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A1_9 The solar contract?

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Abstract

This report examines the claim by the *'Institute for Creation Research'* that the Sun is contracting by about 5 ft per hour. It is determined that the gravitational potential energy released from the Sun contracting from its currently established radius to a radius 2.5 ft smaller would be larger than the Sun's current luminosity. It has also been shown that this would result in Earth being hotter than the current surface temperature of Venus and the Sun's peak of radiation would be in the ultra violet range rather than the visible.

Introduction

In the 1980s studies suggested that the Sun was shrinking by about 0.1% per century. This is not considered accurate due to a lack of accurate data over the last few centuries. However, the *'Institute for Creation Research'* website still has a web page devoted to it, claiming that the Sun is less than billions of years old [1]. This is due to the fact that 20 million years ago, the Sun's radius would have been larger than 1 AU. [1].

This report will go into how the current short term properties (in the order of a few hundred years) would compare to those of the Sun if it was contracting at 5 ft per hour.

Discussion

The first thing to look at the amount of energy liberated if the Sun's radius shrank by 2.5 ft per hour.

The gravitational potential energy U for the Sun can be determined by approximating it to the potential energy of a sphere [2]

$$U = -\frac{3GM_s^2}{5R_s}, \qquad (1)$$

where G is the gravitational constant, M_s=1.989×10^{30} kg is the mass of the Sun, and R_s=6.96×10^{5} km is the radius of the Sun [3]. We will assume that the mass of the Sun remains constant as it shrinks. Taking the initial radius to be R_s, and the shrunk radius to be $r = R_s - 2.5$ ft, the potential energy change is given by

$$\Delta U = -\frac{3GM_s^2}{5}\left(\frac{1}{R_s} - \frac{1}{r}\right), \qquad (2)$$

which gives $\Delta U = 2.49 \times 10^{32}$ J, giving a luminosity of $L = 6.92\times10^{28}$ W. This is bigger than the Sun's current luminosity of $L_{Sun} = 3.83 \times 10^{26}$ W [3]. The power output (6.92×10^{28} W) is now approximated to be the luminosity L that would result from the contraction of the Sun.

We will now look at how this increase in energy output would affect the Earth. The radiation that the Earth absorbs is equal to the flux of radiation from the Sun at the Earth's orbital radius multiplied by the cross sectional area of the Earth as seen from the Sun. The power of this radiation absorbed by the Earth is [4]

$$P_{in} = (1 - A)\frac{R_e^2 L}{4r_o^2}, \quad (3)$$

where $A = 0.3$ is the planetary albedo [5] and $r_o = 1.50\times10^{11}$ m [6] is the orbital radius of the Earth. We will now assume that the power falling onto the Earth is equal to the power radiated out, given by the Stefan-Boltzmann law [7]

$$P_{out} = 4\pi R_e^2 \sigma \epsilon T_{Earth}^4, \quad (4)$$

where σ is the Stefan-Boltzmann constant and $\epsilon \approx 1$ is the emissivity of a black body radiator. Setting this equal to P_{in} gives

$$T_{Earth} = \left[(1 - A)\frac{L}{16\pi\sigma r_o^2}\right]^{1/4}, \quad (5)$$

and the temperature of the Earth is $T_{Earth} = 932$ K. This is above the boiling point for liquid water, making it unlikely that life would have evolved on the Earth.

We can also rearrange equation 4 to get the temperature of the Sun,

$$T_{Sun} = \left[\frac{L}{4\pi R_s^2 \sigma \epsilon}\right]^{1/4}, \quad (6)$$

This gives a temperature of 21,000 K. We can now use Wien's displacement law to determine the peak wavelength that the Sun will radiate at [8]

$$\lambda_{max} = \frac{b}{T_{Sun}}, \quad (7)$$

where $b = 2.898\times10^6$ K nm is Wien's displacement constant. It can be seen that $\lambda_{max} = 137$ nm, placing the peak in the ultra violet range [9]. If we use the current Sun temperature [3] in Equation 7, we find that $\lambda_{max} \cong 500$ nm.

Conclusion

We have discussed the effects on the Earth and the Sun which would result in the Sun contracting by a rate of five feet in diameter per hour. It has been shown that this would result in a luminosity far larger than the one currently observed. It has then been shown that this would result in the Earth being hotter than it currently is and the peak in the Sun's radiation spectrum would shift to the Ultra violet. This shows that only basic observations are required to show that this hypothesis is not very likely to be correct.

References

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