```
Ae := 0.09754278180 (*eV^0.9 cm^-3*)
κ := 0.17
Eerep := 511 000 (*eV*)
Eemin := 1 × 10^6 (*eV*) (*1MeV*)
Eemax := 3.176 * 10^13 (*eV*)
α := 1.9
fvol := 0.16
pc2cm := 3.0857 × 10^18
Rout := 10 * pc2cm (*cm*)
Rin := 7.5 * pc2cm (*cm*)
V := 4/3 π (Rout^3 - Rin^3)
k := 8.61 * 10^-5;    (*eV/kelvin*)
T := 2.7 (*Kelvin*)
h := 4.13 * 10^-15 (*eV s*)
σT := 0.66 × 10^-24 (*cm^2*)
Area := 4 * π * (Rout^2 - Rin^2)
erg2ev := 6.24 * 10^11
c := 3 * 10^10 (*cm/s*)
```

$$\epsilon ph[Eph\_] := \frac{Eph}{Eerep}$$

$$\epsilon \gamma[E\gamma\_] := \frac{E\gamma}{Eerep}$$

$$\gamma[Ee\_] := \frac{Ee}{Eerep}$$

$$x[Ee\_, Eph\_, E\gamma\_] := \frac{\epsilon \gamma[E\gamma]}{4 \, \epsilon ph[Eph] \, \gamma[Ee]^2 \left(1 - \frac{\epsilon \gamma[E\gamma]}{\gamma[Ee]}\right)}$$

```
P[Ee_, Eph_, Eγ_] :=
```
$$HeavisideTheta[1 - x[Ee, Eph, E\gamma]] \, HeavisideTheta\left[x[Ee, Eph, E\gamma] - \frac{1}{4 \, \gamma[Ee]^2}\right]$$

$$f[Ee\_, E\gamma\_, Eph\_] := \Big(2 \, x[Ee, Eph, E\gamma] \, Log[x[Ee, Eph, E\gamma]] + x[Ee, Eph, E\gamma] + 1 - $$
$$2 \, x[Ee, Eph, E\gamma]^2 + \big((4 \, \epsilon ph[Eph] \, \gamma[Ee] \, x[Ee, Eph, E\gamma])^2 \, (1 - x[Ee, Eph, E\gamma])\big)\Big/$$
$$\big(2 \, (1 + 4 \, \epsilon ph[Eph] \, \gamma[Ee] \, x[Ee, Eph, E\gamma])\big)\Big) \, P[Ee, Eph, E\gamma]$$

$$\sigma IC[Ee\_, E\gamma\_, Eph\_] := \frac{3 \, \sigma T}{4 * Eerep * \epsilon ph[Eph] \, \gamma[Ee]^2} \, f[Ee, E\gamma, Eph]$$

$$Iic[Ee\_] := Ae * Ee^{-\alpha} * e^{-\frac{Ee}{Eemax}}$$

$$nBB[Eph\_] := \frac{8 * \pi}{(h * c)^3} * Eph^2 \left(e^{\frac{Eph}{k*T}} - 1\right)^{-1}$$

```
Plot[Log10[(10^Eɣ)² * fvol * V * c/(4 π) * NIntegrate[
    NIntegrate[nBB[Eph] * σIC[Ee, 10^Eɣ, Eph], {Eph, 0, 100 * k * T}, AccuracyGoal → 15] *
      Iic[Ee], {Ee, Eemin, 10 * Eemax}, MaxRecursion → 20] / erg2ev],
  {Eɣ, 6, 15}, PlotPoints → 10, Frame → True, FrameLabel →
   {"Log Eɣ [eV]", "Log Lɣ^IC[erg/s]"}, Axes → False]
```

