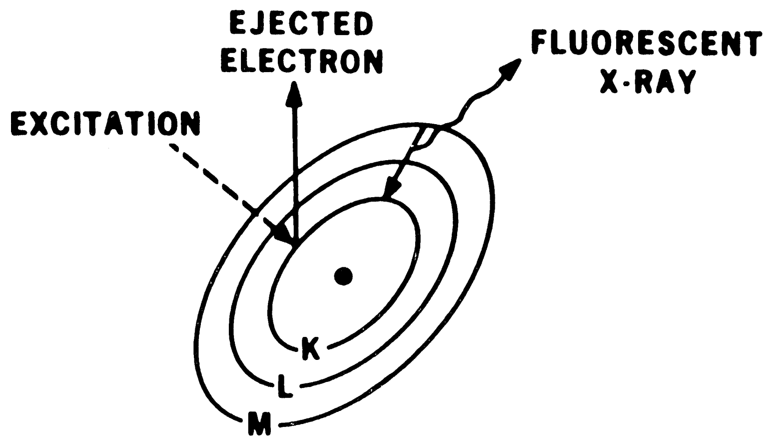
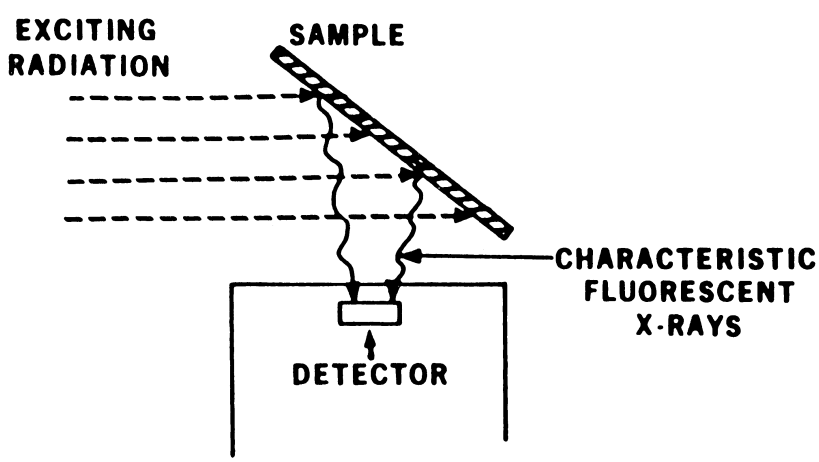
X-Ray Fluorescence

(thanks to Joe Jaklevic, Engineering Div. LBNL)

When excited by radiation of sufficient energy, atoms emit characteristic x-rays that can be used to detect trace contaminants.

