SED

```
e := 4.8 * 10^-10        (*StatCoulomb*)
Bcgs := 7 * 10^-6          (*Gauss=cm^(-1/2) g^(1/2) s^-1*)
Bsi := 7 * 10^-10          (*Tesla*)
mc2 := 511 000             (*eV*)
m := 9.1 * 10^-28           (*g*)
c := 3 * 10^10              (*cm/s*)
h := 6.63 × 10^-27        (*ergios s*)
pc2cm := 3.0857 × 10^18
Rout :=  10 * pc2cm(*cm*)
Rin :=  7.5 * pc2cm(*cm*)
Dsrn := 1000 * pc2cm
f2L := 4 * π * Dsrn^2  (*factor para pasar de flujo a luminosidad en tabla *)
V := 4/3 * π * (Rout^3 - Rin^3)  (*cm^3*)
fvol := 0.16
α := 1.9
A := 2.36 × 10^-12  (*en cgs*)
CC := 1.85    (*viene de la aproximacion bessel*)
Eemaxev := 3.176 * 10^13       (*eV*)
Eeminev := 1 * 10^6             (*= Eph/Ec    eV*)
Eemaxerg := 3.176 * 10^13 * 1.602 * 10^-12      (*ergios*)
Eeminerg := 1.61 * 10^-6           (*ergios*)
erg2ev := 1 / ev2erg
ev2erg := 1.602 * 10^-12
Ae :=  0.0975 (*ev^0.9 cm^-3*)
Eemax := 3.176 * 10^13 (*eV*)
β := 1/137
re := 2.8179 * 10^-13   (*cm*)
n := 0.011 (*cm^-3*)
κ := 0.17
Eerep := 511 000 (*eV*)
Eemin := 1 × 10^6 (*eV*)(*1MeV*)
k := 8.61 * 10^-5;    (*eV/kelvin*)
T := 2.7 (*Kelvin*)
hev := 4.13 * 10^-15 (*eV s*)
σT := 0.66 × 10^-24 (*cm^2*)
Eprep := 938 257 × 10^3 (*eV*);
Eπrep :=  139 600 × 10^3(*eV*);
Epmax := 2.5553 × 10^13 (*eV*);
Ap := 42.5397818502(*eV^0.9 cm^-3*);


(*Sincro*)
```

$$PP[Eph\_, Ee\_] := \frac{\sqrt{3} * \pi * e^3 * Bcgs}{h * m * c^2} * CC * \left(\frac{Eph}{\frac{3}{4\pi} * \frac{e*h*Bcgs}{m*c} * \left(\frac{Ee}{m*c^2}\right)^2} \right)^{\frac{1}{3}} * e^{-\left(\frac{Eph}{\frac{3}{4\pi} * \frac{e*h*Bcgs}{m*c} * \left(\frac{Ee}{m*c^2}\right)^2} \right)}$$

$$NSinc[Ee\_] := A * Ee^{-\alpha} * e^{\frac{-Ee}{Eemaxerg}}$$

```
P[Eph_] :=
 NIntegrate[PP[Eph, Ee] * NSinc[Ee], {Ee, Eeminerg, Eemaxerg}, AccuracyGoal → 12]
```

$$L[Eph\_] := Eph * P[Eph] * V * fvol$$

(*Brems*)

$$\sigma[E\gamma\_, Ee\_] := \frac{4 * \beta * re^2}{E\gamma} * \phi[E\gamma, Ee] * ev2erg \ (*cm\text{^}2 \ eV\text{^}-1*)$$

$$\phi[E\gamma\_, Ee\_] := \left(1 + \left(1 - \frac{E\gamma}{Ee}\right)^2 - \frac{2}{3} * \left(1 - \frac{E\gamma}{Ee}\right)\right) * Log[191] + \frac{1}{9} * \left(1 - \frac{E\gamma}{Ee}\right)$$

$$I1[Ee\_] := \frac{c}{4\pi} * Ae * Ee^{-\alpha} * e^{\frac{-Ee}{Eemax}}$$

(*IC*)

