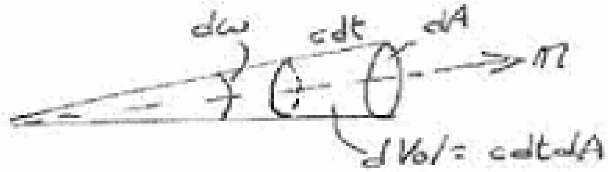
APPENDIX C

Energy density u_λ



Let $dE_\lambda dt$ = energy passing thru dA within solid angle $d\omega$ in time dt.

where $d\omega = \sin\theta\, d\theta d\phi$. From (1-1) with $\cos\theta = 1$

$$dE_\lambda dt = I_\lambda\, d\omega\, dA dt,$$

$$du_\lambda = \frac{dE_\lambda dt}{dV} = \frac{I_\lambda d\omega\, dAdt}{c\,dtdA} = \frac{I_\lambda d\omega}{c}$$

$$u_\lambda = \int du_\lambda = \int \frac{I_\lambda d\omega}{c},$$ where the integral on the left is over all solid angles.

For I_λ isotropic, $u_\lambda = \frac{I_\lambda}{c}\int d\omega = \frac{4\pi}{c} I_\lambda$

Now from (1-6) $F_\lambda = \pi I_\lambda$

so $u_\lambda = \frac{4}{c} F_\lambda$

Then $u_{bol} = \frac{4}{c}\int_0^\infty F_\lambda d\lambda = \frac{4}{c} F_{bol}$

Furthermore, from electromagnetic theory, u_λ due to an electric field is $1/2\,\epsilon E^2$ for SI units. Here E is the elecric field, not energy as used above.

There is a factor of $1/4\pi$ for cgs units and if $\epsilon = 1$, then

$$u_\lambda = \frac{E_\lambda^2}{8\pi}$$