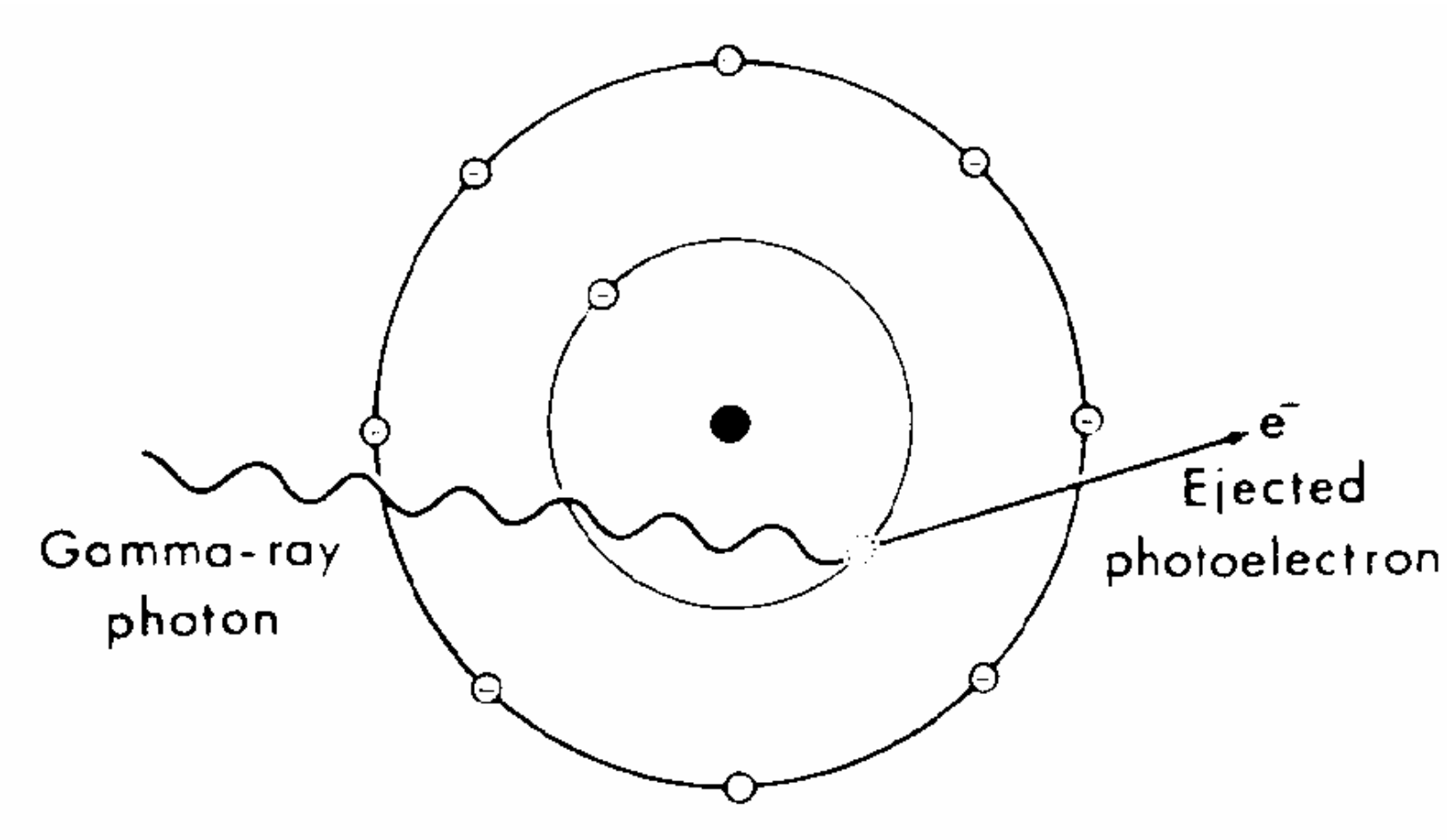
Module 2
Interaction of Radiation with Matter

- Gammas
- Electrons
- Charged Particles
- Neutron
- Others

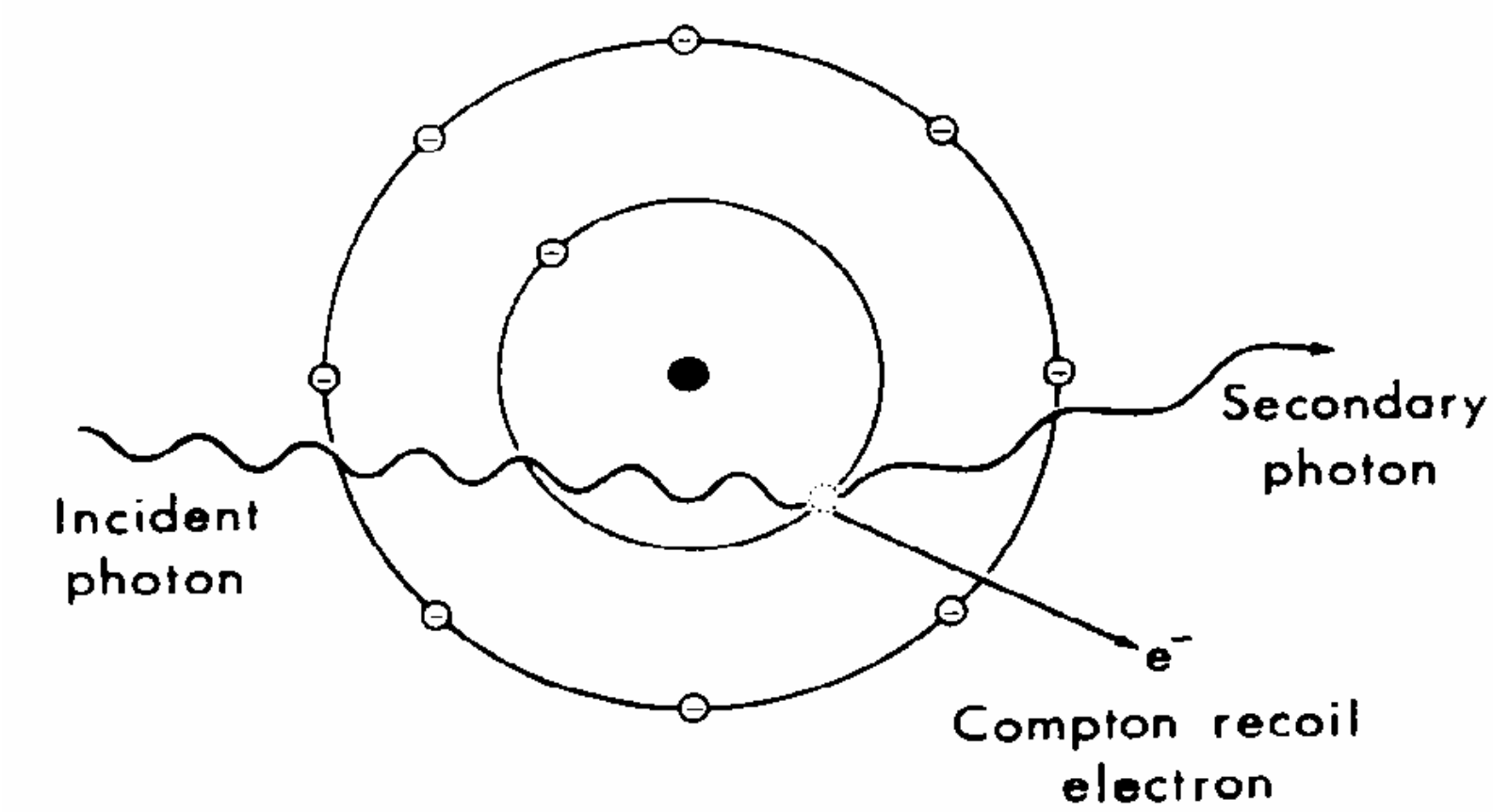
Gamma Rays

- Photo Electric
- Raleigh Scattering (Coherent Scattering)
- Compton Scattering (Incoherent Scattering)
- Pair Production

