

HW 12 DUE NOW!

Please fill out student questionnaires (teaching/course)

REINDER: EXAM ONLINE FRIDAY 5/1 10:00 a.m. → 6:45 p.m. Submission deadline 7:00 p.m.

ecture Notes, HW + Sol, nidden + Sol, Books, your notes ⇒

E M A I L

types, distribution, properties, histories, final states etc. of stars ⇒ H. R. diagram; OBAF.

↳ Supernovae, planetary nebulae, neutron stars, black holes, pulsars, White dwarf, brown dwarf, Red Giants, SG

" " " " " " structure of galaxies ⇒ E2, S3, 1m; AGN

" " of Universe : Inflation → radiation dominated → baryon domination (nodes) → expansion → Genesis → first stars and galaxies → CMB → S

elementary particles, properties, reactions

First stars and galaxies

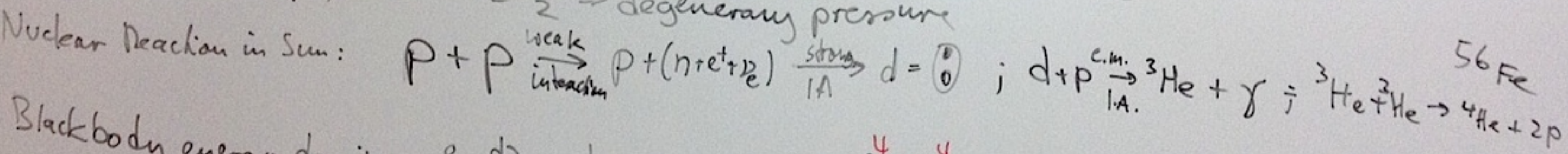
SR: time dilation $\sim \frac{1}{\sqrt{1-v^2/c^2}} \Rightarrow$ Red shift $\frac{\lambda_{obs}}{\lambda_{emit}} = \frac{1+v/c}{\sqrt{1-v^2/c^2}} = \sqrt{\frac{1+v/c}{1-v/c}} = \frac{z+1}{z}$ red shift

$E_{rest} = mc^2$ $E_{rel} = pc$ $general E = \sqrt{m^2c^4 + p^2c^2}$

Grav.: $\frac{v^2}{r} = \frac{GM}{r^2}$ circle orbit $\Rightarrow v \sim \frac{1}{\sqrt{r}}$; virial theorem; Tot grav. energy: $-\frac{3}{5} \frac{GM^2}{R}$ $\Delta E = \frac{3}{10} G \pi^2 \Delta$

G.R.: Time dilation for spherical BH: $\Delta t_{local} = \sqrt{1 - \frac{R_s}{r}} \Delta t_{\infty}$
 comoving coordinate $r_c \Rightarrow D = a(t) \cdot r_c$ $\frac{dD}{dt} = H(t) \cdot D$ $z = \frac{a(t_0)}{a(t_{emit})} - 1$
 critical density: $\rho_c = \frac{3H^2}{8\pi G}$ Today: $\rho(t_0) = \rho_c^{(0)}$

Qn photons: $E = hf$; $\Delta p \Delta x \geq \frac{\hbar}{2} \Rightarrow$ degeneracy pressure



Blackbody energy density: $\beta \pi \frac{d\omega}{\lambda^4} \frac{1}{e^{hc/\lambda kT} - 1} = \frac{8\pi k^3 T^3}{(hc)^3} \frac{dx}{x^4} \frac{1}{e^x - 1}$ $x = \frac{\lambda kT}{hc}$ $total E_{\text{avg}} \text{ density } \frac{4\sigma}{c} T^4$