Part II

1. Place the radioactive Cs^{137} source near the *NaI* scintillator being careful to keep both isolated from other materials such as walls, tables, etc., to minimize the scattering of gamma rays into the scintillator. Collect the data on the computer or PHA, plot it and print out the graphs (use blown up sections as necessary). Identify and determine the energies of the peaks/edges, etc., in the vicinity of 475, 185 and 30 keV. Do the same for the ^{22}Na source and identify the γ ray (peak) energies. (Keep gains, etc., fixed at your calibration values during all this.)

2. Repeat the spectrum of (1) in the same geometry, but with the addition of a thick slab of aluminum behind the Cs^{137} . Explain the additional structure in the vicinity of 185 keV with reference to equation (1). Explain why the sum of the energies of the 185 keV backscattering peak and of the Compton edge at 475 keV equals the energy of the total absorption peak and test this with your data.

3. Repeat the spectrum of (1) (aluminum of (2) removed), but place a thin slab of lead between the Cs^{137} source and the scintillator. Explain the virtual disappearance of the 32 keV peak, the appearance of a peak near 70 keV and the relative lack of change in the 660 and 475 keV structure. Determine the exact energy of the 70 keV peak, identify it, and explain its appearance in terms of photoelectric absorption of gamma rays in lead.

4. With no source, repeat (1) to obtain the background. What causes this background?

In understanding these spectra consider the following facts which have been well-verified by both theory and experiment. For 662 keV photons on *NaI* the Compton scattering cross section is about 8 times larger than the photoelectric absorption cross section, the interactions being predominantly with iodine ($Z = 53$) rather than *Na* ($Z = 11$). (The ratio is larger for the ^{60}Co γ rays.) For 662 keV photons on aluminum ($Z = 13$) the Compton scattering cross section is more than 100 times as large as the photoelectric absorption cross section. For 73 keV or 32 keV photons on *NaI* the photoelectric cross section dominates the Compton cross section by factors of 2 to 3.

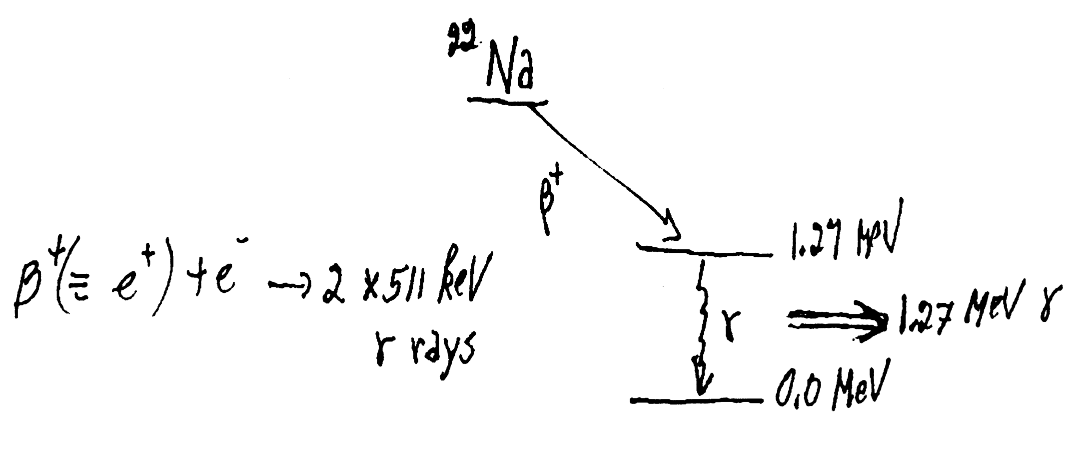

Fig. 5. ^{22}Na decay scheme