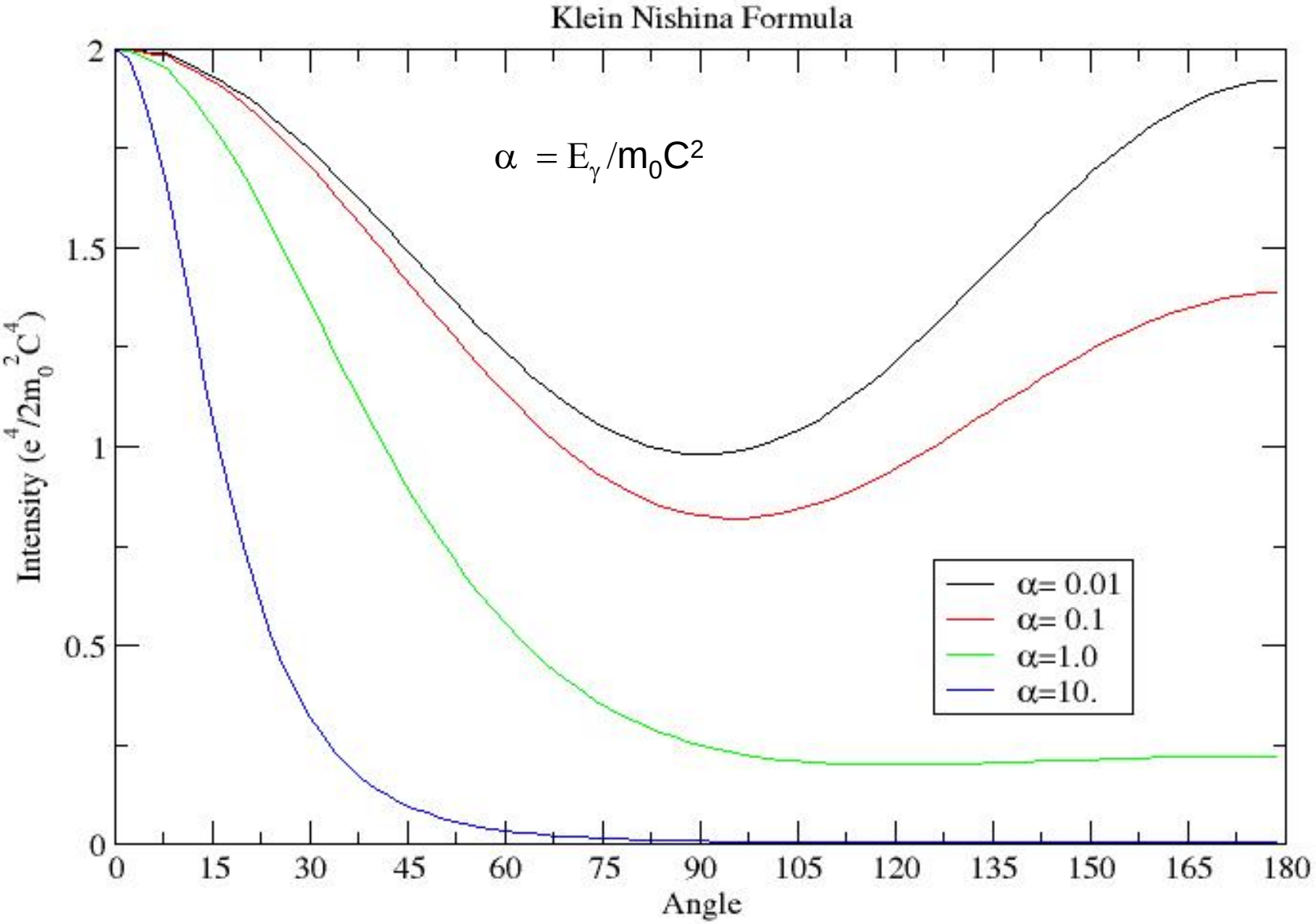
Photo Electric Effect



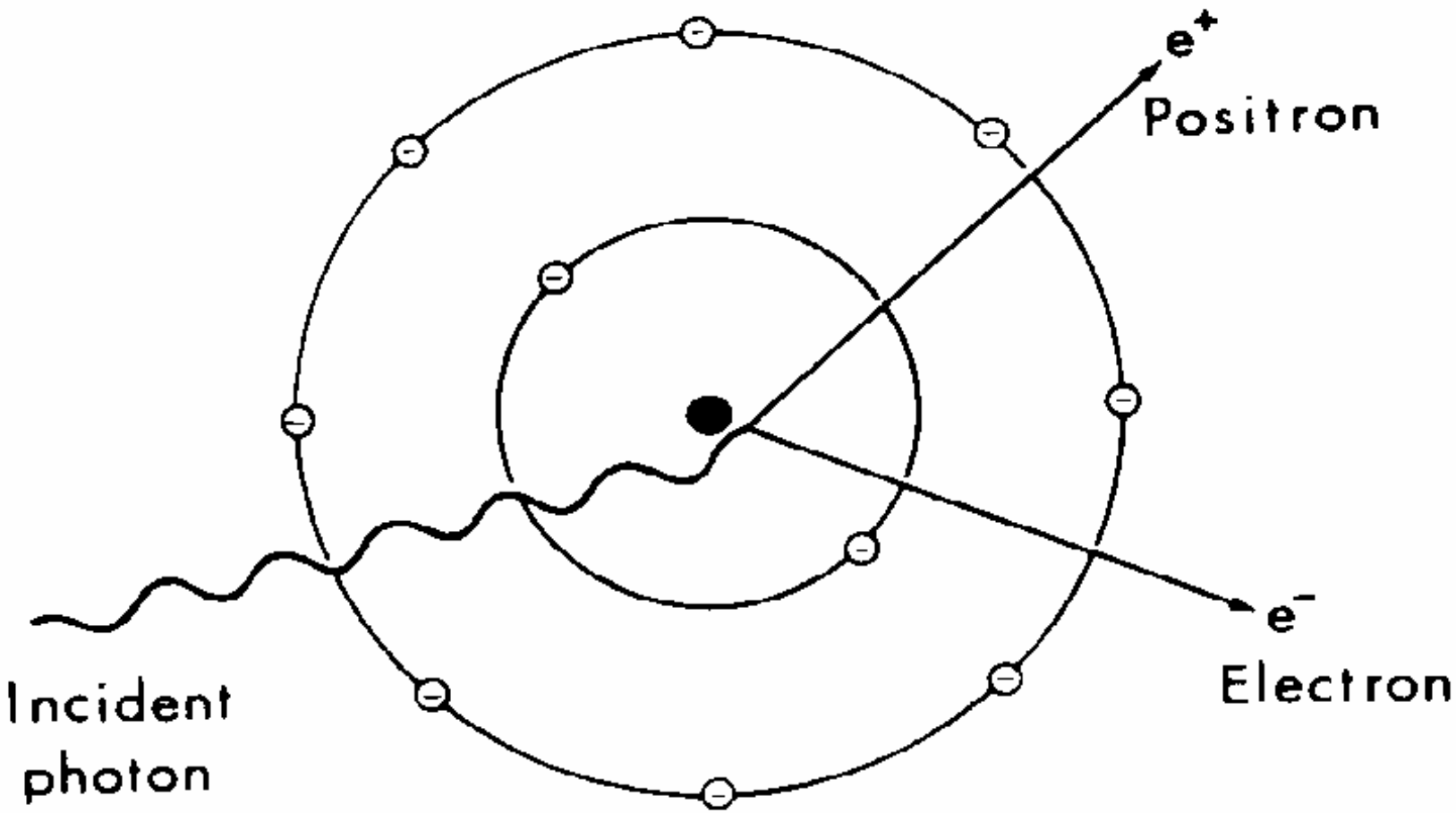