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

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

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

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

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

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

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

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

$$nBB[Eph\_] := \frac{8 * \pi}{(h * c)^3} * Eph^2 \left(e^{\frac{Eph}{k*T}} - 1\right)^{-1} * erg2ev$$

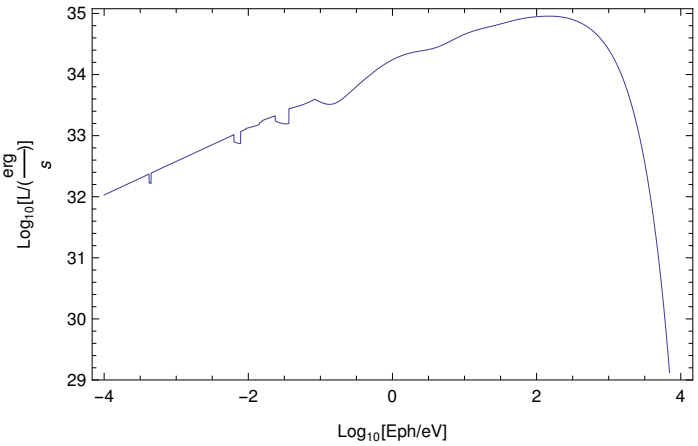
$$Integral1[E\gamma\_, Ee\_] := NIntegrate[nBB[Eph] * \sigma IC[Ee, E\gamma, Eph], \{Eph, 0, 100 * k * T\}]$$

$$Integral2[E\gamma\_] := NIntegrate[Integral1[E\gamma, Ee] * Iic[Ee], \{Ee, Eemin, 10 * Eemax\}]$$

$$luminosidadIC[E\gamma\_] := E\gamma^2 * fvol * V * \frac{c}{4\pi} * Integral2[E\gamma]$$

Sincrotron

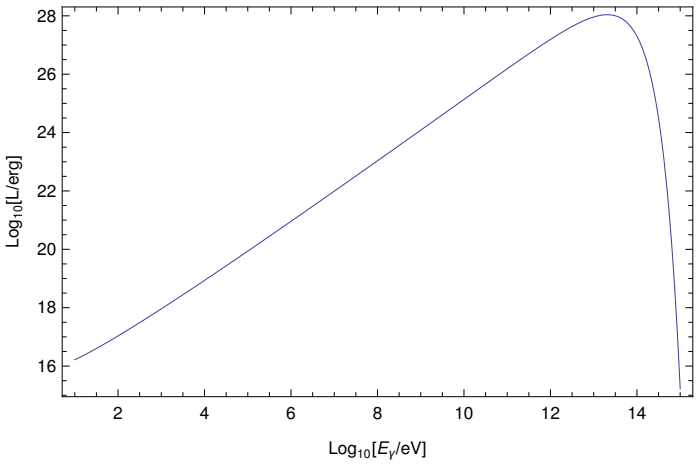
```
Plot[Log[10, L[10^(Eph) / erg2ev]], {Eph, Log[10, 10^-4], Log[10, 10^4]},
 Axes → False, Frame → True, FrameLabel → {"Log10[Eph/eV]", "Log10[L/(erg/s)]"}]
```



Bremsstrahlung

```
Plot[Log10[(10^Eγ)^2 * V * fvol *
    NIntegrate[n * σ[Eγ, Ee] * I1[Ee], {Ee, 10^Eγ, ∞}, MaxRecursion → 15] * ev2erg],
 {Eγ, Log10[10^1], Log10[10^15]}, Axes → False, Frame → True,
 FrameLabel → {"Log10[Eγ/eV]", "Log10[L/erg]"}]
```

