MSE-B AA674N/474N.
Ankitmeena
2003121002
Radio Astronomy

Problem : 1→

we know that luminosity of the
Black Body is –

$= 4\pi R^2 \sigma T^4$

$= 4 \times 3.14 \times (7 \times 10^8)^2 \times (5.67 \times 10^{-8})(10{,}000)^4$

~~= 4 × 3.14 × 49 × 10^16 × 10^16 × 5.67~~

$= 3.4895448 \times 10^{27}$ W.

$\simeq 3489.5 \times 10^{24}$ W

So then flux density at a distance of
3.3 parsec

$$F = \frac{\text{luminosity}}{4\pi d^2}$$

Amitoory

Ankit meena

2003121002

$$F = \frac{L}{4\pi d^2}$$

$$F = \frac{3489.5 \times 10^{24}}{4 \times 3.14 \times (10^{17})^2}$$

$$\boxed{F = 277.83 \times 10^{-10}\ \mathrm{W\,m^{-2}}}$$

for Black Body.

$$\lambda_{max}\ (\mathrm{mm}) = \frac{2.9}{T} = \frac{2.9}{10000}$$

$$\boxed{\lambda_{max}\ (\mathrm{mm}) = 2.9 \times 10^{-4}\ \mathrm{mm}}$$

$$\lambda_{max}\ (\mathrm{m}) = 2.9 \times 10^{-7}\ \mathrm{m}$$

so frequency corresponding to this

$$= \frac{3 \times 10^{6}}{2.9 \times 10^{-7}} = 1.03 \times 10^{18}\ \mathrm{Hz}$$

So then consistency of this frequency to be piece of frequency range for the observations are done -

$$\text{flux density} = \frac{277.83 \times 10^{-10}}{1.03 \times 10^{15}} \; W m^{-2} Hz^{-1}$$

$$\boxed{\text{flux density} \doteq 269.73 \times 10^{-25} \; W m^{-2} Hz^{-1}}$$

Answer

Ankit meena
2003121002

3

Problem: 2 →

given in question →

temperature of the CMB = 2.7 K

we know. Rayleigh - Jeans law is valid
when $h\nu << KT$

$$\boxed{\nu << \frac{KT}{h}}$$

then put value -

$$\nu << \left(\frac{1.38 \times 10^{-23} \times 2.7}{6.6 \times 10^{-34}} \right)$$

$$\nu << 6.463 \times 10^{10} \text{ Hz}$$

$$\boxed{\nu << 64.63 \text{ GHz}}$$

So this observing frequency should be most less than 64.63 GHz

Ankit Meena

2003121002

4

Problem : 3 →

given quantity $P = 1.2\ m^2 = 1.2 \times 10^{-19}\ W$

we know.

$A_{eff} = 1.22\ m^2$

$P = f_v\ A_{eff} \cdot \Delta\nu$ $\Rightarrow \Delta\nu = 2 \times 10^6\ Hz$

we can write →

(flux density) $\boxed{f_v = \dfrac{P}{A_{eff} \cdot \Delta V}}$

put these value -

$$F_v = \frac{1.2 \times 10^{-19}\ W}{1.2\ m^2 \times 2 \times 10^6\ Hz}$$

$$\boxed{\text{flux density } (f_v) = 5 \times 10^{-26}\ W\,m^{-2}\,Hz^{-1}}$$

Anubhav

Ankit meena

2003121002

(4)

Problems 5

5(a)

We know Brightness temperature

is -

$$T_B = \frac{\lambda^2 I_\nu}{2 K_B} \quad \text{--- (A)}$$

So Black Body $I_\nu = 4\pi B_\nu$

then $B_\nu(T) = \frac{2 K_B T}{\lambda^2} = \frac{2 \times 1.38 \times 10^{-23} \times 2400}{(15 \times 10^{-2})^2}$

$$\boxed{B_\nu(T) = 2.94 \times 10^{-18}\ J m^{-2}}$$

then $I_\nu = 2\pi B_\nu(T)$

$I_\nu = 4\pi \times 2.94 \times 10^{-18}\ J m^{-2}$

$I_\nu = 3.69 \times 10^{-17}\ J m^{-2}$ put value in (A) -

then -

$$T_B = \frac{(15 \times 10^{-2})^2 \times 3.69 \times 10^{-17}}{2 \times 1.38 \times 10^{-23}} = 3 \times 10^{4}\ K$$

