Lecture 3.2a Unclear Points:

In a direct collision with the nucleus you say the "incident particle is deflected." If a charged particle is deflected, why doesn't Bremsstrahlung occur?

In an elastic collision, there is no energy transfer to the nucleus. However, the incident particle is deflected and Bremsstrahlung is emitted.

In the derivation for change in momentum of the incident charged particle $\Delta p$ (slide 17) there is a factor of two that comes into the equation. Where does that factor come from?

The factor of 2 comes in on the previous slide, in which we integrate $\cos \theta$ from $-\pi/2$ to $+\pi/2$.

On slide 49 you talk about the term being very similar to that for pair production. Which term do you mean and why is it similar to pair production? I don't see the relationship.

The mass radiative stopping power is given by the equation

$$ S \rho |_{rad} = 4r_0^2 \frac{N_e Z E}{137} \left[ \log \left( \frac{2(E + \mu_0)}{\mu_0} \right) - \frac{1}{3} \right] $$

whereas the cross section for pair production is given by the equation

$$ \frac{d \kappa}{d \Omega} = \frac{Z^2 r_0^2}{137 \sqrt{2}} m_0^2 c^4 F_{pair} $$

In Bremsstrahlung production an electron interacts with Coulomb field of atom making transition between two energy states, emitting a photon. In pair production a photon is destroyed by interaction with the atomic Coulomb field producing a pair.

At a given incident particle energy, which one would have bigger energy loss? Proton beam or electron beam? I think it should be proton beam, since it has less radiative energy loss.

Amount of radiative energy loss is really not an issue here. Ionization density affects stopping power, and heavy charged particles are much more densely ionizing. Also, for heavy charged particles, stopping power decreases with energy whereas for electrons, stopping power essentially independent of energy.

For protons, mass collisional stopping power at 1 MeV is around 100 MeV cm$^2$g$^{-1}$, decreasing to constant value of 2 MeV cm$^2$g$^{-1}$ at 1000 MeV. For electrons, flattening at 2 MeV cm$^2$g$^{-1}$ occurs around 300 keV.

When protons come to a stop, do they always ultimately become hydrogen atoms?
The stopped protons protonate target molecules initiating chemical reactions. Hydrogen is only generated in free space where the protons can only combine with electrons.