```
for i in range(0, 1000):
    s[i] = smin + i*ds
```

pdf = make-pdf(s, s-bar, sigma-s)

$n_H = n_{H,mean} * \exp(s)$

$\lambda_J = calc\text{-}\lambda_J(n_H)$

$n_{LW} = calc\text{-}n_{LW}(n_H, G_0, \lambda_J)$
$X_{H2,a} = calc\text{-}X_{H2}(n_H, Z, n_{LW})$
$n_{H2,a} = n_H * X_{H2,a}$

– without self-shielding; to get initial values for Draine's formula;

$\overline{n}_{LW,\underline{1}}, S_{H2,\underline{1}}, N_{H2,1} = calc\text{-}n_{LWss}(n_H, \underline{n_{H2,a}}, G_0, \lambda_J)$

initial

$X_{H2,\underline{1}} = calc\text{-}X_{H2}(n_H, Z, n_{LW,\underline{1}})$

$n_{H2,\underline{1}} = n_H * X_{H2,\underline{1}}$

$n_{LW,2}, S_{H2,2}, N_{H2,2} = calc\text{-}n_{LWss}(n_H, \underline{n_{H2,1}}, G_0, \lambda_J)$

from previous iteration

$X_{H2,2} = calc\text{-}X_{H2}(n_H, Z, n_{LW,2})$

$n_{H2,2} = n_H * X_{H2,2}$

⋮ (upto $\underline{n_{LW,10}}$)

$n_{LW,ss}, S_{H2}, N_{H2} = calc\text{-}n_{LWss}(n_H, \underline{n_{H2,10}}, G_0, \lambda_J)$

from last iteration

$X_{H2} = calc\text{-}X_{H2}(n_H, Z, n_{LW,ss})$

$n_{H2} = n_H * X_{H2,2}$

final (11th) iteration – just so that I don't have to include numbers in my variable names ($n_{LW,1}, \dots$)

$X_{CO} = calc\text{-}X_{CO}(n_H, \underline{n_{H2,a}, n_{LW}})$

$n_{CO} = calc\text{-}n_{CO}(n_H, X_{CO})$

without Draine's formula, i.e., initial values;

Functions :

def calc_n_{LW} (n_H , G_0 , λ_J) : // for initial values – without Draine's formula

m_p = – –

$K = 10^3 \cdot m_p$

$exp\_\tau = exp(-K \cdot n_H \cdot \lambda_J)$

$n_{LW} = G_0 * exp\_\tau$

return n_{LW}

---

def calc_$n_{LW,ss}$ (n_H , $\underline{n_{H2}}$, G_0 , λ_J) : // $n_{LW,1}$ to $n_{LW,10}$ & $n_{LW,ss}$] – All iterations (for Draine's formula)

this value changes

m_p = – –

$K = 10^3 \cdot m_p$

$exp\_\tau = exp(-K \cdot n_H \cdot \lambda_J)$

$N_{H2} = n_{H2} * \lambda_J$

$$term\_1 = \frac{0.965}{\left(1 + \frac{N_{H2}}{5 \times 10^4}\right)^2}$$

$$term\_2 = \frac{0.035}{\sqrt{1 + \frac{N_{H2}}{5 \times 10^4}}} \cdot exp\left[-\frac{\sqrt{1 + \frac{N_{H2}}{5 \times 10^4}}}{1180}\right]$$

