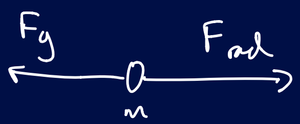
i)



$$F_g = \frac{G M_* m}{r^2}$$

$$m = \frac{4}{3}\pi a_b^3 \rho_d \qquad (i)$$

$$\therefore F_g = \frac{4}{3}\pi \rho_d \frac{G M_* a_b^3}{r^2}$$

$$F_{rad} = \frac{L}{4\pi r^2} \cdot p \cdot \frac{1}{h\nu} \cdot \pi a^2$$

($\frac{1}{h\nu}$: energy of photon; p: momentum of photon)

$$= \frac{L}{4\pi r^2} \cdot \frac{h}{\lambda} \cdot \frac{\lambda}{hc} \cdot \pi a^2$$

$$= \frac{L}{4 r^2 c} \cdot a^2$$

$$\beta \equiv \frac{F_{rad}}{F_g} = \frac{L}{4c} a^2 \cdot \frac{1}{G M_* m}$$

$$= \frac{L a^2}{4 c G M_* m}$$

Sub (i) : $\beta = \frac{3}{16\pi} \frac{L_*}{GM_* c} \cdot \frac{1}{a \rho_d}$

$a_{blowout}$ when $F_{rad}/F_g = 1$

$\therefore a_{blowout} = \frac{3}{16\pi} \frac{L_*}{M_*} \frac{1}{G c \rho_d}$ //

ii) if $a = 2a_{blowout}$

then $\frac{F_{rad}}{F_g} = \frac{1}{2}$, does not decrease with radius

K3 : $\frac{a^3}{P^2} \simeq \frac{GM}{4\pi^2}$

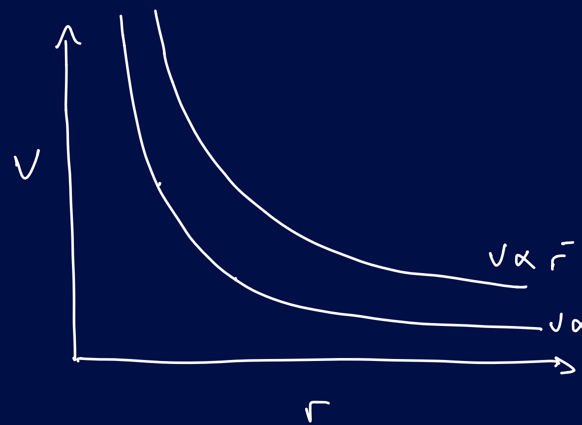
$v_k = (\mu/a)^{\frac{1}{2}}$

$v_k \propto a^{-\frac{1}{2}}$

Now, for grain partly supported by Frad

$\frac{mv^2}{r} = \frac{GMm}{2r^2}$

$v = \frac{\mu}{2r} = \frac{v_k}{2}$



iii) $n(a) \propto a^{-3.5}$

$$m(a) = n(a)\,\frac{4}{3}\pi a^3 \rho_d$$

$$n(a) = \frac{3}{4}\frac{m(a)}{\pi a^3 \rho_d}$$

So, $m(a) \propto a^{-0.5}$

Now $L_* \propto M_*^3$

and from above $a_{blowout} \propto \frac{L_*}{M_*}$

$\therefore a_{blowout} \propto M_*^2$

So for Stars of $1 M_\odot$ and $2 M_\odot$

$$a_{blowout}(2 M_\odot) = 4 a_{blowout}(1 M_\odot)$$

$$\frac{M_T(2 M_\odot)}{M_T(1 M_\odot)} = \frac{\int_{4a_b}^{1e6} a^{-0.5} \, da}{\int_{a_b}^{1e6} a^{-0.5} \, da}$$

$$= \frac{\left[2 a^{0.5}\right]_{4a_b}^{1e6}}{\left[2 a^{0.5}\right]_{a_b}^{1e6}}$$

$$= \frac{2e^3 - 2 a_b^{\frac{1}{2}}}{2e^3 - a_b^{\frac{1}{2}}}$$

Now, $a_b = \frac{3}{16\pi} \cdot \frac{4 \times 10^{26}}{2 \times 10^{30}} \cdot \frac{1}{2\pi \times 10^{-11} \, 3000 \cdot 3 \times 10^8}$

$\sim 1 \mu m$

$\therefore$ Insignificant difference in mass //