Ankit meena
2003121002

5

5(b) given in question . $\Delta\nu = 2 \times 10^6$ Hz

We know flux density is -

$$\boxed{F_\nu = \frac{P}{A_{eff} \cdot \Delta\nu}} \quad \text{— (C)}$$

where $A_{eff} = \eta\, A_{geometric}$

$A_{eff} = 0.6 \times \pi \times 10^2$

$$\boxed{A_{eff} = 60\pi}$$

power → $P = K \Delta\nu T_{sys} = 100\ K\Delta\nu$.

So put value in equation (C)

Amisha

Ankit meena
2003121002

6

$$F_V = \frac{100 \text{ ke} \cancel{V}}{604 \ \cancel{A\nu}}$$

$$F_V = 7.32 \times 10^{-24} \text{ W } m^{-2} \text{ Hz}^{-1}$$

$$\boxed{F_V = 732.1 \text{ Jy}}$$

5(c)

use above

Antena temprature is -

$$T_A = \frac{A_{eff} \cdot F_V}{2k}$$

~~thus~~ put value A_{eff}, F_V -

$$T_A = \frac{604 \times 732.1 \times 10^{-26}}{2 \times 1.38 \times 10^{-23}}$$

$$\boxed{T_A \simeq 50 \text{ K}}$$

[illegible]

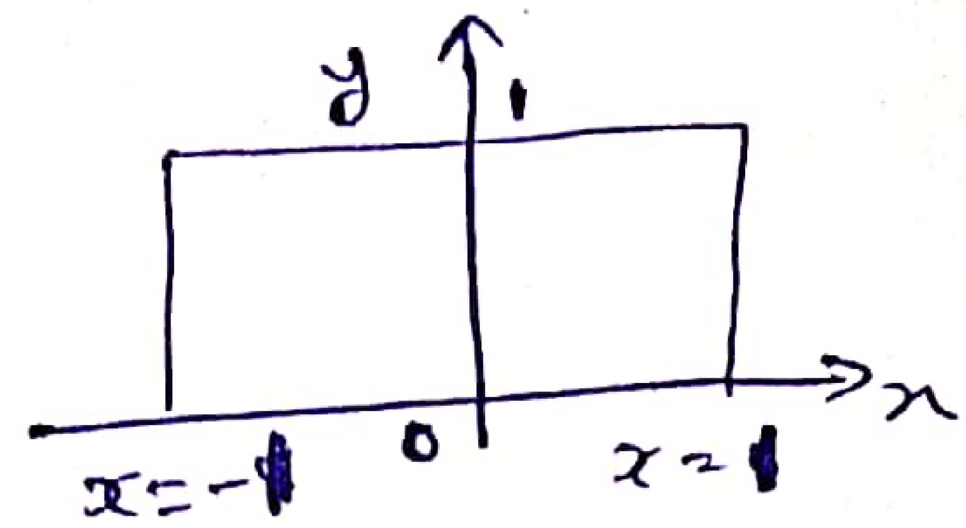
Ankit meena

2003121002

7

Problem: 6

$$F(x) = \begin{cases} 1, & |x| < a \\ 0, & |x| \geq a \end{cases}$$



using
The fourier transform of $f(x)$ is —

$$F\{f(x)\} = F(s) = \int_{-\infty}^{\infty} f(x)\, e^{isx}\, dx \quad \text{— (A)}$$

let $a = 1$ then $f(x) = \begin{cases} 1, & |x| < 1 \\ 0, & |x| > 1 \end{cases}$

then from equation (A) —

$$F\{F(x)\} = \int_{\infty}^{-1} F(x)\, e^{isx}\, dx + \int_{-1}^{1} F(x)\, e^{isx}\, dx$$

$$+ \int_{1}^{\infty} f(x)\, e^{isx}\, dx$$

Ankit Meena
2003121002

8

$$= \cancel{\int_{-\infty}^{-1} f(x)\, e^{isx}\, dx}^{\,0} + \int_{-1}^{1} f(x)\, e^{isx}\, dx + \cancel{\int_{1}^{\infty} f(x)\, e^{isx}\, dx}^{\,0}$$