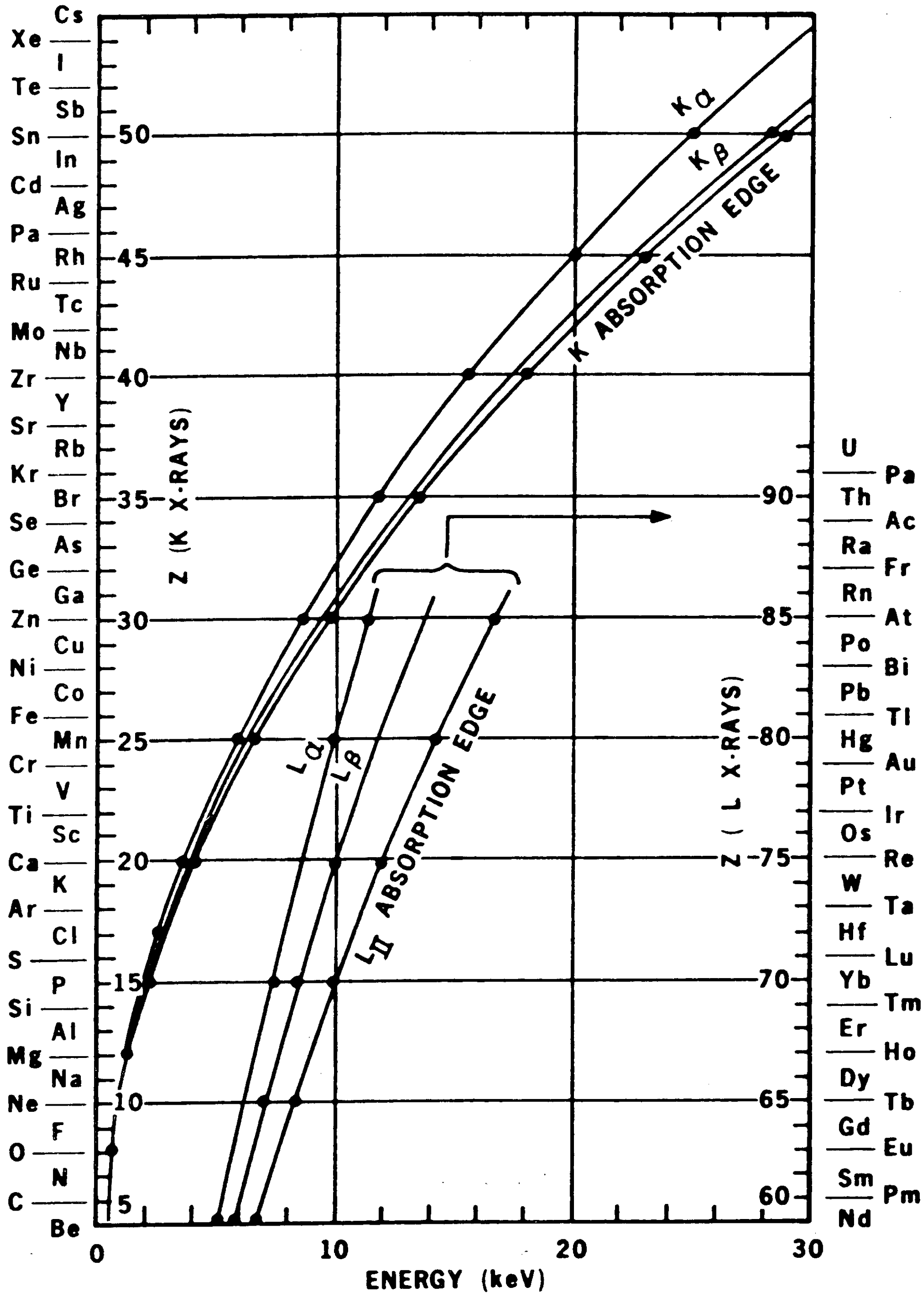


Experimental arrangement



The incident radiation can be broad-band, as long as it contains components of higher energy than the atomic transitions of the atoms to be detected.

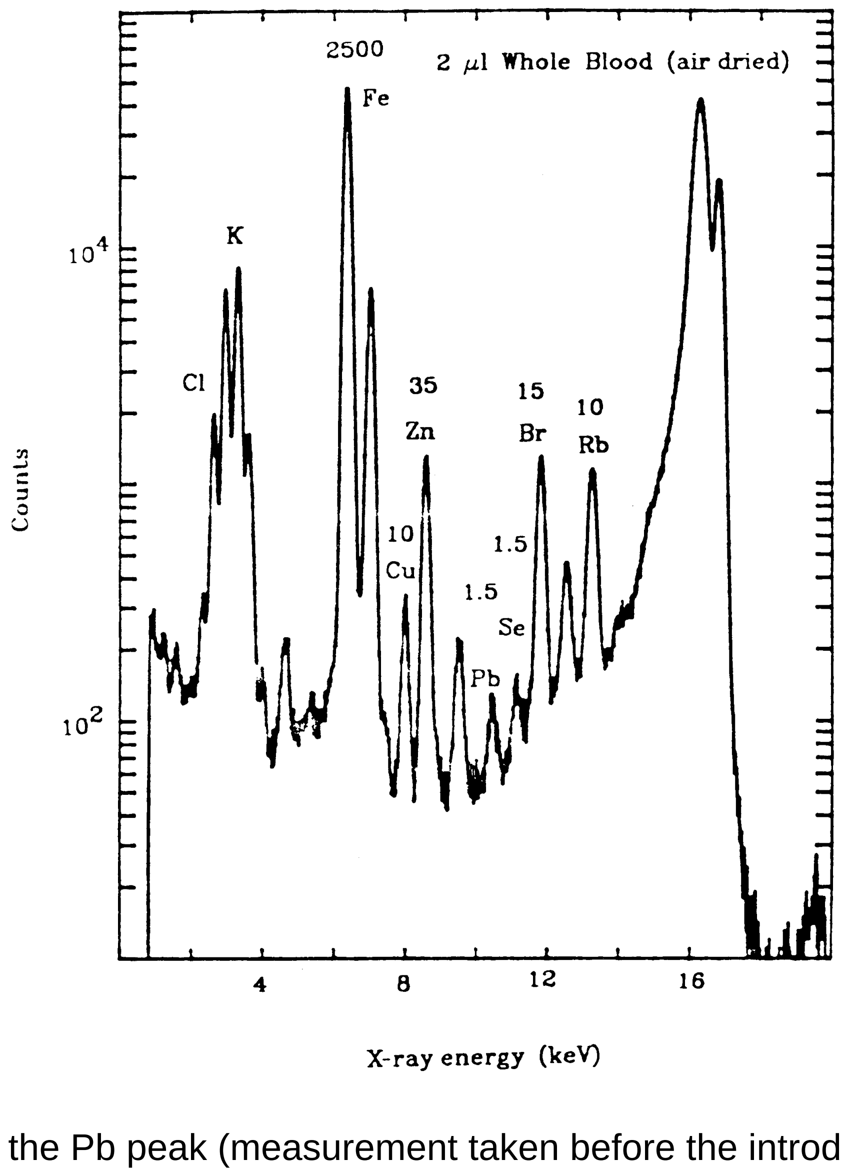
Energy of the K and L absorption edges vs. atomic number Z.