Bremsstrahlung



Inverse Compton

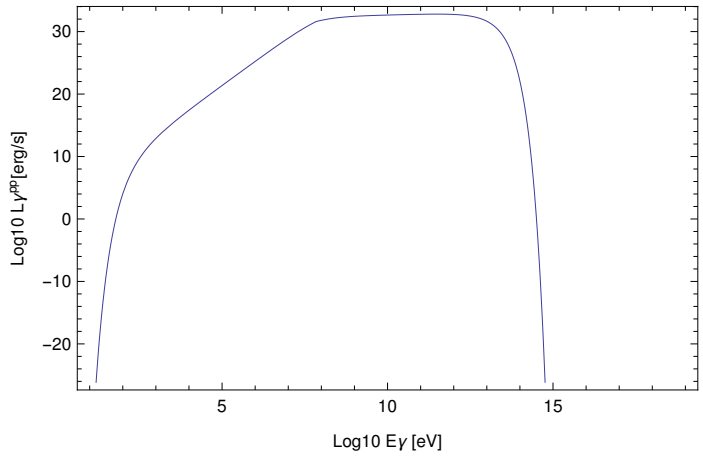
```
Plot[Log10[(10^Eγ)^2 * fvol * V * c/(4 π) * NIntegrate[
      NIntegrate[nBB[Eph] * σIC[Ee, 10^Eγ, Eph], {Eph, 0, 100 * k * T}, AccuracyGoal → 15] *
       Iic[Ee], {Ee, Eemin, 10 * Eemax}, MaxRecursion → 20] / erg2ev],
 {Eγ, 6, 15}, PlotPoints → 10, Frame → True, FrameLabel →
  {"Log Eγ [eV]", "Log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

Compton Inverse

Proton Proton

```
Plot[Log[10, (10^Eγ)^2 * fvol * V * (2 * c * n)/κ *
    Ap * 10^-27 NIntegrate[1/Sqrt[Eπ^2 - Eπrep^2] (Eprep + Eπ/κ)^-α * e^-((Eprep + Eπ/κ)/Epmax) *
      (34.3 + 1.88 * Log[(Eprep + Eπ/κ) * 10^12] + 0.25 * Log[(Eprep + Eπ/κ) * 10^12]^2),
     {Eπ, (10 ^ Eγ) + Eπrep^2/(4 * (10 ^ Eγ)), 10^16}, MaxRecursion → 20]/erg2ev],
 {Eγ, Log10[10^1], Log10[10^19]}, Frame → True, FrameLabel →
  {"Log10 Eγ [eV]", "Log10 Lγ^pp[erg/s]"}, Axes → False]
```

Proton^2



Observaciones

$$\text{radio} := \begin{array}{c|c} 5.4 * 10^{-6} & 8.4 * 10^{-14} * \text{f2L} \\ \hline 8.6 * 10^{-6} & 1.1 * 10^{-13} * \text{f2L} \end{array}$$

$$\text{ex} := \begin{array}{c|c} 5.4 * 10^{2} & 4.42 * 10^{-10} * \text{f2L} \\ \hline 1.6 * 10^{3} & 4.05 * 10^{-10} * \text{f2L} \\ \hline 3.4 * 10^{3} & 3.12 * 10^{-10} * \text{f2L} \\ \hline 6.3 * 10^{3} & 2.29 * 10^{-10} * \text{f2L} \\ \hline 8.6 * 10^{3} & 1.69 * 10^{-10} * \text{f2L} \\ \hline 1.4 * 10^{4} & 1.30 * 10^{-10} * \text{f2L} \\ \hline 2.2 * 10^{4} & 8.04 * 10^{-11} * \text{f2L} \\ \hline 2.9 * 10^{4} & 4.55 * 10^{-11} * \text{f2L} \end{array}$$

$$\text{gamlat} := \begin{array}{c|c} 7.4 * 10^{8} & 5.4 * 10^{-12} * \text{f2L} \\ \hline 1.8 * 10^{9} & 4.5 * 10^{-12} * \text{f2L} \\ \hline 4.6 * 10^{9} & 6.6 * 10^{-12} * \text{f2L} \\ \hline 1.4 * 10^{10} & 1.0 * 10^{-11} * \text{f2L} \\ \hline 3.4 * 10^{10} & 2.1 * 10^{-11} * \text{f2L} \\ \hline 1.0 * 10^{11} & 1.9 * 10^{-11} * \text{f2L} \\ \hline 2.5 * 10^{11} & 1.8 * 10^{-11} * \text{f2L} \end{array}$$

$$\text{gamhess} := \begin{array}{c|c} 2.9 * 10^{11} & 4.4 * 10^{-11} * \text{f2L} \\ \hline 3.4 * 10^{11} & 3.3 * 10^{-11} * \text{f2L} \\ \hline 7.4 * 10^{11} & 2.6 * 10^{-11} * \text{f2L} \\ \hline 1.4 * 10^{12} & 3.4 * 10^{-11} * \text{f2L} \\ \hline 4.6 * 10^{12} & 2.8 * 10^{-11} * \text{f2L} \\ \hline 5.4 * 10^{12} & 2.4 * 10^{-11} * \text{f2L} \\ \hline 6.3 * 10^{12} & 2.0 * 10^{-11} * \text{f2L} \\ \hline 8.6 * 10^{12} & 1.5 * 10^{-11} * \text{f2L} \\ \hline 1.8 * 10^{13} & 9.9 * 10^{-12} * \text{f2L} \\ \hline 3.4 * 10^{13} & 1.2 * 10^{-11} * \text{f2L} \\ \hline 4.0 * 10^{13} & 3.6 * 10^{-12} * \text{f2L} \\ \hline 8.6 * 10^{13} & 2.3 * 10^{-12} * \text{f2L} \end{array}$$

$8.4 * 10^{-14} * \text{f2L}$

1.00507×10^{31}

