AA472N / 672N End SEM. Exam.

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Name- Ankit Meena

Roll.No- 2003121002

I am Ankit Meena. Roll. No. - 2003121002 here by declear that during the course of this exam have not used any means of communication through phone, chat or any messaging VOIP of social media app to discuss regarding this exam with any human or any bot.

Ankit Meena

08-03-2021

Ankit Meena

2003121002

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Problem: 1

a) we know $\boxed{I_d(s) = I_d(0)\, e^{-\tau_d}}$ — (A)

The relation in terms of flux can be written -

$$\boxed{S_d(s) = S_d(0)\, e^{-\tau_d(h)}} \quad \text{— (B)}$$

where $S_d(s)$ = flux at distance s

$S_d(0)$ = flux without absorption

So apparent magnitude related to flux

$$m = -2.5 \log S + \text{const}$$

$$S \propto 10^{-0.4m}$$

Now $$\frac{S_d}{S_{d,0}} = 10^{-0.4(m-m_0)}$$

$$\frac{S_d}{S_{d,0}} = e^{-\tau_d} = 10^{-\log \tau_d}$$

then $$A_d = m - m_0 = -2.5 \log\left(\frac{S_d}{S_{d,0}}\right) = 2.5 \ln \tau_d$$

$$\boxed{A_d = 1.086\, \tau_d}$$

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(3)

1(b) use the tully-fisher relation to estimate the dpc →
we know the H-I line width W ~70 km/s
I can predict the absolute magnitude M. so
I can derive the distance to the galaxy using
the standard relation –

$$\boxed{M = m - 5\log_{10} D_{pc} + 5 - A} \quad (1)$$

~~in given question for H-band~~

~~$M_H = -9.50 (\log_{10} W - 2.50) - 21.67$~~

where – D_{pc} = distance in parsec
A = dust attenuation along the line of sight

To convert the measured H-I line width W
into an absolute magnitude in the H-Band
thus (in given question)

$$M_H = -9.50 (\log_{10} W - 2.50) - 21.67 \quad (2)$$

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where $w \simeq 70$ km/s

$\because$ we are dealing with flux measurement in the infrared, where the effects of dust. attenuation are typically very small

then neglect the attenuation correction A in equation (1) -

then $M = m - 5 \log_{10} D_{pc} + 5$

$$\Rightarrow \boxed{D_{pc} = 10^{\frac{M_H - m_H - 5}{-5}}} \quad (3)$$

from equation (2) $w \simeq 70$ km/s

$$M_H \simeq -9.50\,(\log_{10} 70 - 2.50) - 21.67 \simeq -15.44$$

$$M_H \simeq -15.44$$

from equation (3) put $M_H \simeq -15.44$, $m_H = 15.1$

then $D_{pc} = 10^{\frac{-15.44 - 15.1 - 5}{-5}} \simeq 12.8$ Mpc

$$\boxed{D_{pc} = 12.8 \text{ Mpc}}$$

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1(d)

Fundamental plane for elliptical galaxy:-

$\Rightarrow$ we get a relation between the surface brightness and effective radius

$$\boxed{R_e \propto \langle I_e \rangle^{-0.83}} \quad \text{— (A)}$$

where $\langle I_e \rangle$ = average surface brightness

effective radius -

$$\boxed{L = 2\pi R_e^2 \langle I_e \rangle} \quad \text{— (B)}$$

from (A) & (B) -

$$L \propto R_e^2 \propto \langle I_e \rangle \langle I_e \rangle^{-0.66}$$

so $\langle I_e \rangle \propto L^{-1.5}$. — (C)

Answer

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elliptical galaxies distribution in the 3-D diameter space (R_e, $\langle I_e \rangle$, σ_0) is located close to a plane define by –

$$\boxed{R_e \propto \sigma_0^{1.4} \langle \bar{I_e} \rangle^{0.85}} \quad (D)$$

where σ_0 = central velocity dispersion.

log form of $\langle R_e \rangle$ –

$$\boxed{\log R_e = 0.34 \langle M \rangle_c + 1.4 \log \sigma_0 + \text{const.}} \quad (E)$$

So

where $\langle M \rangle_c$ ~~is~~ average surface brightness in

R_e.

equation (E) defines a plane in 3D parameter space known as fundamental plane

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Problems 2 →

(a)

given in questions -

⇒ Coma cluster has a radial velocity = 6750 km/s.