Compton Scattering



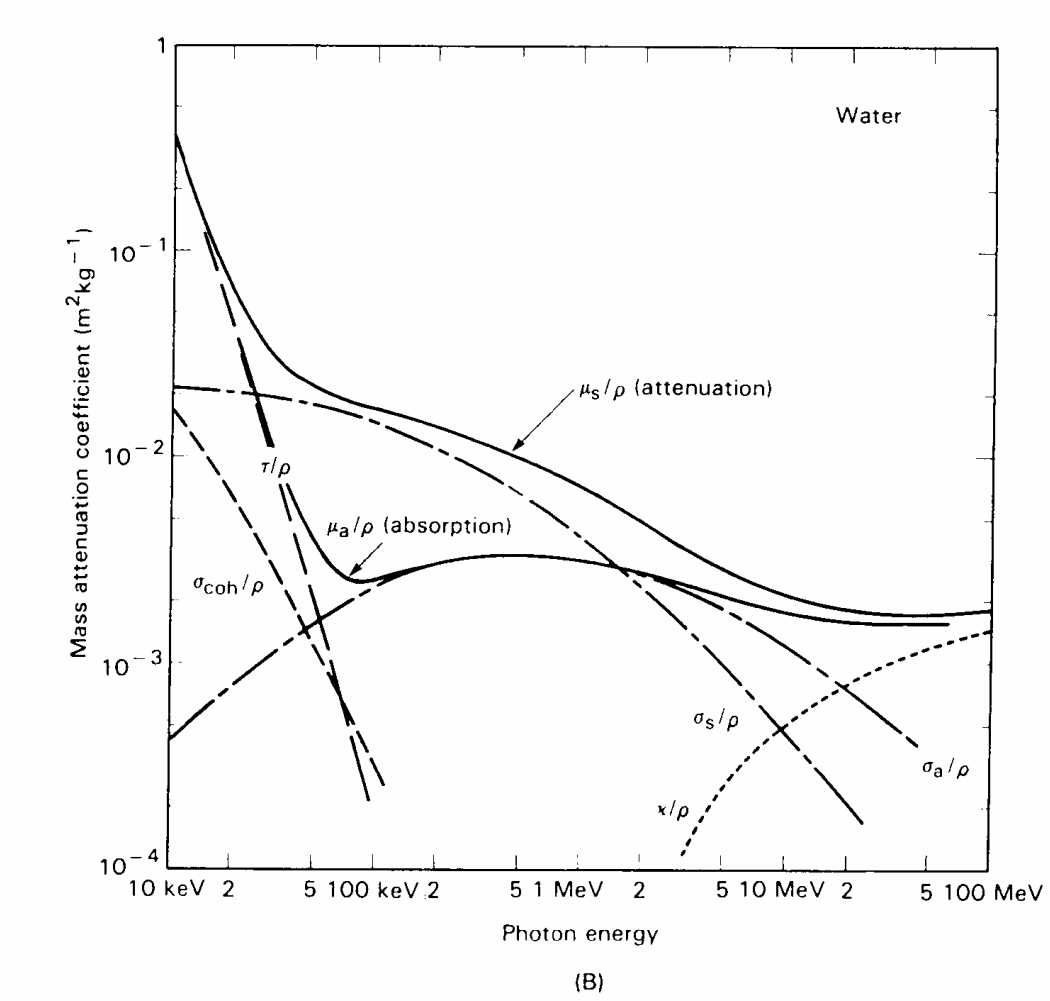
Compton Scattering



Pair Production