```
Show[Plot[{Log[10, L[10^(Eγ) / erg2ev]],
   Log10[(10^Eγ)^2 * V * fvol * NIntegrate[n * σ[Eγ, Ee] * I1[Ee], {Ee, 10^Eγ, ∞},
       MaxRecursion → 15] * ev2erg], Log[10, (10^Eγ)^2 * fvol * V * (2 * c * n)/κ *
     Ap * 10^-27 NIntegrate[1/Sqrt[Eπ^2 - Eπrep^2] (Eprep + Eπ/κ)^-α * e^-((Eprep + Eπ/κ)/Epmax) *
       (34.3 + 1.88 * Log[(Eprep + Eπ/κ) * 10^12] + 0.25 * Log[(Eprep + Eπ/κ) * 10^12]^2),
       {Eπ, (10^Eγ) + Eπrep^2/(4 * (10^Eγ)), 10^16}, MaxRecursion → 20] / erg2ev],
   Log10[(10^Eγ)^2 * fvol * V * c/(4 π) * NIntegrate[NIntegrate[nBB[Eph] * σIC[Ee, 10^Eγ, Eph],
       {Eph, 0, 100 * k * T}, AccuracyGoal → 15] * Iic[Ee],
      {Ee, Eemin, 10 * Eemax}, MaxRecursion → 20] / erg2ev]},
  {Eγ, Log[10, 10^-6], Log[10, 10^15]}, Axes → False,
  Frame → True,
  FrameLabel → {"Log10[Eγ/eV]", "Log10[L/(erg/s)]"}],
 ListPlot[{Log10[radio], Log10[ex], Log10[gamlat], Log10[gamhess]}],
 PlotRange →
  {{-6, 16}, {20, 39}},
 PlotRangeClipping → True,
 Frame → True,
 GridLines → Automatic,
 GridLinesStyle → GrayLevel[.9],
 Axes → False]
```

NIntegrate::izero : Integral and error estimates are 0 on all integration subregions. Try increasing the value of the MinRecursion option. If value of integral may be 0, specify a finite value for the AccuracyGoal option. »

NIntegrate::izero : Integral and error estimates are 0 on all integration subregions. Try increasing the value of the MinRecursion option. If value of integral may be 0, specify a finite value for the AccuracyGoal option. »

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General::stop : Further output of NIntegrate::izero will be suppressed during this calculation. »

NIntegrate::inumr : The integrand

$$\left(2.57703\times 10^{47}\,\text{«3»}\left(1+\frac{5.00989\times 10^{-13}\left(1-\frac{\text{«19»}}{(1+\text{«1»})\,\text{«1»}\,\text{«1»}\,\text{Eph}}\right)}{\left(1-\frac{\text{«23»}}{\text{Ee}}\right)^2\left(1+\frac{\text{«23»}}{\text{Plus[«2»]}\,\text{Ee}}\right)\text{Ee}^2}-\frac{\text{«20»}}{\text{«1»}}+\frac{65344.8}{\left(1-\frac{\text{«23»}}{\text{Ee}}\right)\text{«2»}^2\,\text{Eph}}+\right.\right.$$
$$\left.\left.\frac{130690.\,\text{Log}\left[\frac{65344.8}{(1+\text{Times[«2»]})\,\text{Ee}^2\,\text{Eph}}\right]}{\left(1-\frac{1.00099\times 10^{-6}}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}}\right)\right)\Big/\left(\left(-1+e^{4301.63\,\text{Eph}}\right)\text{Ee}^2\right)$$ has evaluated to