S_{H2} = term1 + term 2

$n_{LW,ss} = G_0 \cdot exp\_\tau \cdot S_{H2}$

return $n_{LW,ss}$, S_{H2} , N_{H2}

---

def calc_X_{H2} (n_H , Z , $\underline{n_{LW}}$): // for X_{H2} – all values

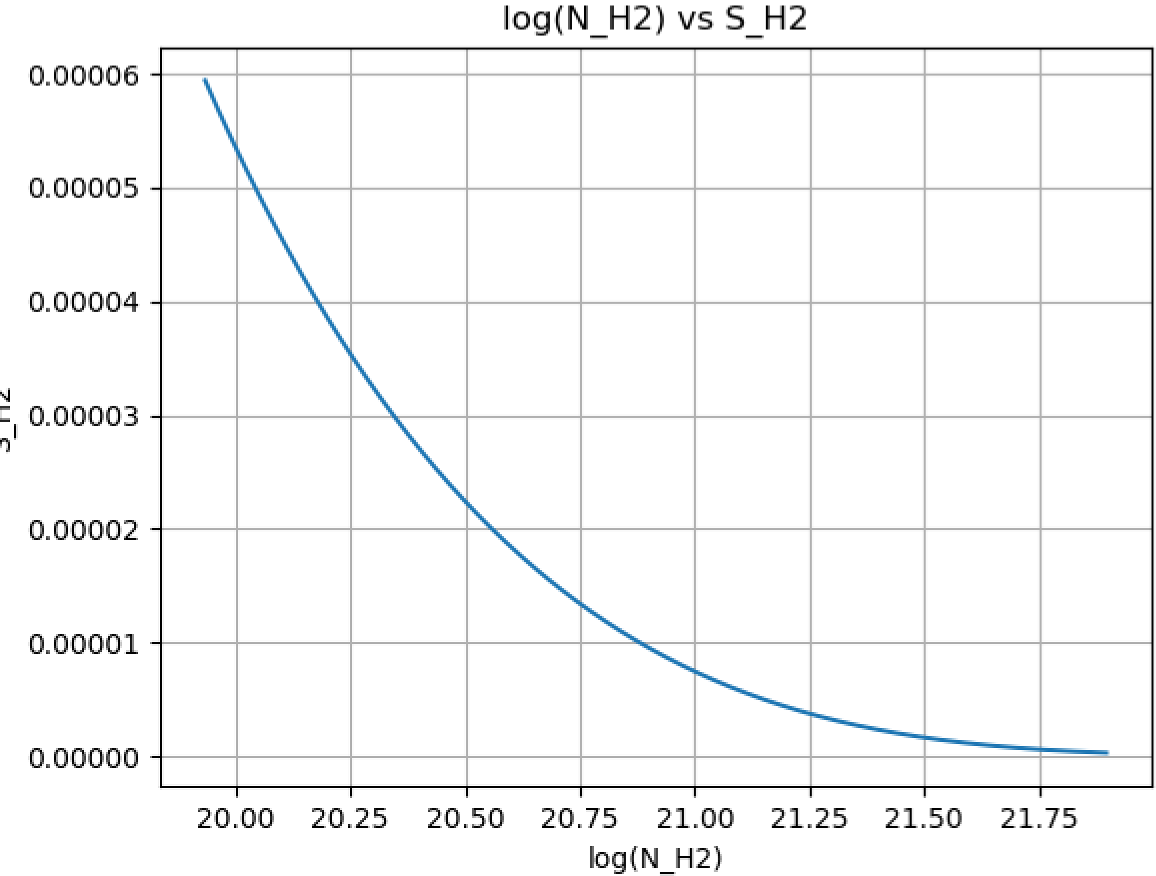
n_{LW} in the arguments changes, so X_{H2} changes