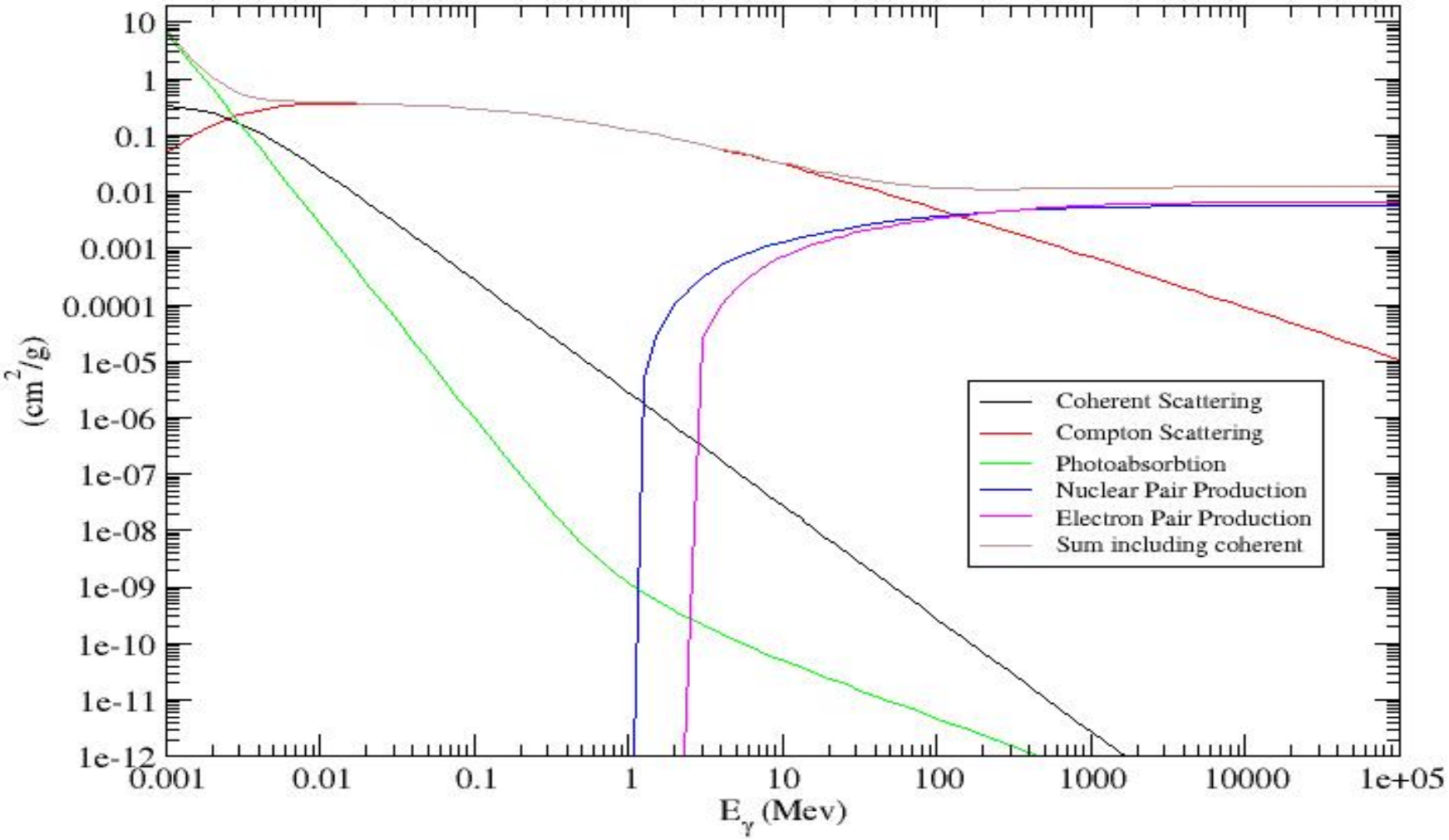


Gamma Interaction with Water



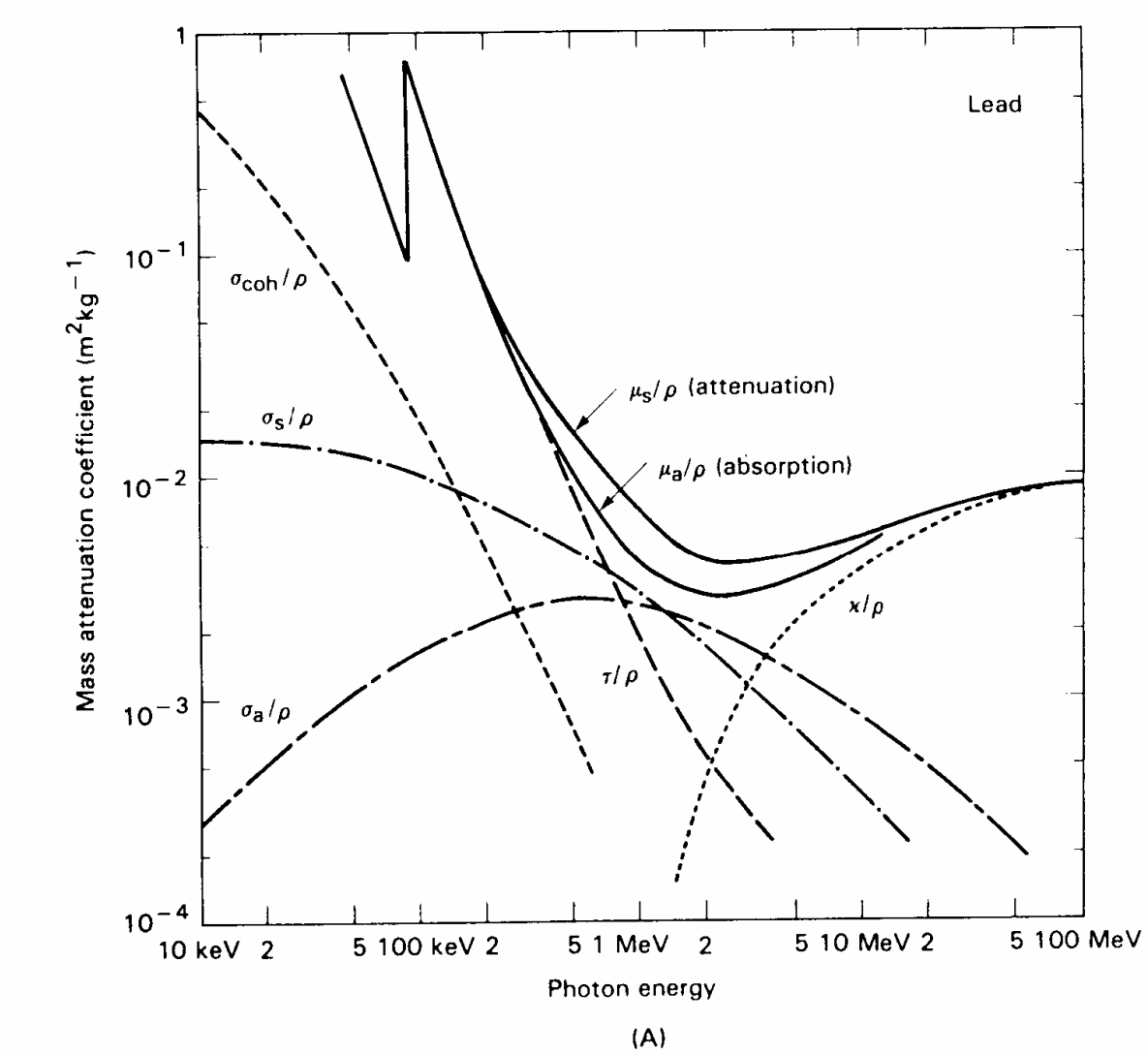
(B)