NIntegrate::inumr : The integrand

$$\left(1.70794\,\text{Eph} \ll 1 \gg \ll 1 \gg \left(1 + \frac{5.0231 \times 10^{11}\left(1 - \frac{\ll 22 \gg}{\ll 1 \gg}\right)}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)^2 \left(1 + \frac{1.00231 \times 10^6}{\text{Plus}[\ll 2 \gg]\,\text{Ee}}\right)\text{Ee}^2} - \frac{\ll 22 \gg}{\ll 1 \gg^2 \ll 1 \gg \ll 1 \gg} + \frac{6.54309 \times 10^{16}}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}} + \right.\right.$$

$$\left.\left.\frac{1.30862 \times 10^{17}\,\text{Log}\left[\frac{6.54309 \times 10^{16}}{(1 + \text{Times}[\ll 2 \gg])\,\text{Ee}^2\,\text{Eph}}\right]}{\left(1 - \frac{1.00231 \times 10^6}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}}\right)\right) \Big/ \left(\left(-1 + e^{4301.63\,\text{Eph}}\right)\text{Ee}^2\right) \text{ has}$$

evaluated to non–numerical values for all sampling points in the region with boundaries {{0, 0.023247}}. ≫

NIntegrate::inumr : The integrand

$$\left(1.70794\,\text{Eph} \ll 1 \gg \ll 1 \gg \left(1 + \frac{5.0231 \times 10^{11}\left(1 - \frac{\ll 22 \gg}{\ll 1 \gg}\right)}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)^2 \left(1 + \frac{1.00231 \times 10^6}{\text{Plus}[\ll 2 \gg]\,\text{Ee}}\right)\text{Ee}^2} - \frac{\ll 22 \gg}{\ll 1 \gg^2 \ll 1 \gg \ll 1 \gg} + \frac{6.54309 \times 10^{16}}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}} + \right.\right.$$

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evaluated to non–numerical values for all sampling points in the region with boundaries {{0, 0.023247}}. ≫

NIntegrate::inumr : The integrand

$$\frac{1}{\left(-1 + e^{4301.63\,\text{Eph}}\right)\text{Ee}^2}1.70794\,\text{Eph} \ll 1 \gg \ll 1 \gg \left(1 + \frac{5.0231 \times 10^{11}\left(1 - \frac{\ll 22 \gg}{\ll 1 \gg}\right)}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)^2 \left(1 + \frac{1.00231 \times 10^6}{\text{Plus}[\ll 2 \gg]\,\text{Ee}}\right)\text{Ee}^2} - \frac{\ll 22 \gg}{\ll 1 \gg^2 \ll 1 \gg \ll 1 \gg} + \right.$$

$$\left.\frac{6.54309 \times 10^{16}}{\left(1 - \frac{\ll 22 \gg}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}} + \frac{1.30862 \times 10^{17}\,\text{Log}\left[\frac{6.54309 \times 10^{16}}{(1 + \text{Times}[\ll 2 \gg])\,\text{Ee}^2\,\text{Eph}}\right]}{\left(1 - \frac{1.00231 \times 10^6}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}}\right) \text{ has evaluated to}$$

non–numerical values for all sampling points in the region with boundaries {{0, 0.023247}}. ≫

General::stop : Further output of NIntegrate::inumr will be suppressed during this calculation. ≫
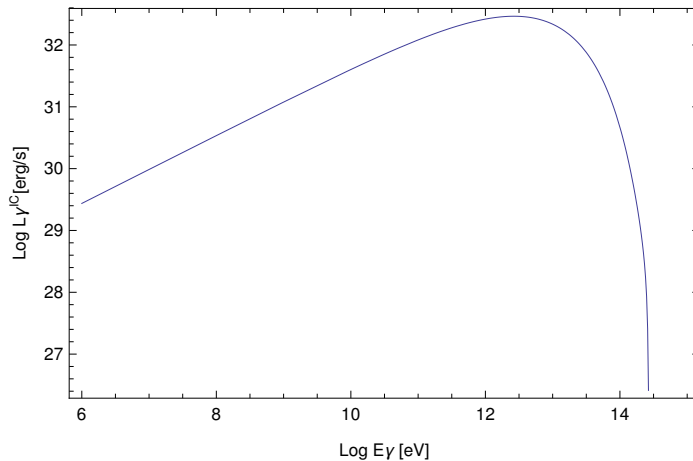
# En Ergios

```
erg2ev := 6.24 * 10^11
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```