$DC = 1.7 \times 10^{-11}$

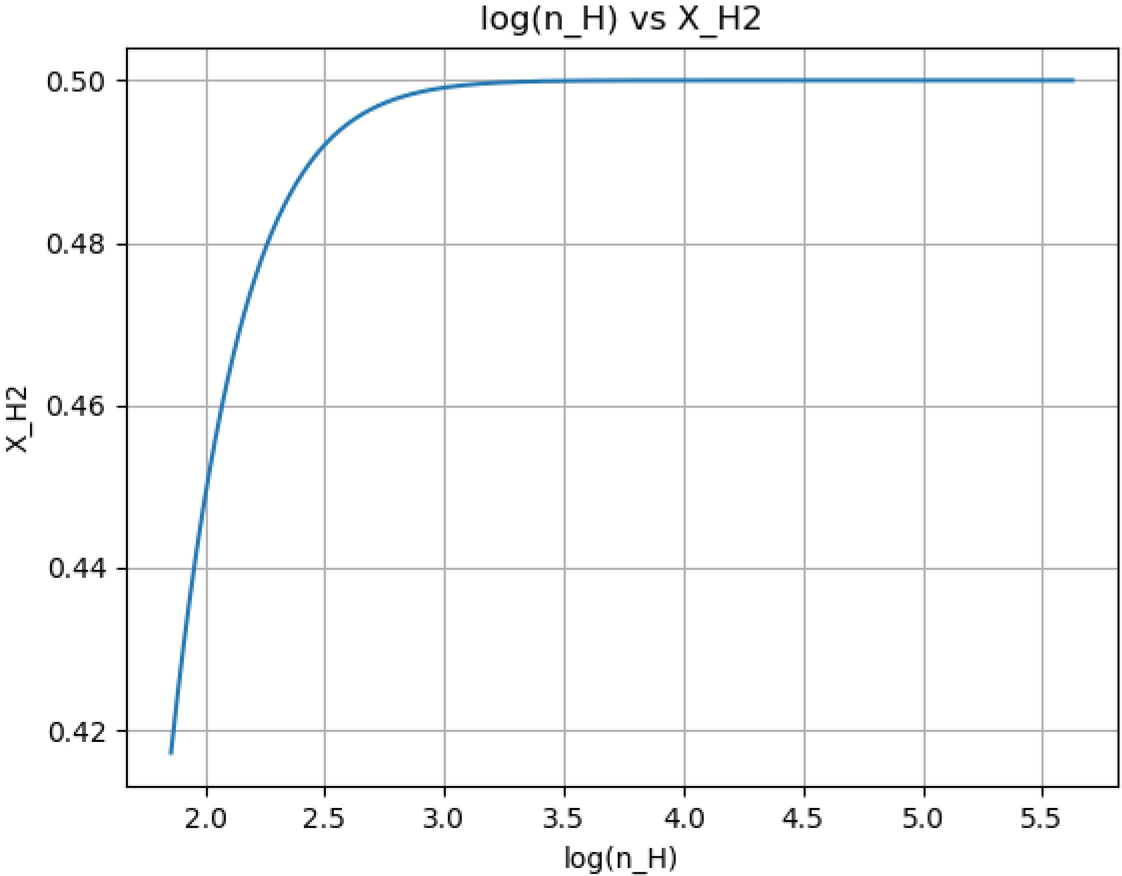
$CC = 2.5 \times 10^{-17}$

$$X_{H2} = \frac{1}{\left[2 + \left(\frac{DC \cdot n_{LW}}{CC \cdot Z \cdot n_H}\right)\right]}$$

