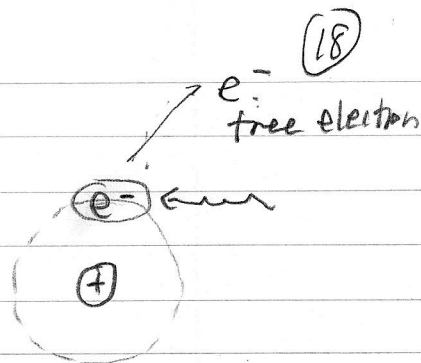


Nov. 13, 2012

* Bound-free Absorption K_{bf}

This is an ionization process:
electron in an atom in a bound state becomes free after absorbing the radiation



$$K_{bf} = 4 \times 10^{25} Z^2 (1+X) \rho T^{-3.5} \text{ cm}^2 \text{ g}^{-1} (4.63)$$

$$n=1, \quad s=3.5$$

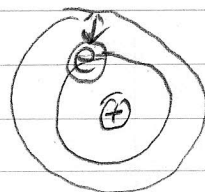
In low-temperature area close to the surface,
where neutral atoms start to form through recombination:

$$(n \sim 10^4 \text{ K})$$

* Bound-Bound absorption

photon induced transition between bound levels
in atoms, forming spectral lines.

In low temperature atmosphere



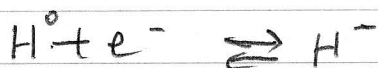
* H^- opacity

Hydrogen minus, also called metal hydrogen

When temperature is very low, e.g. $T = 2000 \text{ K}$,

H , He are neutral; $K_e = 0$, $K_{ff} = 0$, $K_{bf} = 0$.

Only metals are ionized, providing small amount of free e^- , which combine with H

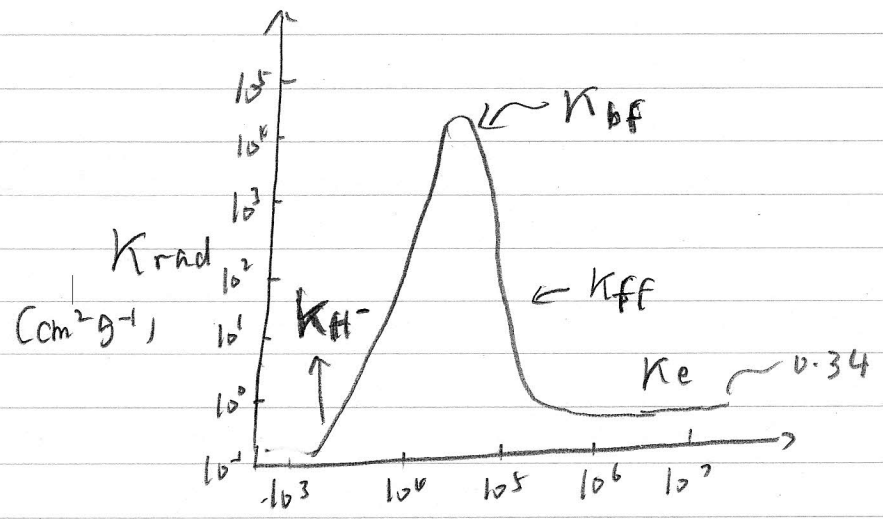
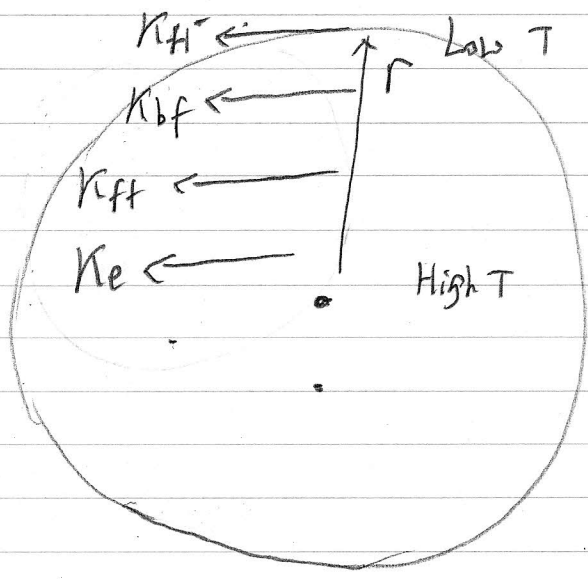


Ionization of H^- : 0.75 eV

(Ionization of H is 13.6 eV)

$$\kappa_{H^-} = 2.5 \times 10^{-31} \left(\frac{Z}{0.02} \right) \rho^{\frac{1}{2}} T^9 \text{ cm}^2 \text{ g}^{-1} \quad (4.65)$$

$$n = \frac{1}{2}, \quad s = -9$$



T
Fig. 4.2

κ can increase by 4-5 orders of magnitude when neutral atoms start to form.