Tutorial Questions:

1. In the discussion of liquid noble gasses, discrimination based on the number of singlet and triplet states was introduced. What does this actually mean? What is a singlet state, what is a triplet state, could you sketch the argon system with levels indicating how the singlet and triplet are formed (schematically, not quantitatively).

2. In low background experiments, measuring the amount of U in the detector materials is critical, as if there is to much, the experiment will be swamped by background signals.
   a. Looking at the decay scheme, attached, can you explain why measurements with Ge crystals only probe the amount of the very long lived parents eg ^{238}U.
   b. Because a. is true experimentalists also try very hard to measure the activity at the end of the chain. Why? Why isn't measuring the parent good enough?
   c. A technique that has been developed, called "BiPo" that exploits the short time coincidence between the beta from ^{214}Bi and the alpha from the ^{214}Po. In addition to the correlation in time, one can look at the energies of the beta and the alpha. The samples are normally dissolved into a liquid scintillator. Can you sketch what you expect the scintillation signal would look like, superimposing the beta spectrum on the alpha?

3. In argon detectors some people worry about the impact of ^{39}Ar (a radioactive isotope of normal argon). Can you calculate the rate of ^{39}Ar in the DEAP detector? How many events per year would you see if you can discriminate them at the rate of 10^9. (ie if only 1 in a billion get through cuts). Mining for underground Ar, depleted in ^{39}Ar, is underway.

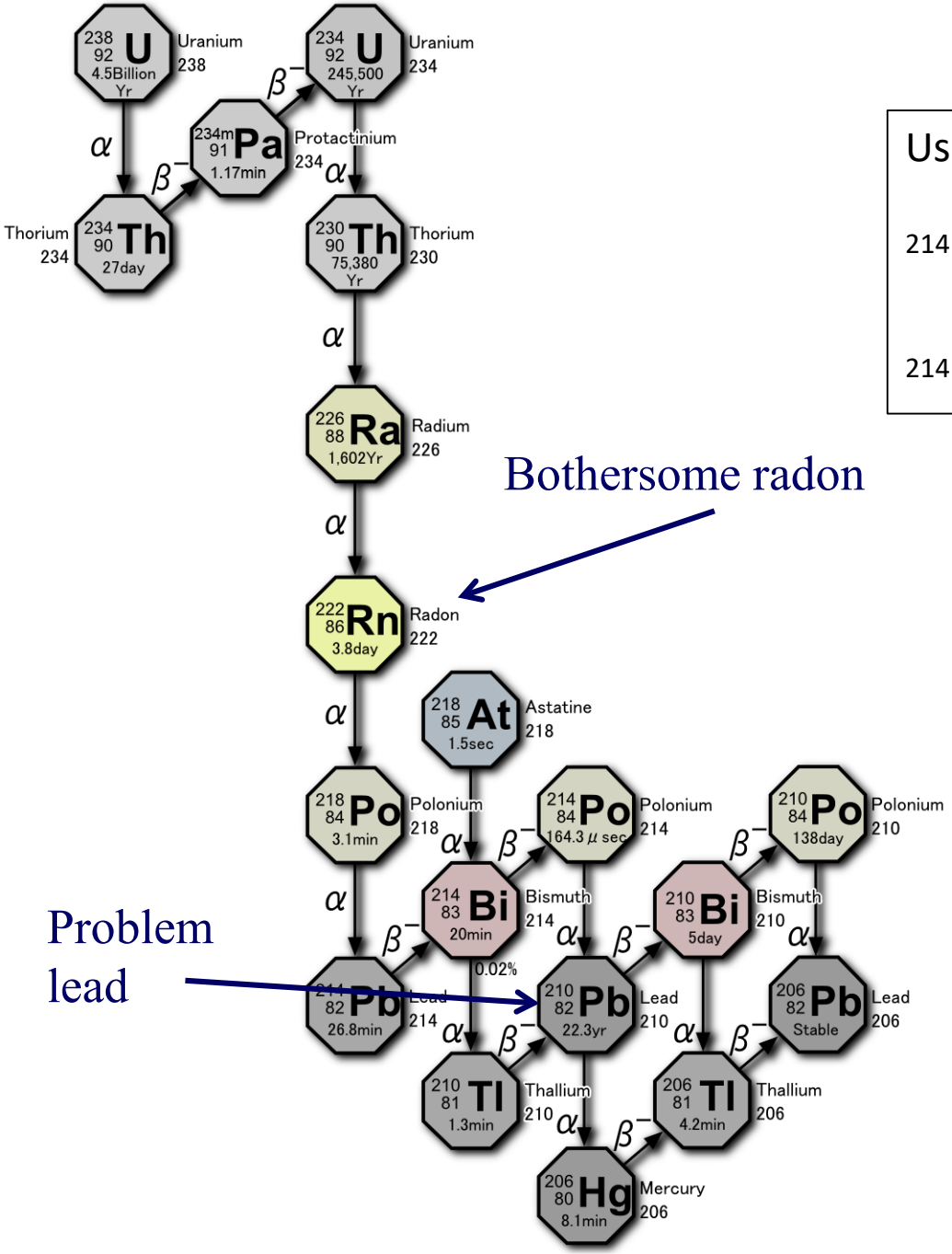
<u>Useful facts:</u>

^{39}Ar concentration: $8.1\times10^{-16}\ \mathrm{g}(^{39}\mathrm{Ar})/\mathrm{g}(^{40}\mathrm{Ar})$

^{39}Ar half life: 269 years

Deap Detector: 3600 Kg of Ar

4. Why are you still here on a sunny Friday in the late afternoon?



Bothersome radon

Problem lead

Useful facts:

^{214}Bi decay: Q-value for decay is 3272 keV

^{214}Po decay: Q-value for decay is 7833 keV