Interaction with Gammas Water

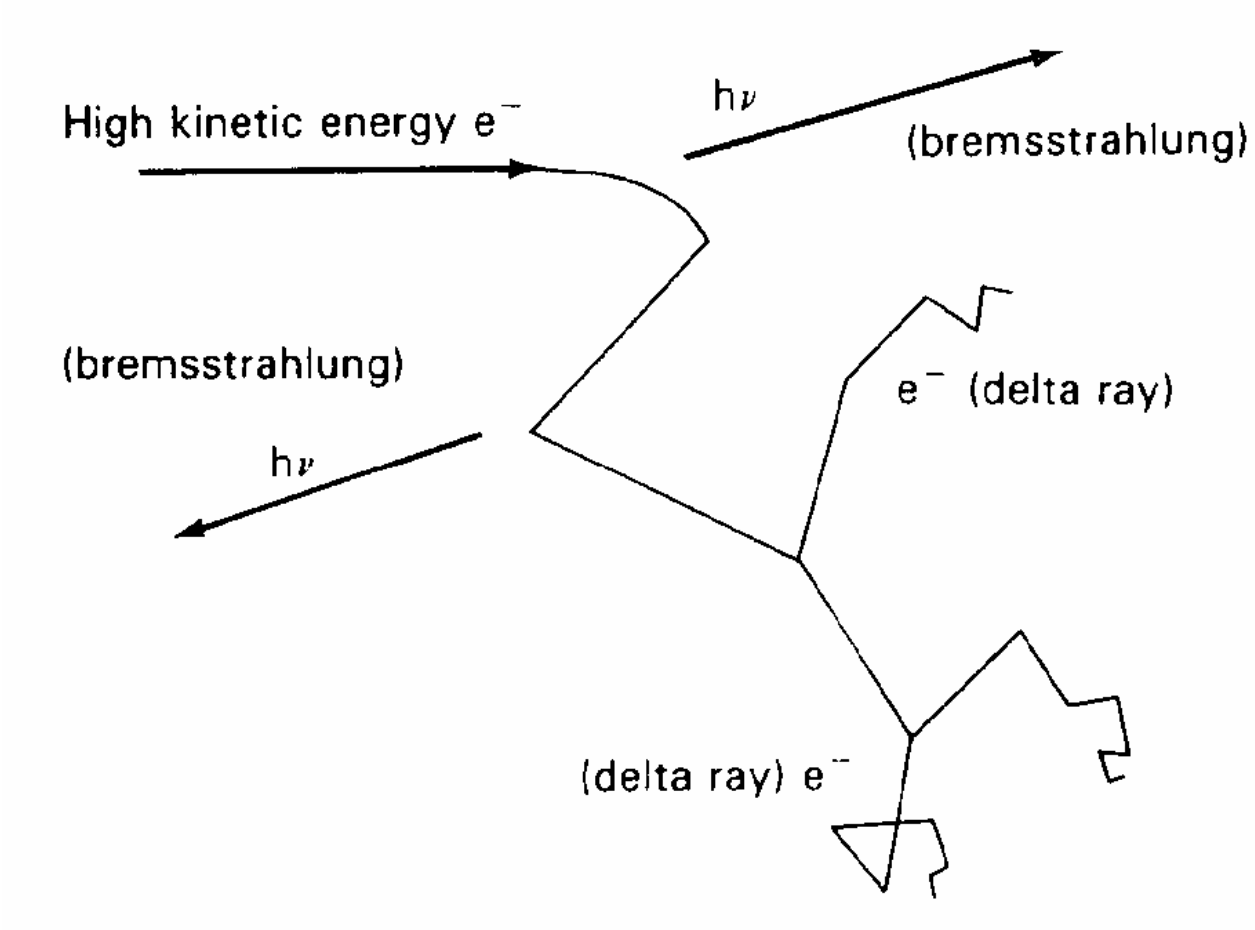


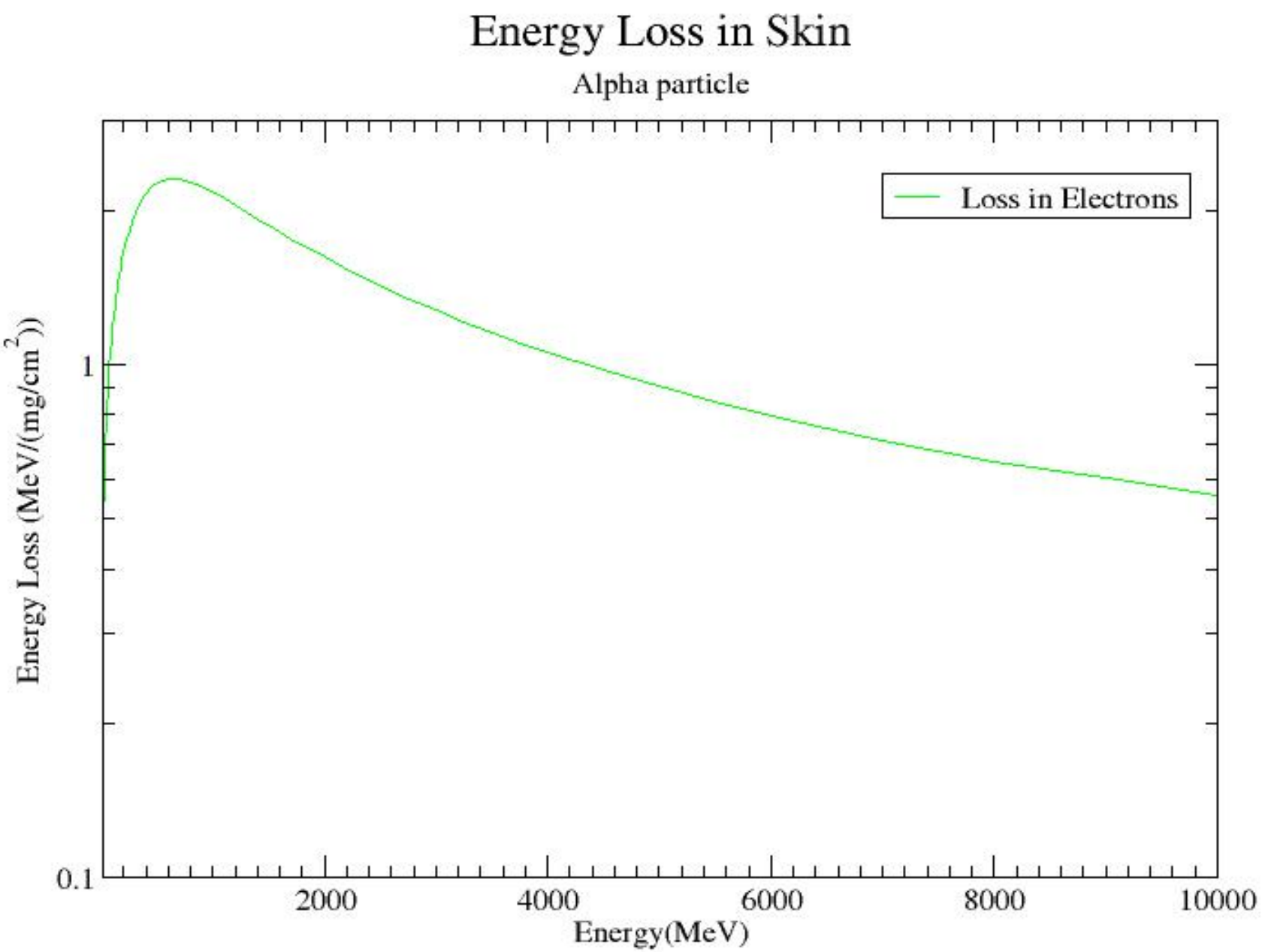
http://physics.nist.gov/PhysRefData/Xcom/Text/XCOM.html