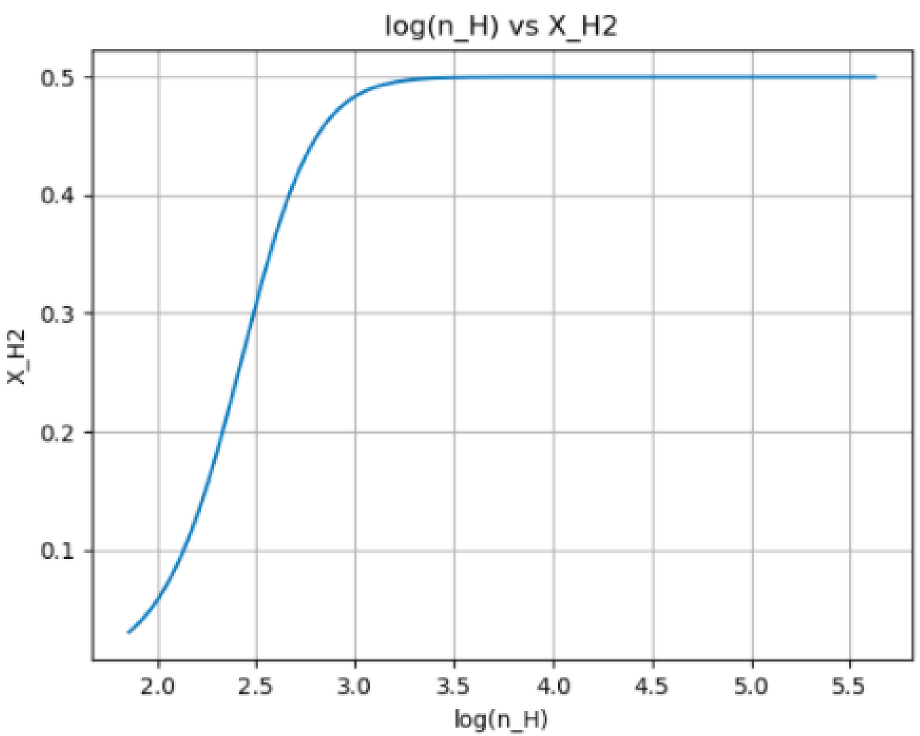
return X_{H2}



log(N_H2) vs S_H2
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
S_H2
20.00
20.25
20.50
20.75
21.00
21.25
21.50
21.75
log(N_H2)

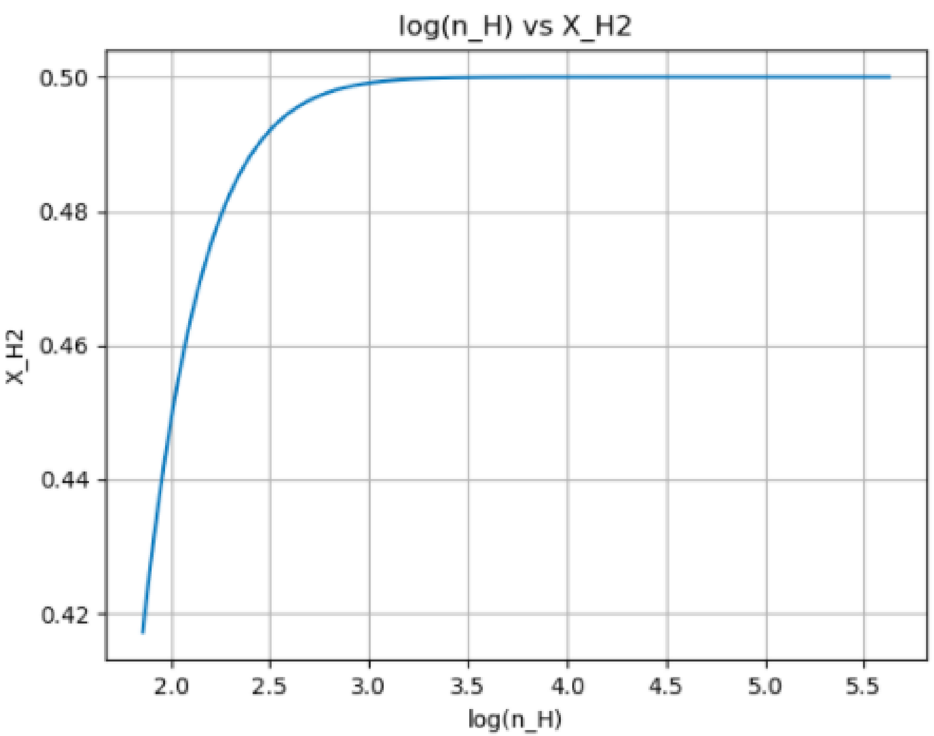

log(n_H) vs X_H2
0.50
0.48
0.46
0.44
0.42
X_H2
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
log(n_H)