X-ray fluorescence can provide high sensitivity with small samples.

Spectrum taken from 2 μl (1 mm^3) of blood.

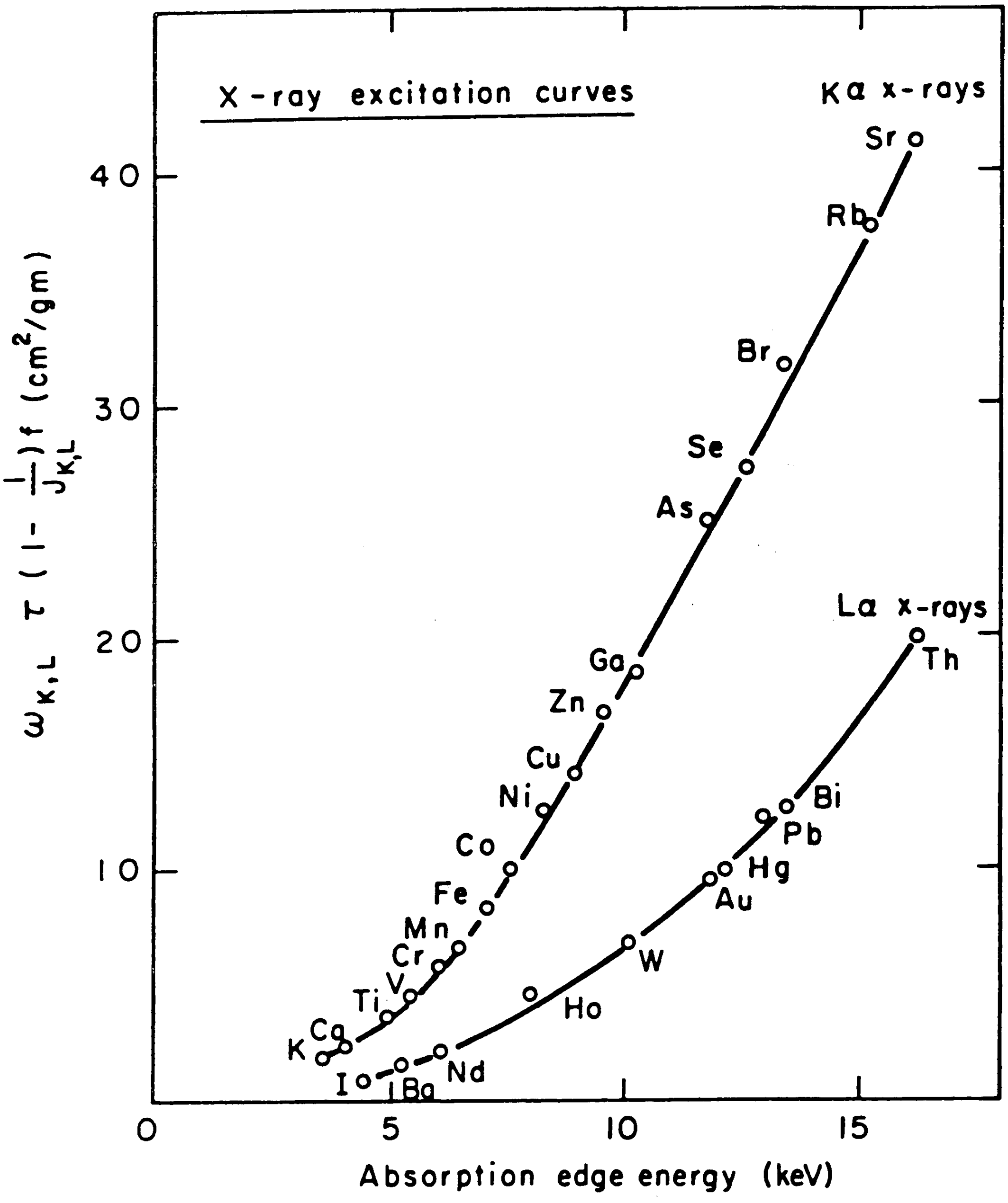
Concentrations are given in parts per million



