$$\therefore\ n_e\Gamma_c = \frac{n_e\sigma}{mc}\int_0 d\nu\, U_\nu (h\nu - 4kT)$$

This expresses the net heating rate of the electrons taking into account heating by e⁻ recoil & cooling by inverse Compton scattering.

Note: this expression does not take into account KN x-section & stimulated scattering

This equation shows that there is a temperature T_c where Compton heating (by e⁻ recoil) & Compton cooling (by inverse scatterings) balance. This is the Compton temperature

$$4kT_c = \frac{\int d\nu\, h\nu\, U_\nu}{\int d\nu\, U_\nu}$$

This temperature only depends on spectral shape. e.g. for a Planck spectrum w/ BB temp kT_{BB}

$$kT_c \simeq 0.97\, kT_{BB}$$

Part II: ACCRETION PROCESSES

Accretion is the falling of material onto a central gravitating body. For a mass M & radius R_*, the grav. P.E. released per gram is $\Delta E_{acc} = \frac{GM}{R_*} \simeq 10^{20}\ \frac{\text{erg}}{\text{g}}$ for a NS w/ $R_* \sim 10\,\text{km}$ & $M \sim M_\odot$. Much of this energy will be released as radiation.

Compare to H→He in stars: $\Delta E_{nuc} = 0.007c^2 \simeq 6\times10^{18}$ erg g^{-1}

Clearly, accretion power is dependent on compactness $\left(\frac{M}{R_*}\right)$ and accretion rate ($\dot{M}$). BHs ; NSs are very important/luminous accreting sources.

Eddington Luminosity

Consider a H atom falling radially onto a BH w/ mass M_{BH}. The immediate surroundings of the BH are producing rad'n at a rate L (erg/s). What L is required to halt the H atom due to radiation pressure?

$$F_{grav} = F_{rad}$$

$$\frac{G M_{BH} m_p}{\cancel{r^2}} = P_{rad}\,(A_{H\text{-atom}}) = \frac{S}{c}\sigma_T = \frac{L^*}{4\pi \cancel{r^2} c}\sigma_T$$

$$\therefore L^* = \frac{4\pi c G M_{BH} m_p}{\sigma_T} = \text{Eddington Luminosity}$$

$$L_{Edd} = 1.3\times10^{38}\,\frac{erg}{s}\left(\frac{M_{BH}}{M_\odot}\right)$$

This assumes steady ; spherical accretion, but observationally no good example of a long-lived source above L_{Edd}.

L_{Edd} implies an upper-limit to the steady accretion rate $\dot{M}$.

If all the KE of infalling matter is released as radiation at the stellor surface

$$\Delta E_{acc} = \frac{GM}{R_*}$$

$$\Delta e = \frac{GMm}{R_*} \longrightarrow \frac{\Delta e}{\Delta t} = \frac{GMm}{R_* \Delta t}$$

then let $\Delta t \to 0$: $L_{acc} = \frac{GM\dot{M}}{R_*}$

$$L_{ac} = 1.3\times10^{36}\left(\frac{\dot{M}}{10^{16}\,\frac{g}{s}}\right)\left(\frac{M}{M_\odot}\right)\left(\frac{10\,km}{R_*}\right)\frac{erg}{s}$$