⇒ Re → effective radius = 50'

⇒ 3-dimensional velocity dispersion = 900 km/s

R gravitation radius = 2.5 Reffective radius.

we know mass estimate

$$\boxed{M = \frac{R_G \langle v^2 \rangle}{G}}$$

Virial mass ⇒ $M_{vir} = \frac{3 R_{vir} \sigma_v^2}{G}$

where σ_v = velocity dispersion

$$M_{vir} = \frac{4\pi}{3} \cdot \Delta_c \cdot \rho_{cR} \cdot R_{vir}^3$$

$\Delta_c = 200$ & $\rho_{cr} = 10^{-26}$ kg/m³

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So equating the two relation ~~...~~ →

$$\frac{4\pi}{3} \times 200 \times 10^{-26} \times R_{vir}^3 = \frac{r_{vir} \times (900 \times 10^3)^2}{G}$$

$$r_{vir}^2 = \frac{(900 \times 10^3)^2 \times 3}{200 \times 4\pi \times 10^{-26} \times G}$$

$$r_{vir} = 1.45 \times 10^{27}$$

So using estimate mass (galaxy cluster).

$$M_{vir} = \frac{R_v \sigma_v^2}{G}$$

$$M_{vir} = \frac{(900 \times 10^3)^2 \times 1.45 \times 10^{27}}{6.67 \times 10^{-11}}$$

$$\boxed{M_{vir} = 1.76 \times 10^{27}}$$

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(9)

3(c)

given in question -

dishyes $\tau = 0.15 \tau_0$

$\Rightarrow \tau(t=0) = 0.15 \tau_0$

$\Rightarrow \tau(now) \simeq \tau_0$

& $\dfrac{mg(t=0)}{mg(t)} = \dfrac{50}{13}$

using $\rightarrow$ $\tau(t) = \tau(t=0) + p \ln \left[\dfrac{mg(t=0)}{mg(t)} \right]$

put above value -

$\tau_0 = 0.15 \tau_0 + p \ln [50/13]$

$\tau_0 = 0.15 \tau_0 + p(1.345)$

$p = \dfrac{\tau_0 - 0.15 \tau_0}{1.345} = 0.637 \tau_0$

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2003121002
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(d)

⇒ Synchrotron emission from a single ~~electron~~ electron

polarization is linear so-

we know

$$\frac{I_\perp}{I_{\parallel}} = \frac{\int_0^\infty [F(x) + G(x)]\,dx}{\int_0^\infty [F(x) - G(x)]\,dx}$$

where $I_\perp$ = perpendicular Component of Intensity

$I_{\parallel}$ = parallel component of the intensity,

the function obtained adding $I_{\parallel}(\omega)$ & $I_\perp(\omega)$

where $G(x)$ is obtained by subtracting $I_{\parallel}(\omega)$

from $I_\perp(\omega)$. then -

Also $$\int_0^\infty x^{\mu} f(x)\,dx = \frac{2^{\mu+1}}{(\mu+2)} \Gamma\left(\frac{\mu}{2} + \frac{7}{3}\right) \Gamma\left(\frac{\mu}{2} + \frac{7}{3}\right)$$

where Γ = gamma function

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$$\Rightarrow \int_0^\infty x^{\mu} G(x)\, dx = 2^{\mu} \Gamma\left(\frac{\mu}{2}+\frac{4}{3}\right) \Gamma\left(\frac{\mu}{2}+\frac{2}{3}\right)$$

then setting $\mu = 0$ we get -

$$\frac{I_\perp}{I_{\parallel}} = \frac{\Gamma(7/3)\Gamma(2/3)+\Gamma(4/3)\Gamma(2/3)}{\Gamma(7/3)\Gamma(2/3)-\Gamma(4/3)\Gamma(2/3)}$$

$$\frac{I_\perp}{I_{\parallel}} = \frac{\Gamma(2/3)\{\Gamma(7/3)+\Gamma(4/3)\}}{\Gamma(2/3)\{\Gamma(7/3)-\Gamma(4/3)\}}$$