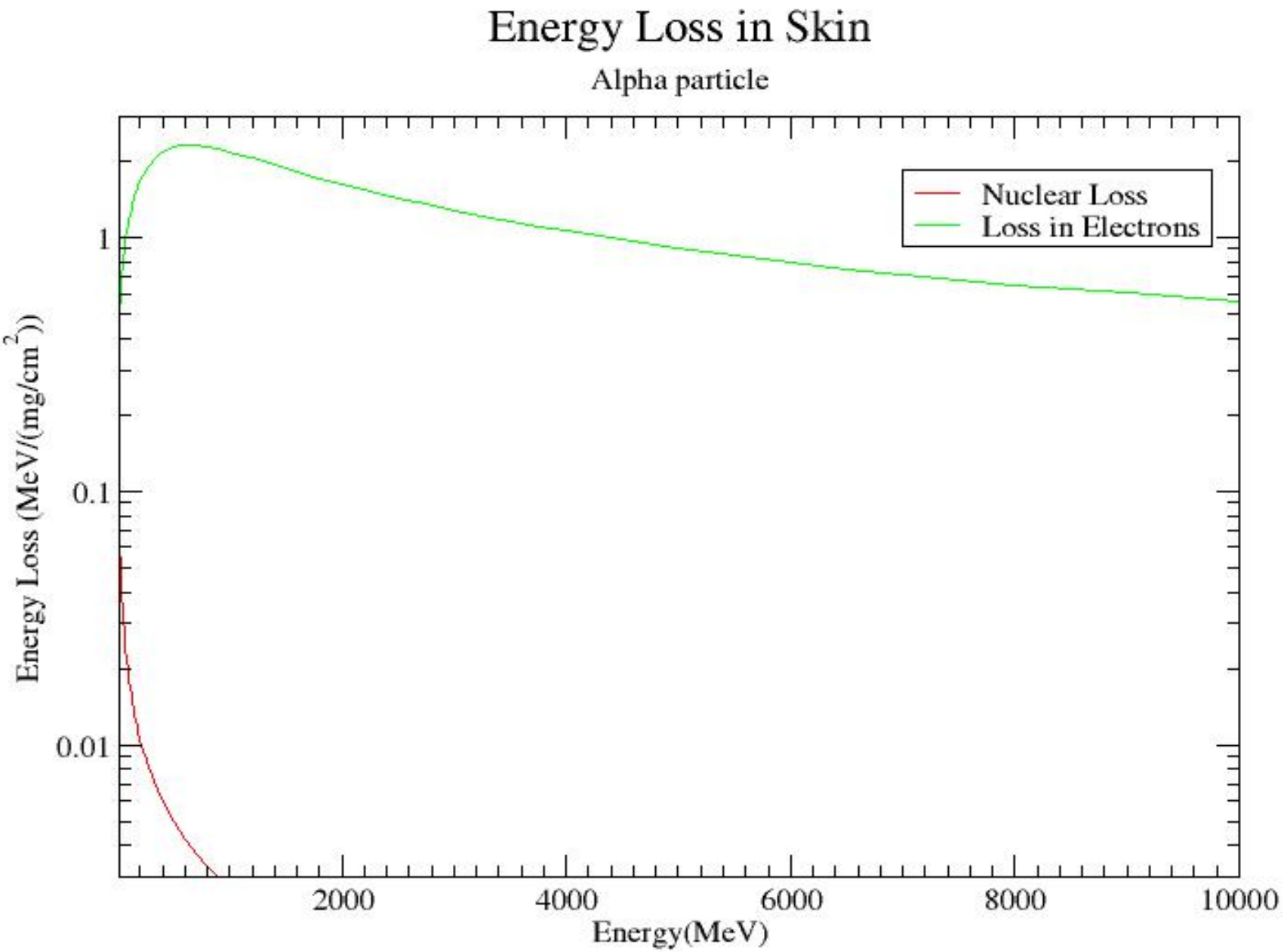
Gamma Interaction with Lead



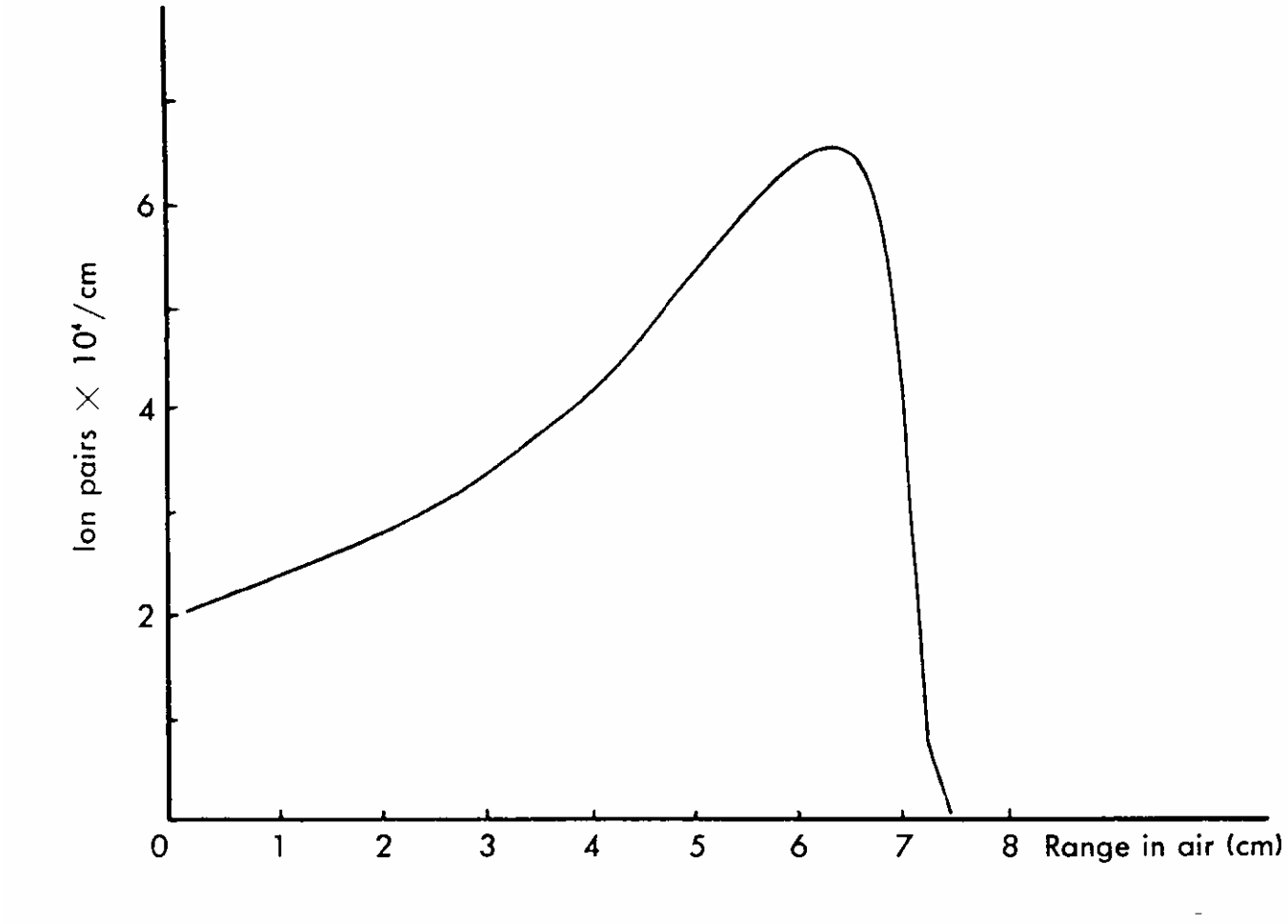
Electron Interactions



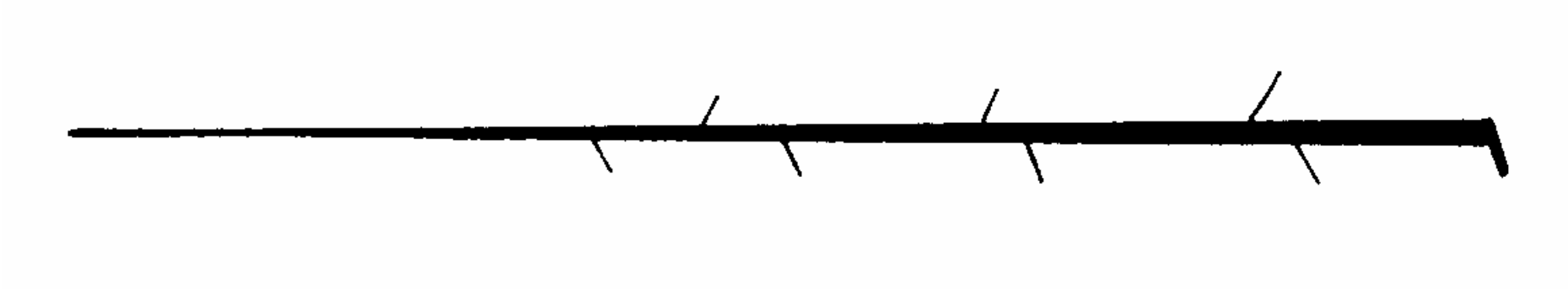

Energy Loss in Skin
Alpha particle
Loss in Electrons
Energy Loss (MeV/(mg/cm 2))
1
0.1
2000
4000
6000
8000
10000
Energy(MeV)


