 48 absorption edges and below that for $Z=49$, corresponding to a transition energy greater than 26.713 kev for the $Z=48$ edge.

The lowest-order vacuum polarization effect, as given by the Uehling integral,[5] has been evaluated for these states by two independent approximate methods which agree to within 2 percent. The effect always increases the binding energy. This amounted to 0.40 percent, 0.099 percent, 0.25 percent, 0.103 percent, 0.094 percent, and 0.034 percent for the $1S$ and $2P$ levels in carbon, the $2P$ and $3D$ levels in phosphorus, and the $3D$ and $4F$ levels in silicon, respectively. Table I lists the corresponding upper or lower limits on the μ^- meson mass before and after applying the vacuum polarization correction. The Dirac formula for a point nucleus was used and a nuclear size correction was needed only for the $1S$ level of carbon (decreases binding energy 0.45 percent).

The latest reported value of the μ^- meson mass, measured by independent means,[6] is 206.9 ± 0.2 electron mass units.[7] The stated uncertainty does not include estimates of possible systematic errors which could be of comparable amount. We therefore conclude that an effect of the order of magnitude of the vacuum polarization is necessary for agreement with the lower limit for the meson mass ($3D-2P$ transition in phosphorus with $Z=82$ filter) measured here.

TABLE I. Upper or lower limits on the μ^- meson mass/electron mass without and with vacuum polarization correction.

Transition		Without V_p	With V_p
C: $2P-1S$	less than	209.99	208.95
P: $3D-2P$	greater than	207.67	206.89
Si: $4F-3D$	greater than	206.82	206.47

We wish to thank Professor Norman M. Kroll and Mr. Eyvind Wichmann for helpful discussions on the subject of vacuum polarization.

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Decay of Sb^{124}

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THERE is still some disagreement in the literature[1,2] on the interpretation of the decay of Sb^{124}. In an attempt to resolve these difficulties, the gamma radiation following the decay has been investigated in a 3 in.×3 in. NaI(Tl) scintillation spectrometer. The crystal was placed in an aluminum can, 0.005 inch thick, and mounted on a Dumont K-1197 photomultiplier. The data were taken using a 20-channel pulse-height analyzer.[3] Energy calibration was obtained from Cs^{137}, Co^{60}, and Y^{88} gamma rays. The spectrum obtained is shown in Fig. 1. For purposes of subtraction, the Compton distributions from the gamma rays at 2.11, 1.71, and 1.38 Mev were constructed from gamma radiation from Pr^{144} (2.18 Mev), Y^{88} (1.85 Mev), and Na^{24} (1.38 Mev). Relative intensities of the gamma rays (Table I) were determined from the peak areas and experimentally determined peak-to-total efficiency data for this crystal and geometry. Lower-energy gamma rays (<0.6 Mev) were looked for with techniques which eliminated most of the back-scatter peak at pulse height 90, but no indication of other gamma rays was found.

From the intensities and energies of the gamma rays and from the previously reported beta-ray analysis,[1] a consistent decay scheme may be proposed (Fig. 2). The ratio of the sums of the intensities of the gamma

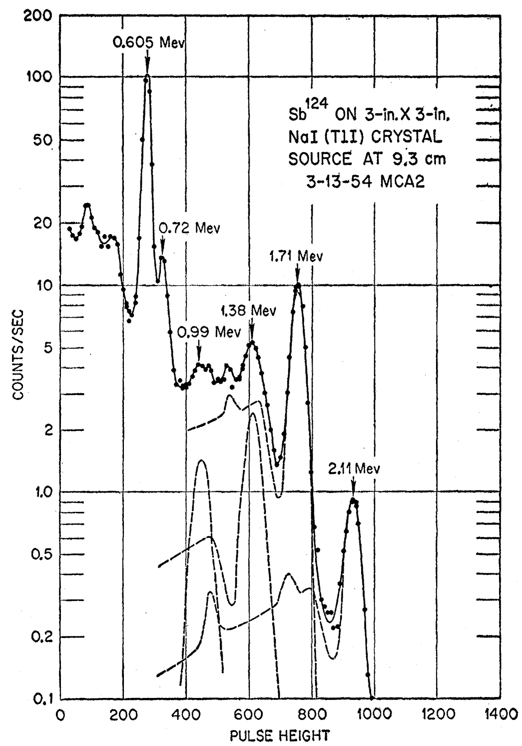

FIG. 1. Pulse-height spectrum from scintillation spectrometer caused by gamma rays following decay of Sb^{124}.

