Cosmic Background Radiation

$n := 43$ $\quad$ $i := 1..n$

$\nu_i :=$	$B_i :=$
2.27	2.0110
2.72	2.5003
3.18	2.9369
3.63	3.2858
4.08	3.5503
4.54	3.7316
4.99	3.8269
5.45	3.8477
5.90	3.8027
6.35	3.7025
6.81	3.5551
7.26	3.3773
7.71	3.1752
8.17	2.9535
8.62	2.7281
9.08	2.4957
9.53	2.2721
9.98	2.0552
10.44	1.8438
10.89	1.6488
11.34	1.4672
11.80	1.2973
12.25	1.1438
12.71	1.0019
13.16	0.8771
13.61	0.7648
14.07	0.6631
14.52	0.5749
14.97	0.4965
15.43	0.4265
15.88	0.3669
16.34	0.3136
16.79	0.2684
17.24	0.2287
17.70	0.1945
18.15	0.1657
18.61	0.1396
19.06	0.1185
19.51	0.1003
19.97	0.0846
20.42	0.0717
20.87	0.0587
21.33	0.0459

The cosmic background radiation fills all space and is a relic from the "big bang" that created the universe approximately 18 billion years ago. The data[1] shown at the left, spectral brightness[2] as a function of wave number, was recorded recently (1989) by the Cosmic Background Explorer satellite (COBE). Below the data is fit with the Planck blackbody radiation equation to determine the cosmic background temperature.

Define the fundamental constants h, k, and c.

$h := 6.62608 \cdot 10^{-34}$ $\quad$ $k := 1.380622 \cdot 10^{-23}$ $\quad$ $c := 2.99792458 \cdot 10^{8}$

$\nu_i := 100 \cdot \nu_i$ $\qquad$ $B_i := 10^{-18} \cdot B_i$

Provide a seed value for the background temperature: $\quad T := 10$

Define spectral brightness equation:

$$F(\nu, T) := 2 \cdot h \cdot \nu^3 \cdot c \cdot \frac{1}{\left(\exp\left(\frac{h \cdot c \cdot \nu}{k \cdot T}\right) - 1\right)}$$

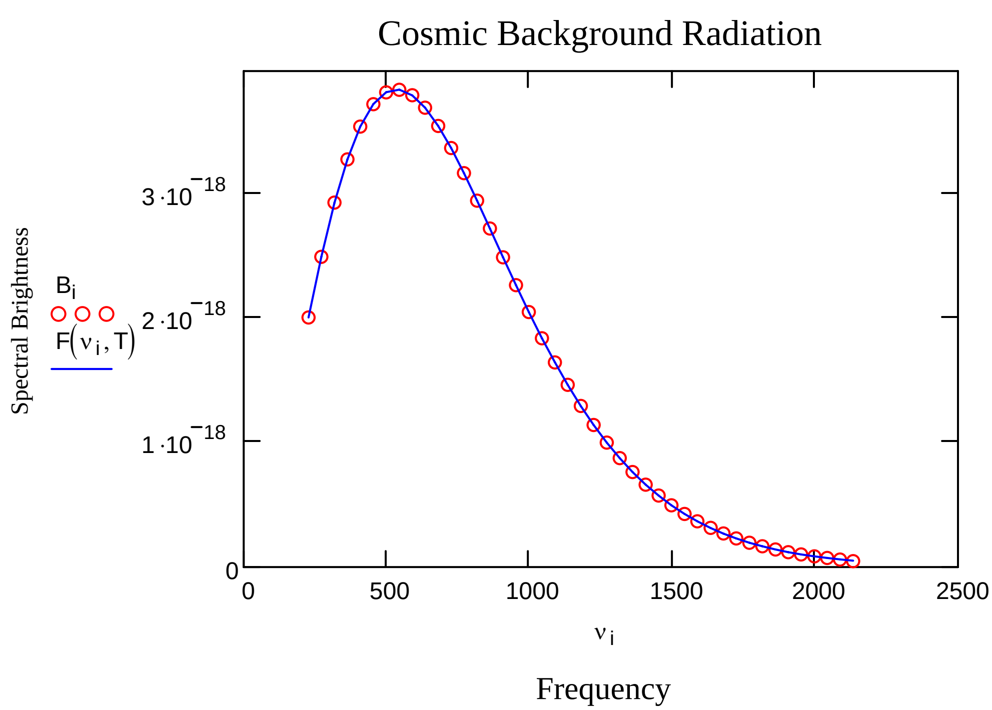
Fit equation to data by finding the value of T that minimizes the difference between the data and the function.

SSD stands for **s**um of the **s**quare of the **d**eviations between data and the equation that is being fit to the data.

$$SSD(T) := \sum_i \left(B_i - F(\nu_i, T)\right)^2$$

Given $\qquad SSD(T) = 0 \qquad T := \text{Minerr}(T) \qquad T = 2.728$

Thus the best fit to the data is obtained with a cosmic background temperature of 2.728 K.



Notes:

1. Data taken from: S. Bluestone, JCE **78**, 215-218 (2001).

2. The relationship between spectral brightness and Planck's radiation density function is:

$$B(\nu, T) = \frac{c}{4 \cdot \pi} \cdot \rho(\nu, T)$$