Energy Loss in Skin
Alpha particle
Nuclear Loss
Loss in Electrons
Energy Loss (MeV/(mg/cm 2))
1
0.1
0.01
2000
4000
6000
8000
10000
Energy(MeV)

Charged Particles Bragg Curve

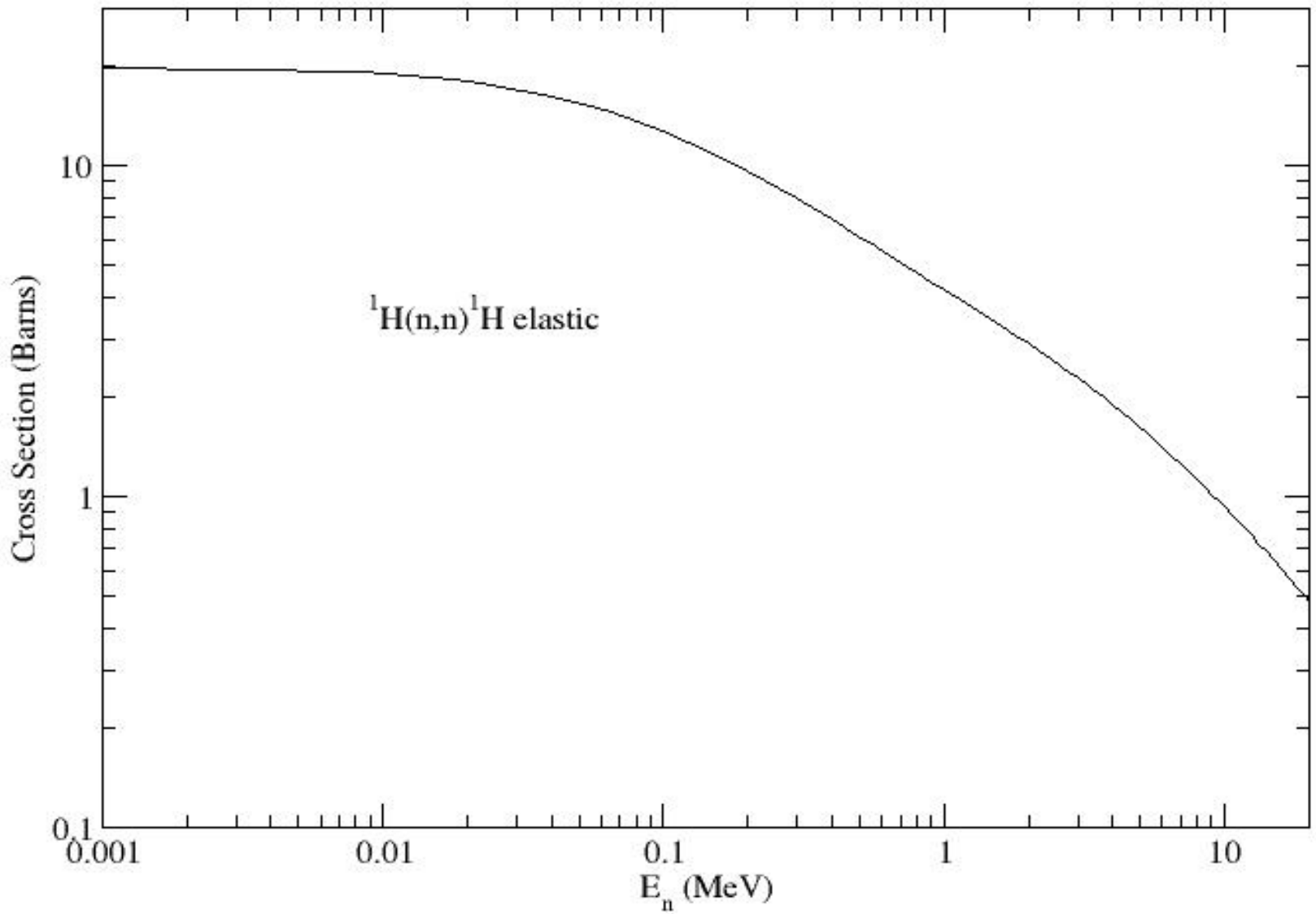


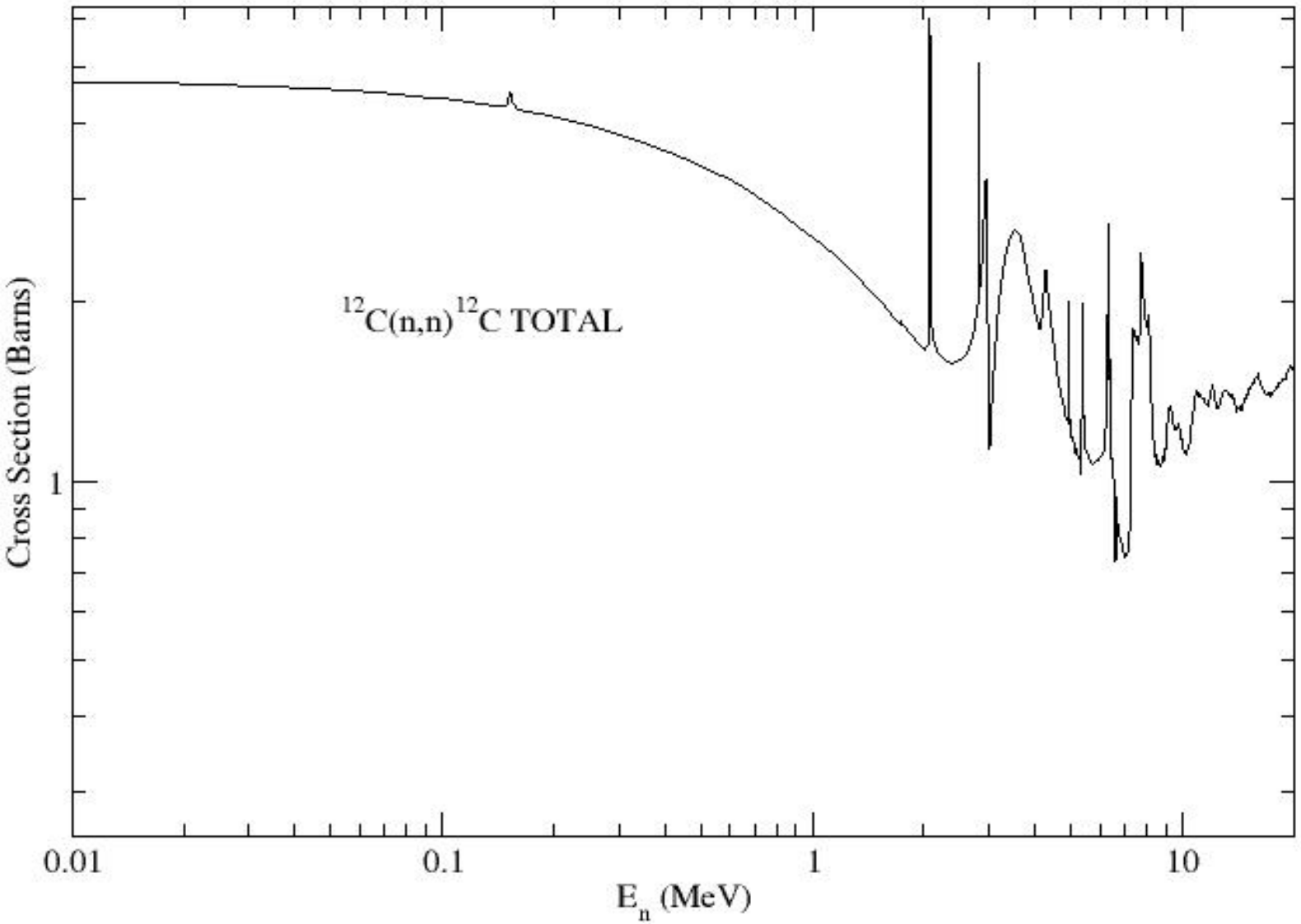
Charged Particle Track

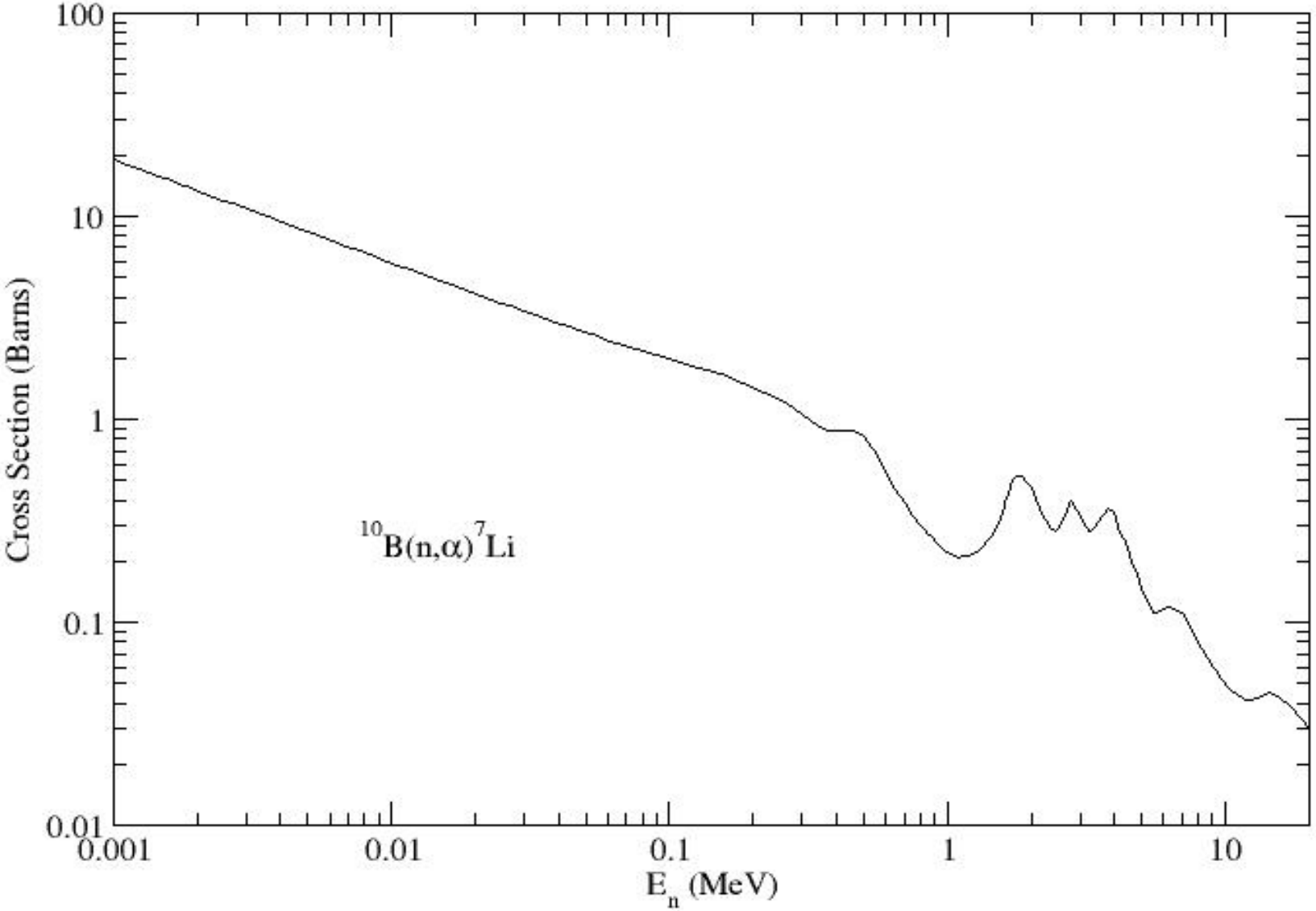


Neutron Interactions

- Energy loss by elastic scattering from the nuclei.
- Maximum energy loss is inversely proportional to the mass.
- Neutron reactions (n,γ), (n,n'), (n,2n), (n,Z) are all energy dependent.
- A large mass of low Z material needed for shielding.


Cross Section (Barns)
10
1
0.1
0.001
0.01
0.1
1
10
E_n (MeV)
1H(n,n)1H elastic


Cross Section (Barns)
1
$^{12}C(n,n)^{12}C$ TOTAL
0.01
0.1
1
10
E_n (MeV)


100
10
1
0.1
0.01
0.001
0.01
0.1
1
10
Cross Section (Barns)
$^{10}B(n,\alpha)^{7}Li$
E_n (MeV)

Chernenkov Radiation

- If a charged particle is traveling faster than the local speed of light, a cone of light is emitted at an angle to the charged particles.
- This light is in the blue region of the spectrum.
- This energy loss in non-ionizing.

Dose Review

- Dose is the energy deposited per kilogram of mass.
- Energy from radiation only deposited if it interacts with the material.
- Only the amount of energy which stays in the material is important (eg. Compton Scattering).

Linear Energy Transfer

- Gammas and electrons must have the same LET since the energy depositions is from electrons.
- Neutrons, charged particles can have a higher LET but it is also energy dependent.
