Warm Ionized Medium of ISM

- The discovery of free-free absorption of the Galactic synchrotron background led to propose the existence of an extended layer of diffuse ionized gas, now known in the Milky Way and other galaxies as the warm ionized medium (WIM).
- It consists of a plasma with nearly fully ionized hydrogen which extends more than 1 kpc from the mid-plane.Temperature ranging from 8000 - 10000 k.
- **Absorption cross-section:**

$$\sigma = \sigma_0 (\frac{\nu_0}{\nu})^3 \tag{1}$$

Where:

$$\sigma_0 = 10^{-17} cm^2$$

  - There are two different processes involved in the warm H II region
    1. Photo-ionization
       * It involves the ionization of an atom with surplus of energy hv $(E > 13.6evforH)$ which leads to transfer of energy to ionized electron in form of kinetic energy.
       $$\mathrm{H} + hv(>= 13.6ev) \longrightarrow \mathrm{p}^+ + \mathrm{e}^-$$
    2. Recombination
       * The heating effect by ionization being balanced by cooling effect or the recombination of free electron being produced in ionization and the proton surrounding the H II region.
       $$\mathrm{p}^+ + \mathrm{e}^- \longrightarrow \mathrm{H} + hv$$

- **Volumetric rate of Recombination:**

$$r = \alpha_H * n_e * n_H \tag{2}$$

Where:

$$n_e \sim n_H = 10^2 - 10^4 cm^{-3}$$

$$\alpha_H(T) =< \sigma * v >$$

α_H is temperature dependent quantity.
σ is cross-section of interaction at a particular energy.
v is relative velocity between e^- and p^+.

Figure 1: Rossete Nebulae

- **Time Scale for recombination:**

$$\tau = (\frac{n_e}{r}) \tag{3}$$

Where:

'r' is the rate of recombination found out in equation 2.

At Steady State,

Rate of recombination(r) = Rate of ionization(n_{LY})

- **Stromgen Sphere:**

$$(\frac{4}{3}\pi r^3 \alpha_H n_e n_H) = N_{LY} \tag{4}$$

Where:

N_{LY} is the count of ionizing photon coming out of the star per sec.

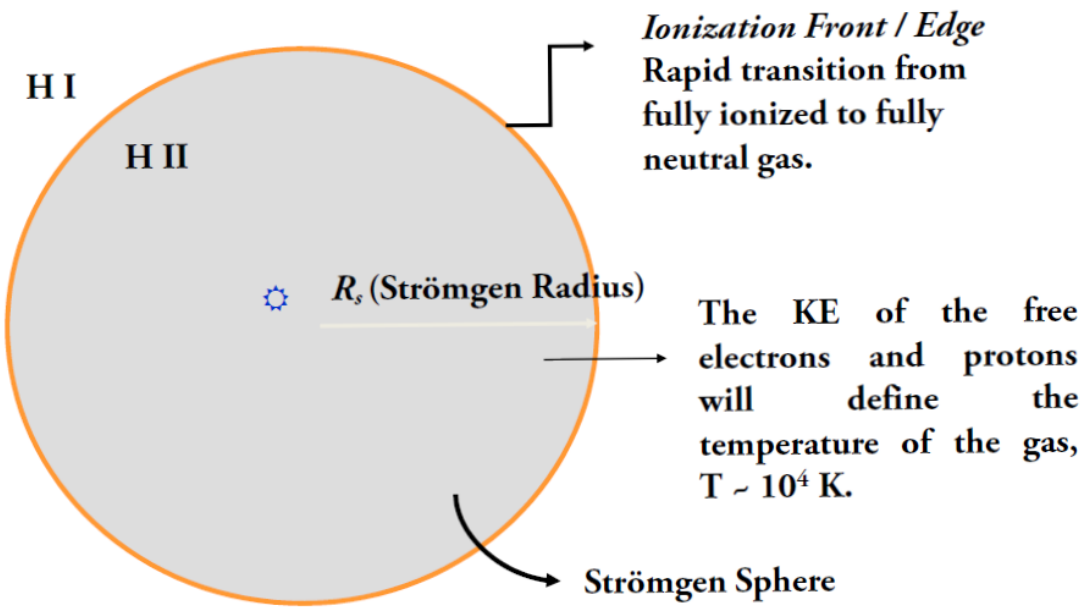

Figure 2: Stromgen Sphere

Stromgen Radius:

$$R_s = [\frac{3N_{LY}}{4\pi\alpha_H n_e n_H}]^{\frac{1}{3}} \tag{5}$$

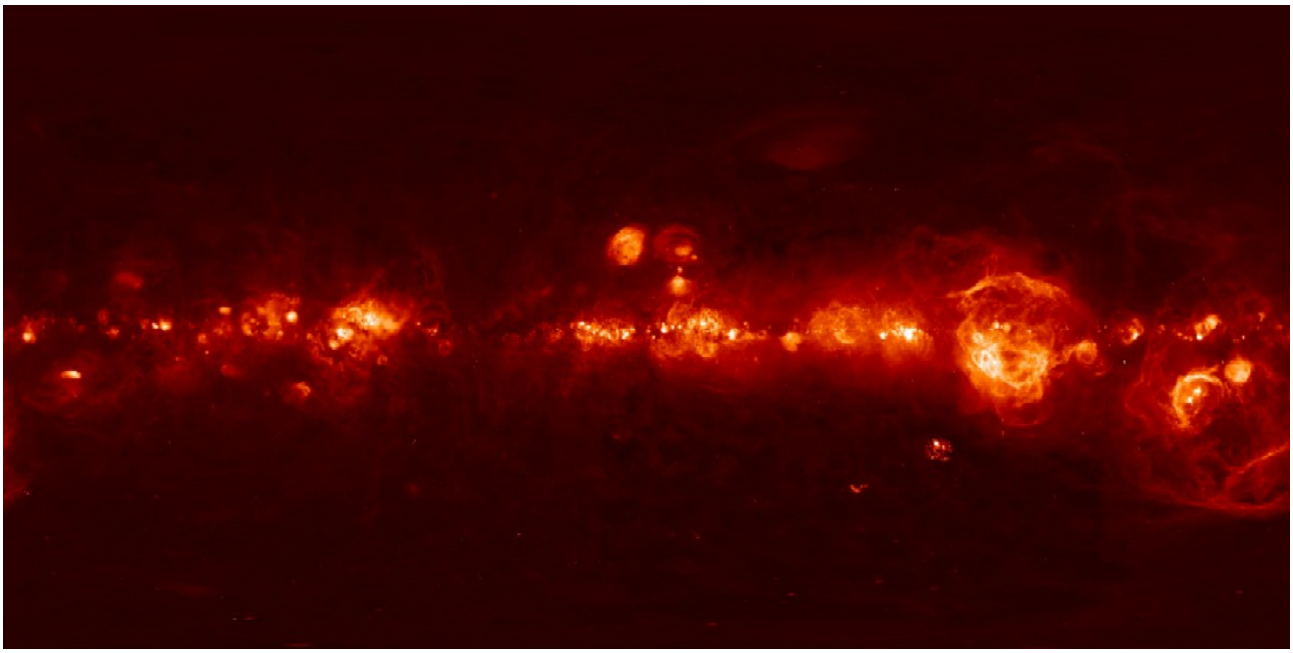

Figure 3: Composite image of the Galaxy taken in H by three different sky surveys; the Wisconsin H-Alpha Mapper WHAM, Virginia Tech Spectral-Line Survey (VTSS)and the Southern H-Alpha Sky Survey Atlas (SHASSA) Finkbeiner (2003)