Deleted



W: 640px | H: 480px | Size: 18KB

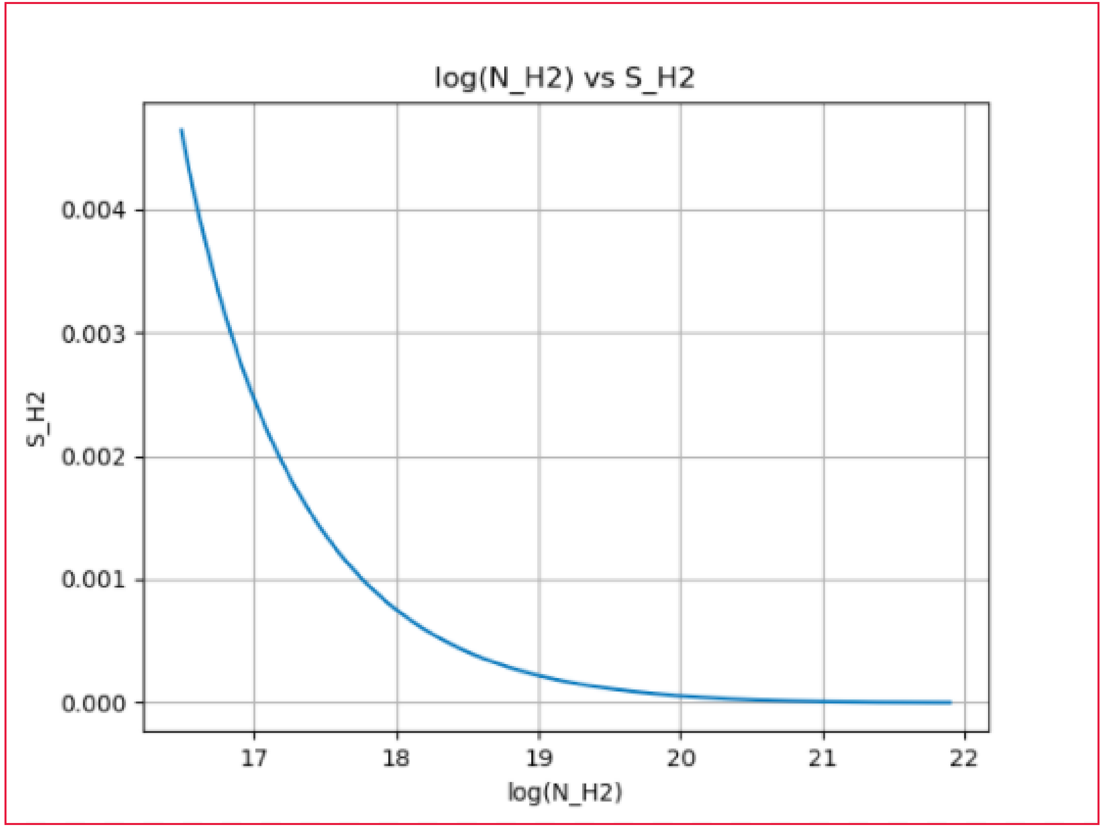
Added



W: 640px | H: 480px | Size: 19KB

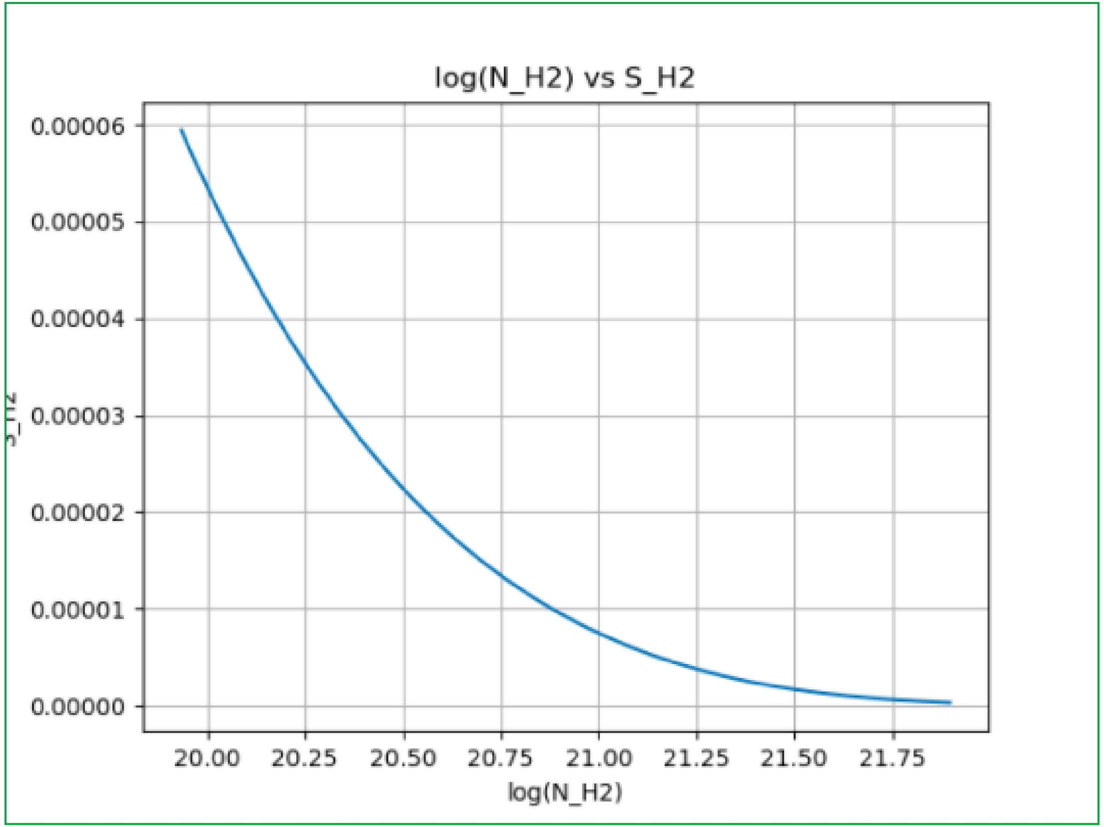
Diff: +145B (+1%)