- Charged particles have their highest LET at the end of their range.

Modeling of Energy Transfer

- GIANT- CERN based code for modeling high energy experiments by Monte Carlo.
- MNCP- Neutron, electron, and photon code devised primarily for neutron scattering.
- PERIGRINE – Health physics code written by a group of Physicists at LLNL.

Module 3
Current Issues in Radiation Biophysics

- The biological effect of nuclear accidents.
- The occupational exposure.
- Natural sources of radiation in the environment and their effect on biological systems.
- Specific radiochemical effectiveness on causing damage to biological systems.

The biological effect of nuclear accidents.

- Chernobyl
- Three Mile Island
- Dirty bombs
- Japanese criticality accident at a Uranium retrocession site
- Hiroshima and Nagasaki atomic weapon sites
- Others?

The occupational exposure.

- Accelerator beams
- Tritium exposure
- Neutron exposure
- Gamma exposure
- Radionuclide you are working with.
- Radium Dial Painters
- Early Radiologists

Natural sources of radiation in the environment and their effect on biological systems

- Exposure of Flight crews to Cosmic Rays
- Monazite Sands
- Natural Reactor in Africa
- Radon gas in homes
- Background variation with geography

Specific radiochemical effectiveness on causing damage to biological systems.

- Iodine radionuclide
- Calcium (Ra, Sr) biological response
- Tritium exposure as hydrogen gas versus water.
- ^{210}Po used as poison for spies.