$\therefore \Gamma(7/3) = \frac{4}{3}\Gamma(4/3)$

$$= \frac{\frac{4}{3}+1}{\frac{4}{3}-1} \frac{\Gamma(4/3)}{\Gamma(4/3)} = 7$$

$$\frac{I_\perp}{I_{\parallel}} = \frac{7}{1} \Rightarrow 7:1$$

fractional polarization is defined -

$$\Pi = \frac{I_\perp(\omega) - I_{\parallel}(\omega)}{I_\perp(\omega) + I_{\parallel}(\omega)} = \frac{G(x)}{F(x)}$$

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Now the electron have energy spectrum.

$$\boxed{N(E) = K E^{-p} dE}$$

So then

$$\Pi = \frac{\int_0^\infty G(x)\, x^{(p-3)/2}\, dx}{\int_0^\infty F(x)\, x^{(p-3)/2}\, dx}$$

$$\Pi = \frac{p+1}{4} \frac{\Gamma\left(\frac{p}{4} + \frac{7}{12}\right)}{\Gamma\left(\frac{p}{4} + \frac{19}{12}\right)} = \frac{p+1}{p+7/3}$$

$$\boxed{\Pi = \frac{p+1}{p+7/3}}$$

~~So for a typical values of p=2 then $\Pi = \frac{9}{13} \simeq 70\%$~~

~~So this is maximum value of linear polarization~~

~~[illegible] radiation is 70%~~

For so $p = 2$, then $\Pi = \frac{9}{13} \simeq 70\%$.

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Ankit Meena
2003121002

Problem : 5 :→

5 (b) Superluminal motion has been found to occur in many of celestial Bodies with relativistic ejecta.

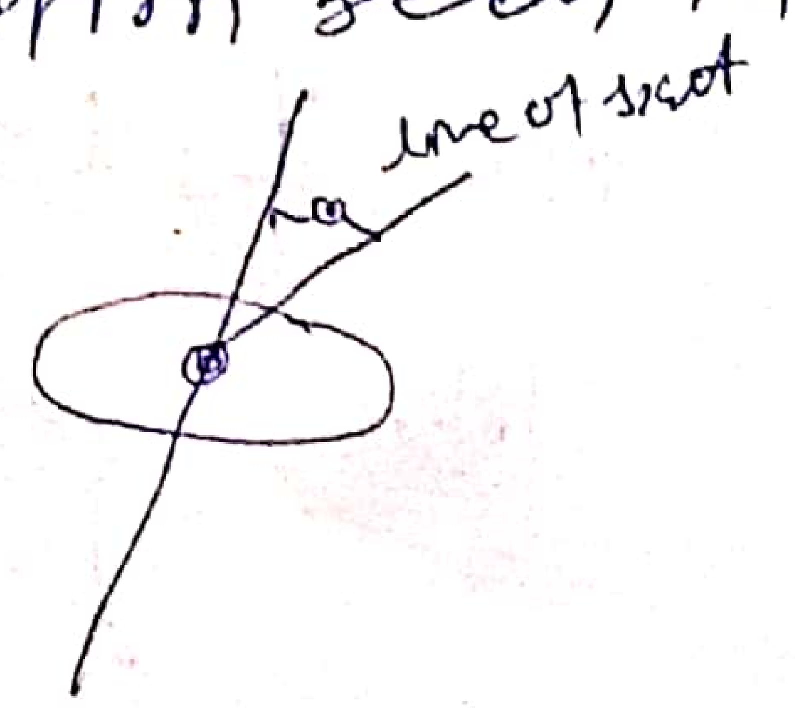
⇒ For some active galactic nuclei distribute around the line $\boxed{\beta_{app} = \delta}$

where β_{app} = apparent transverse velocity

δ = Doppler factor.

a weak correlation of β_{app} with δ in contrast β_{app} is positively correlated with Lorentz factor γ or $\gamma^2 (1+z)^{-1}$

⇒ In astronomy superluminal motion is the apparently faster than light motion seen in some radio galaxies.