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

NIntegrate::inumr : The integrand

$$\left(2.57703\times10^{47}\,\text{≪3≫}\left(1+\frac{5.00989\times10^{-13}\left(1-\frac{\text{≪19≫}}{(1+\text{≪1≫})\,\text{≪1≫}\,\text{≪1≫}\,\text{Eph}}\right)}{\left(1-\frac{\text{≪23≫}}{\text{Ee}}\right)^2\left(1+\frac{\text{≪23≫}}{\text{Plus[≪2≫]}\,\text{Ee}}\right)\text{Ee}^2}-\frac{\text{≪20≫}}{\text{≪1≫}}+\frac{65344.8}{\left(1-\frac{\text{≪23≫}}{\text{Ee}}\right)\text{≪2≫}^2\,\text{Eph}}+\right.\right.$$
$$\left.\left.\frac{130690.\,\text{Log}\left[\frac{65344.8}{(1+\text{Times[≪2≫]})\,\text{Ee}^2\,\text{Eph}}\right]}{\left(1-\frac{1.00099\times10^{-6}}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}}\right)\Big/\left(\left(-1+e^{4301.63\,\text{Eph}}\right)\text{Ee}^2\right)$$ has evaluated to

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

NIntegrate::inumr : The integrand

$$\left(2.57703\times10^{47}\,\text{≪3≫}\left(1+\frac{5.00989\times10^{-13}\left(1-\frac{\text{≪19≫}}{(1+\text{≪1≫})\,\text{≪1≫}\,\text{≪1≫}\,\text{Eph}}\right)}{\left(1-\frac{\text{≪23≫}}{\text{Ee}}\right)^2\left(1+\frac{\text{≪23≫}}{\text{Plus[≪2≫]}\,\text{Ee}}\right)\text{Ee}^2}-\frac{\text{≪20≫}}{\text{≪1≫}}+\frac{65344.8}{\left(1-\frac{\text{≪23≫}}{\text{Ee}}\right)\text{≪2≫}^2\,\text{Eph}}+\right.\right.$$
$$\left.\left.\frac{130690.\,\text{Log}\left[\frac{65344.8}{(1+\text{Times[≪2≫]})\,\text{Ee}^2\,\text{Eph}}\right]}{\left(1-\frac{1.00099\times10^{-6}}{\text{Ee}}\right)\text{Ee}^2\,\text{Eph}}\right)\Big/\left(\left(-1+e^{4301.63\,\text{Eph}}\right)\text{Ee}^2\right)$$ 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. ≫

NIntegrate::slwcon : Numerical integration converging too slowly; suspect one of the following: singularity, value of the integration is 0, highly oscillatory integrand, or WorkingPrecision too small. ≫

NIntegrate::ncvb : NIntegrate failed to converge to prescribed accuracy after 20 recursive bisections in Ee near {Ee} = $\left\{1.4868358178656297386623919010162353515625000000000000000000000000\times10^{6}\right\}$. NIntegrate obtained 1.1640341572549428`*^21 and 4.132746724863664`*^15 for the integral and error estimates. ≫

$Aborted

```
Show[ListPlot[{Log10[radio], Log10[ex], Log10[gamlat], Log10[gamhess]}]]
```