1)

Notes for Paper 49, Part 4

Assis' equation (3) is important because it computes the total flux received from the universe for n objects in a unit volume. Although not stated, the volume used by Assis is a sphere, and he integrates over the surface of a sphere of area $4\pi r^2$. The spherical polar coordinates are:

$$x = r\sin\phi\cos\theta \quad -(1)$$

$$y = r\sin\phi\sin\theta \quad -(2)$$

$$z = r\cos\phi. \quad -(3)$$

The surface element of the sphere is:

$$dS = \left| \frac{\partial \underline{r}}{\partial\phi} \times \frac{\partial \underline{r}}{\partial\theta} \right| d\phi\, d\theta. \quad -(4)$$

If

$$E = \frac{\partial \underline{r}}{\partial\phi} \cdot \frac{\partial \underline{r}}{\partial\phi} = r^2 \quad -(5)$$

$$G = \frac{\partial \underline{r}}{\partial\theta} \cdot \frac{\partial \underline{r}}{\partial\theta} = r^2 \sin^2\phi \quad -(6)$$

$$S = \int_0^{2\pi} d\theta \int_0^{\pi} r^2 \sin\phi\, d\phi \quad -(7)$$

$$= 4\pi r^2.$$

$$\boxed{\begin{aligned} &\underline{\text{Surface of a sphere}} = 4\pi r^2. \\ &\underline{\text{Volume of a sphere}} = \int_0^r 4\pi r^2\, dr = \frac{4}{3}\pi r^3 \\ &\underline{\text{Volume element}} = dV = r^2 \sin\phi\, dr\, d\phi\, d\theta \end{aligned}} \quad -(8)$$

2)

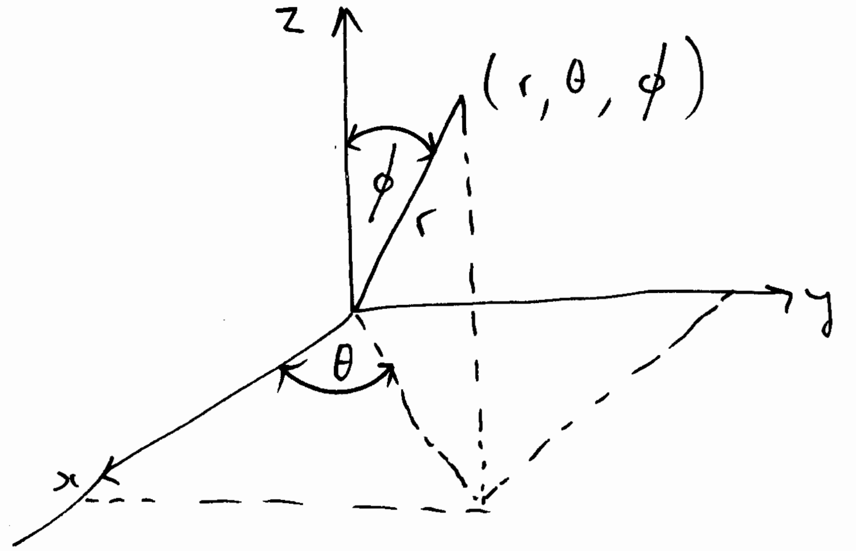

Fig (1)

Assis's equation (3) is then:

$$\langle F \rangle = \int_0^\infty \frac{\langle L \rangle}{4\pi r^2} \, n \, 4\pi r^2 \, dr \quad -(9)$$

$$= \int_0^\infty n \langle I \rangle . \, 4\pi r^2 \, dr \quad -(10)$$

where: $$\langle I \rangle = \frac{\langle L \rangle}{4\pi r^2} . \quad -(11)$$

Eq. (11) is the equation used in astronomy to relate the intensity I to the intrinsic luminosity L. The $4\pi r^2$ in the denominator is the surface of a sphere of radius r, the star being at the centre of the sphere. Therefore from eq. (7), eq. (9) is:

$$\boxed{\langle F \rangle = n \int_0^\infty r^2 I \, dr \int_0^{2\pi} d\theta \int_0^{\pi} \sin\phi \, d\phi} \quad -(12).$$

Therefore eq. (10) integrates over a sphere and eqn. (12) is equivalent to eqn. (10). These equations integrate over all the stars, galaxies, quasars, pulsars, dust and background radiation to obtain an average value for $\langle F \rangle$. The average temperature corresponding to this is 2.7 K. This is the average temperature of the universe (Regener, 1933).

It is seen that the limits of integration in eqn. (12) are ∞, 2π and π for r, θ and ϕ of Fig (1). Therefore the universe is considered as infinite in extent and spherical.

From eqn. (9):

$$\langle F \rangle = n \int_0^\infty \langle L \rangle \, dr \qquad \text{— (13)}$$

where:

$$\langle L \rangle = \langle L_0 \rangle e^{-\alpha r} \qquad \text{— (14)}$$

from the Beer–Lambert law. Therefore the luminosity observed at the telescope is observed after absorption over a path length r. Thus:

$$\langle F \rangle = n \langle L_0 \rangle \int_0^\infty e^{-\alpha r} \, dr$$

$$= - n \langle L_0 \rangle \frac{1}{\alpha} e^{-\alpha r} \Big|_0^\infty$$

$$\boxed{\langle F \rangle = \frac{n \langle L_0 \rangle}{\alpha}} \qquad \text{— (15)}$$

4) It is seen from eqn. (15) that the units of $\langle F \rangle$ are watts metres. This quantity is the heat reaching a detector from the average temperature of the universe, 2.7 K. It can also be calculated from the Stefan Boltzmann law. Equation (15) is very important because it shows that absorption is an intrinsic process of cosmology. Light reaching a telescope, or black body radiation reaching a telescope, has always been absorbed. The root cause of this absorption is gravitation. The power absorption coefficient α must always therefore be calculated from a unified field theory, and not a theory of gravitation only.

Integration over a Cone or Solid Angle

If a single distant object is being observed, then:

$$n = 1, \quad r \rightarrow \infty, \quad \theta = \theta, \quad \phi = \phi$$

and eqn. (12) becomes:

$$\langle F \rangle = \int_0^\infty I \, dr \int_0^\theta d\theta \int_0^\phi \sin\phi \, d\phi \quad -(16)$$

$$\boxed{\langle F \rangle = \frac{\langle L_0 \rangle}{\alpha} \cdot \frac{1}{4\pi} \int_0^\theta d\theta \int_0^\phi \sin\phi \, d\phi} \quad -(17)$$

5) Eqn. (17) is for one object, such as the sun, sending a cone of radiation into a telescope. However, in deriving eqn. (17) we have assumed:

$$r \to \infty. \quad — (18)$$

More accurately:

$$\boxed{\langle F \rangle = \langle L_0 \rangle \int_0^r e^{-\alpha r} dr . \frac{1}{4\pi} \int_0^\theta d\theta \int_0^\phi \sin\phi \, d\phi} \quad — (18)$$

For the sun:

$$\boxed{r = 93 \text{ million miles.}}$$

and parallax gives the angle θ and ϕ.

Notes

1) $$\int_0^{2\pi} d\theta \int_0^\pi \sin\phi \, d\phi = 4\pi.$$

2) $$d\Omega = \sin\phi \, d\phi \, d\theta$$

is the infinitesimal of the solid angle.