$L_{app} = \delta^4 L$

$\delta = \gamma^{-1} / (1-\beta \cos(\theta))$

$\boxed{\beta_{app} = \beta \sin\theta / (1-\beta \cdot \cos\theta)}$ =

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5(b)

Flat spectrum radio quasars and Narrow-line Seyfert 1 (NLSI) →

⇒ AGNs can be divided according to the radio power as Radio-Loud and Radio-Quiet objects. Almost 10% of the AGNs are radio loud and all others fall in the category of radio-quiet objects

(1) radio Loud AGNs or Radio galaxies have emission line spectra similar to the Seyferts-1 but they are extremely Bright in the radio wavelength range

(2) AGNs with the broad permitted lines emerging from hot, high-velocity gas that is near the black hole are type-1 AGNs in the radio-quiet group. these include the Seyfert-I galaxies and higher-luminosity radio-quiet quasars

Astronomy

Ankit meena

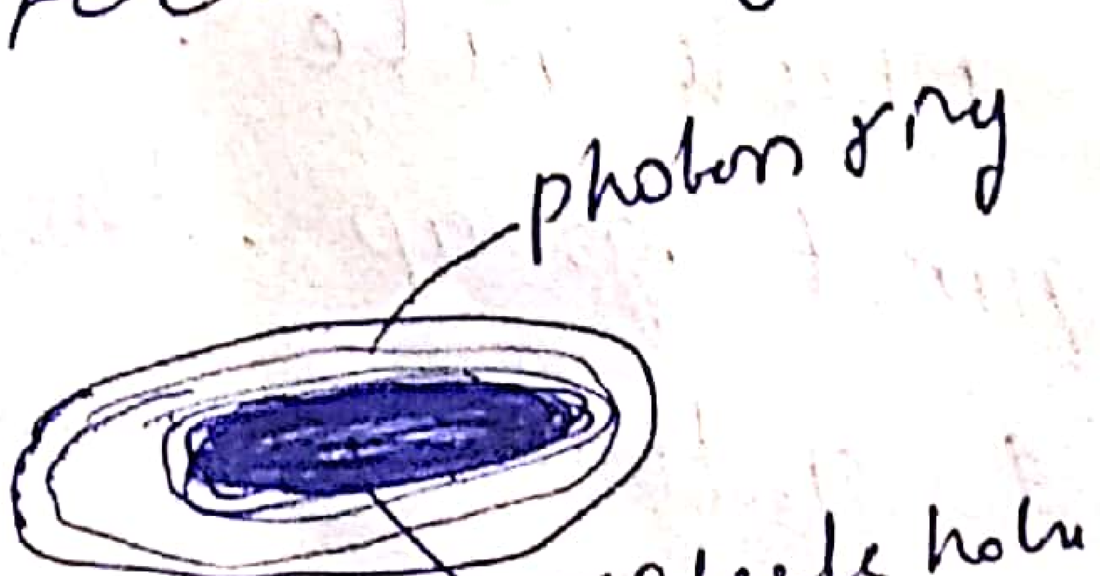
2003121002

5 (d)

M 87 - black hole image →

⇒ Supermassive black holes are bathed in glowing as that is heated to Billions of degrees. Because their extreme gravity traps light. So black holes cast a shadow on this bright emission. The shadow is surrounded by bright photon ring

⇒ The photon ring is composed of series of necessarily sharp subrings. Each subring n is produced by photons that travelled around the black hole ~~image~~ $\frac{n}{2}$ times. Before reaching the obscure. so these subring stack to give to the full image.



Black hole M-87