Lecture 25 — dark cloud composition, proto star behaviour/evolution

Why cloud are completely opaque? and not just an absorption lines? ⇒ dust

The Mie theory

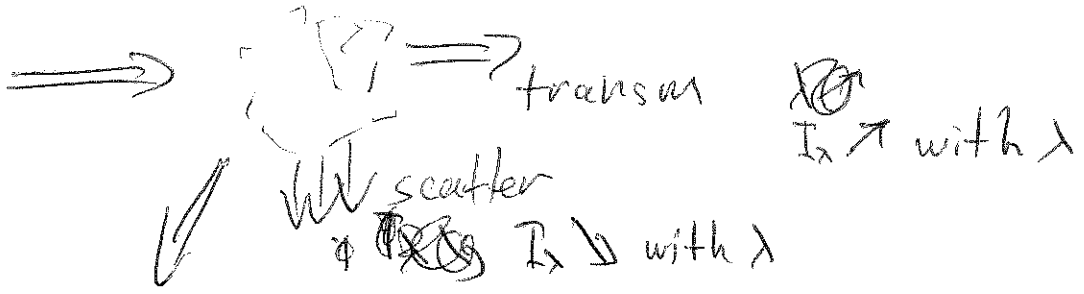
Optical depth $\tau_\lambda = \sigma_\lambda N_d$ ← column density

dust part size

$\sigma_\lambda \sim \frac{a^3}{\lambda}$, $\lambda \gtrsim a$ | $\sigma_\lambda \sim a^2$ $(\lambda \ll a)$

so bluish light absorbed stronger and transmitted appears reder

Scattered though is bluish



Sky is blue, sunset/sunrise is red

Cloud Composition - Inter stelar Medium (ISM)

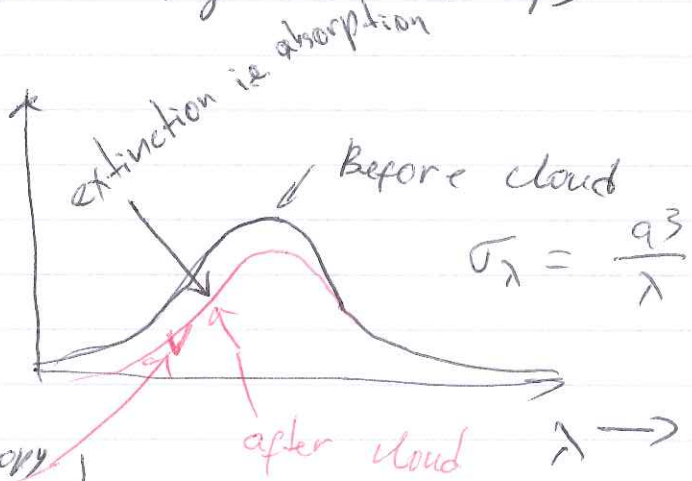
H - hard to detect but there is forbiden transition due to splitting of ground level (spin interaction)

at $\lambda = 21$ cm $\leftrightarrow$ $f \simeq 1.4$ GHz

H_2 - molecular hydrogen
only at high temperature $\gtrsim 2000$K when vibration band are exited

PAM - polycyclic aromatic hydrocarbons
↳ complex molecular
↙ resonance lines

Dust - big size clumps

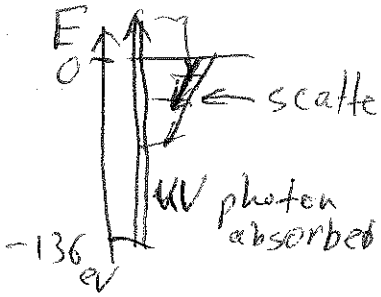


spectroscopy resonances hints on composition

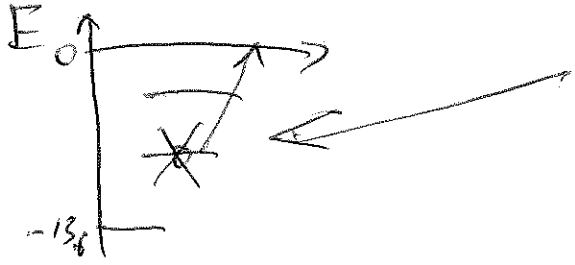
So spectrum is more red which need to be taken in account or thus give information on cloud composition

light after cloud is polarized $\Rightarrow$ need B field to orient molecular or dust

Emission nebula



they are not absorbed since we need electron not in ground state which is not possible in cold cloud



Size of Emission

U.V. photon gives $H\,II$ which recombines with e^- to give a photon

Absorption rate $(\alpha \cdot n_{H\,II} \cdot n_e) \cdot V = N_{UV}$

α: recomb coef; V: $\frac{4\pi}{3} R_{Nebula}$

$$R_{Nebula} = \left(\frac{N_{UV}}{\frac{4\pi}{3}\alpha}\right)^{1/2} (n_{H_{II}} \cdot n_e)^{-1/3}$$

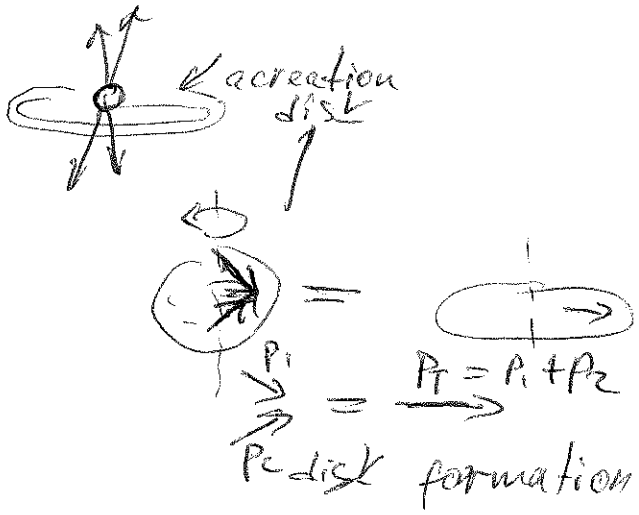
$n_{H_{II}} \cdot n_e \approx n_H^2$

$$= \left(\frac{3}{4\pi} N_{UV}\right) n_H^{-2/3}$$

Strömgren radius

Another option = angular momentum should be "droped" away

⇒ Jets



Another way to see it