radiation leaving the levels at 2.7 and 2.3 Mev above the ground state was determined as 0.32. From the previous beta-ray analysis, the ratio of intensities of the beta rays feeding these levels is 0.29, indicating the correct placement of the 0.99- and 1.38-Mev gamma rays. From the energy of these gamma rays, the energy of the second excited state is determined.

The coincidence experiment reported by Metzger[2] can now be explained by the coincidence of the 0.72-Mev gamma ray and the Compton electrons from the newly reported gamma rays at 1.38 and 0.99 Mev. The gamma rays of energy 0.99 and 1.38 Mev are exceedingly difficult to observe with NaI crystals of smaller size than were used in this experiment because of the relatively smaller peak intensity for these gamma rays in such detectors and their unfortunate coincidence, energy-wise, with expected effects due to the other gamma rays.

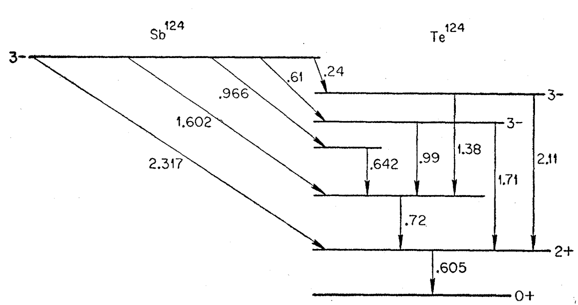

FIG. 2. Proposed decay sheme for Sb^{124}.

TABLE I. Energy and relative intensities of gamma rays in decay of Sb^{124}.

Energy (Mev)	Relative intensity
0.603	1.00
0.99	0.054
1.38	0.062
1.71	0.457
2.11	0.099

It would like to express my appreciation to P. R. Bell for his interest and advice on this subject.

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Evidence for Subshell at $N=152$*

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LARGE breaks in the plots of alpha-particle energy *vs* mass number at constant Z give striking evidence[1] for the closing of a major shell at 126 neutrons ($N=126$). We have applied this sensitive criterion to look for the much smaller "subshell" effects which

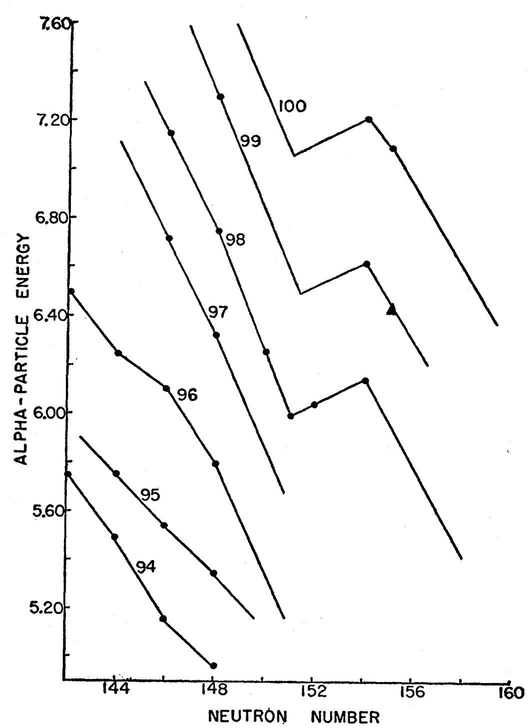

FIG. 1. Plot of alpha energy *vs* mass number.