Note the Pb peak (measurement taken before the introduction of unleaded gasoline).

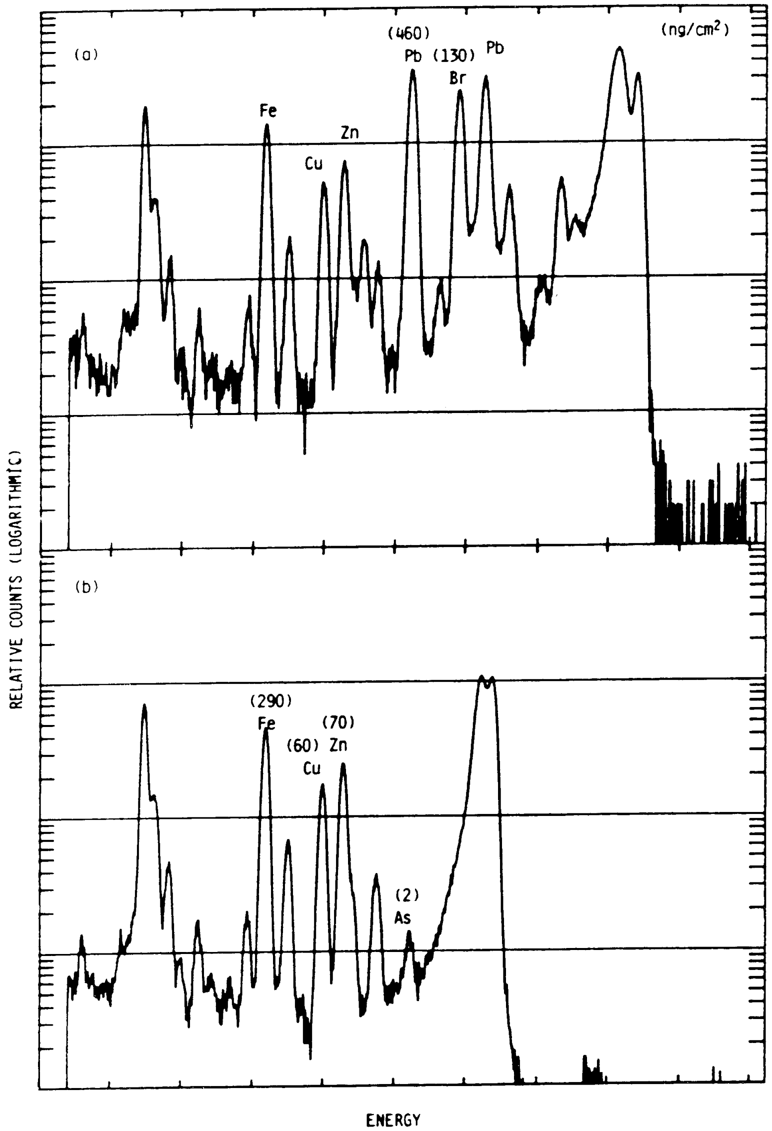
The sensitivity is limited by background.

In part, the signal-to-background ratio can be improved by judicious choice of the excitation energy.



Note the increase in cross section with energy. Using the smallest possible excitation energy for a specific element reduces background from higher energy transitions.

Air sample, particles captured on filter, particle size < 2.5 µm.