$$F\{f(x)\} = \int_{-1}^{1} 1 .\, e^{isx}\, dx = \left| \frac{e^{isx}}{is} \right|_{-1}^{1}$$

$$F\{f(x)\} = \frac{e^{is} - e^{-is}}{is} = \frac{2\sin s}{s}$$

$$\Rightarrow \boxed{F\{f(x)\} = F(s) = \frac{2\sin s}{s}}$$

Ankit Meena
2003121002

9

Problem : 7 :→

given in questions →

Latitude of indore = 22.7196 0N

longitude of indore = 75.8577° E

LST = 5.98 Hrs

RA = 05 h, 55 m, 10.3 s.

Dec = + 07° 24' 25''

we know –

LST = HA → RA

HA = LST – RA

∴ 360 rotation = 24 hrs

1 hr → rotation

$= \left(\frac{360}{24}\right)^{\circ} = 15^{\circ}$

$\boxed{1\ hr = 15^{0}}$

HA = (5.98 – 5.919) hrs

HA = 0.061 hr

$\boxed{HA = 0.915^{0}}$

Ankit Meena
2003121002

then :

$$\boxed{\sin h = \sin\phi \sin\delta + \cos\phi \cos\delta \cos H} \quad (A)$$

where h is the altitude δ is the Declination
φ is the latitude & H is Hour Angle.

put these value in equation (A) -

$$\sin h = \sin(22.7196°) \sin(7.4069°) + \cos(22.7196°) \cos(7.4069°) \cos(0.915°)$$

$$\sin h = 4.979 \times 10^{-2} + 0.915$$

$$\sin h = 0.964$$

$$\Rightarrow h = \sin^{-1}(0.964)$$

$$\boxed{h = 74.66°}$$

Ankit Meena

2003121002

(11)

Also,

$$\sin A = \frac{-\cos\delta \sin H}{\cos h}$$

$\therefore A =$ Azimuth

$$\sin A = \frac{-\cos(7.4069°)\sin(0.915°)}{\cos(74.66°)}$$

$$\boxed{\sin A = -0.0548}$$

$\Rightarrow A = \sin^{-1}(-0.0548)$

$$\boxed{A = 183.43°}$$

So altitude of Betelgeuse star is true 74.66°.

& azimuth 183.43°

Amitmeena

Ankit Meena

2003121002

12

Problem: 8 →

~~we~~ we know trigonometric Parallax

so -

$1'' = 1 pc$

then

$2'' = \frac{1}{2} pc$

$2'' = 0.5 pc$

$2'' = (0.5 \times 3.086 \times 10^{16}) m$

$2'' = 1.54 \times 10^{16} m$

Ankit meena
2003121002

13

Problem: 9

· we know

Scale factor is defined -

$$S = 206265'' / F$$

So putting F = 10 m then.

$$S = 20.6265'' / mm$$

field of view of the system -

$$FOV = (90 \times 20.6265)'' \times (90 \times 20.6265)''$$

$$FOV = 1856.385'' \times 1856.385''$$

$$\boxed{FOV = 30.94' \times 30.94'}$$

Anitmeay

Ankit Meena
200312100Ž

14

Problem: 10 →

Image scale is -

$$S = \frac{206265''}{F}$$ wi. F = focal length

given f-ratio = 8

we know

$$f\text{-ratio} = \frac{\text{Focal length}}{\text{max aperture diameter}}$$

$$8 = \frac{F}{4}$$

$$\boxed{F = 32\ m}$$

image scale $S = \frac{206265}{32} = 6445.8''/m$

given ; 1 pixel size = 15 μm

in 1m, there are $\frac{1}{15 \times 10^{-6}} = 6.67 \times 10^{4}$ pixels

Anitesh

Ankit Meena
200312002

15

Image scale in arcsec / pixel =

$$\frac{6445.8}{6.67 \times 10^4} = 0.097''/\text{pixel}$$

⇒ The angular dimension of the sky observed

Setup for FOV →

$$(0.097 \times 2048)'' \times (0.097 \times 2048)''$$

$$\text{FOV} = 198.7'' \times 198.7''$$

$$\boxed{\text{FOV} = 3.31' \times 3.31'}$$