Deleted



W: 640px | H: 480px | Size: 22KB

Added



W: 640px | H: 480px | Size: 29KB

Diff: +7KB (+31%)

```
In [1]: n_LW_1[2]
Out[1]: 0.00322214566132755

In [2]: n_LW_2[2]
Out[2]: 0.00019648292534582554

In [3]: n_LW_3[2]
Out[3]: 5.668271807067599e-05

In [4]: n_LW_4[2]
Out[4]: 4.3212746372888535e-05

In [5]: n_LW_5[2]
Out[5]: 4.176112849050782e-05

In [6]: n_LW_6[2]
Out[6]: 4.160266501485209e-05

In [7]: n_LW_7[2]
Out[7]: 4.158534210219995e-05

In [8]: n_LW_8[2]
Out[8]: 4.15834481024183e-05

In [9]: n_LW_9[2]
Out[9]: 4.158324101854026e-05

In [10]: n_LW_10[2]
Out[10]: 4.1583218376609484e-05

In [11]: n_LW_ss[2]
Out[11]: 4.1583215901008095e-05
```

```
In [1]: X_H2_1[2]
Out[1]: 0.031391078584521888

In [2]: X_H2_2[2]
Out[2]: 0.2617391610903421

In [3]: X_H2_3[2]
Out[3]: 0.3960053750117867

In [4]: X_H2_4[2]
Out[4]: 0.41659612325774287

In [5]: X_H2_5[2]
Out[5]: 0.4189436594488337

In [6]: X_H2_6[2]
Out[6]: 0.41920152705928176

In [7]: X_H2_7[2]
Out[7]: 0.419229735883962

In [8]: X_H2_8[2]
Out[8]: 0.4192328203246219

In [9]: X_H2_9[2]
Out[9]: 0.4192331575702503

In [10]: X_H2_10[2]
Out[10]: 0.4192331944437099

In [11]: X_H2[2]
Out[11]: 0.4192331984753447
```

```
In [1]: n_H2_1[2]
Out[1]: 2.3037004663199134

In [2]: n_H2_2[2]
Out[2]: 19.208280016071576

In [3]: n_H2_3[2]
Out[3]: 29.061689123662845

In [4]: n_H2_4[2]
Out[4]: 30.572784583742834

In [5]: n_H2_5[2]
Out[5]: 30.745063475134142

In [6]: n_H2_6[2]
Out[6]: 30.76398763324609

In [7]: n_H2_7[2]
Out[7]: 30.76605779730226

In [8]: n_H2_8[2]
Out[8]: 30.7662841554813

In [9]: n_H2_9[2]
Out[9]: 30.76630890496257

In [10]: n_H2_10[2]
Out[10]: 30.76631161099912

In [11]: n_H2[2]
Out[11]: 30.766311906869138
```