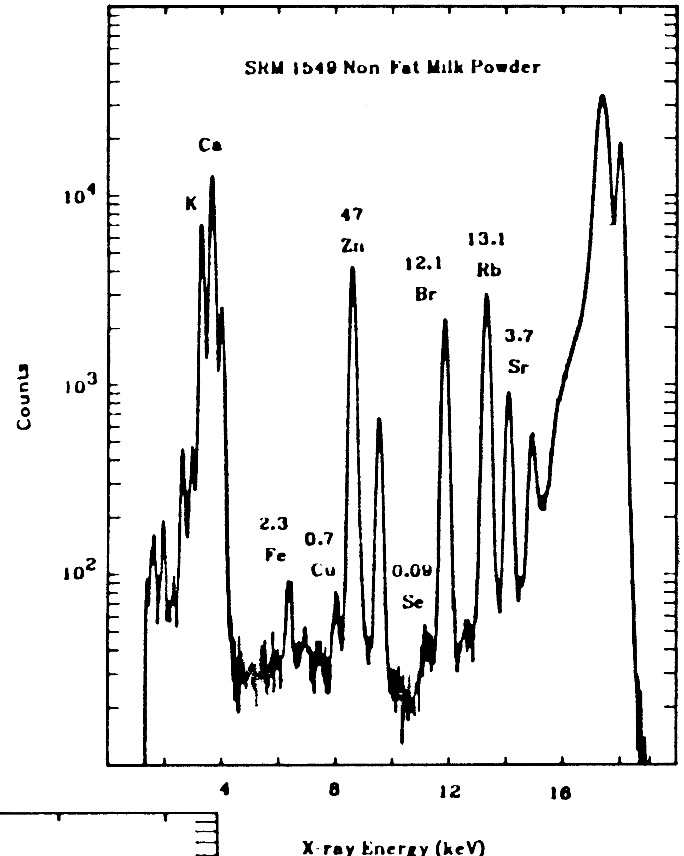
The upper edge of the spectrum indicates the excitation energy.

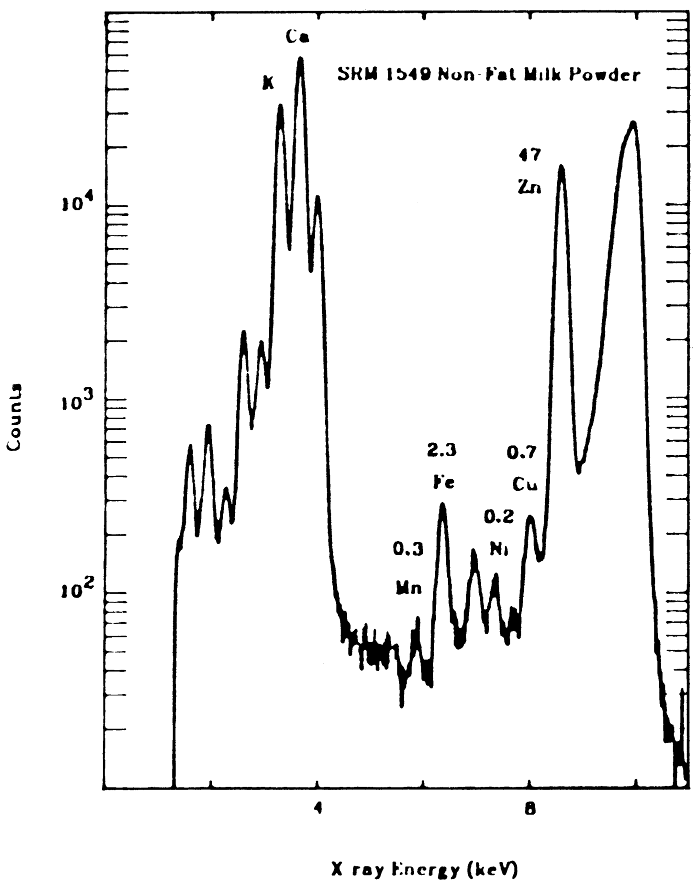
Note the As peak in the lower spectrum, which is obscured by more intense peaks from other elements at higher excitation.

At low excitation energies (<10 keV) emissions from high Z elements and high order transitions are significantly reduced.

Trace contaminants in milk powder, taken at two excitation energies.

Concentrations in ppm.





Reduced excitation energy:

Improved sensitivity for Mn, Ni.