Table II: Modeling Parameters and Intrinsic Luminosities for the Sun, Planets, and Sirius B.

Planet	M (g)	R (cm)	ϕ_0 (cm^2/s^2)	ϕ_{sun} (cm^2/s^2)	ϕ_{gal} (cm^2/s^2)	ϕ_g (cm^2/s^2)	$\bar{\mu}$ (s^{-1})	$\bar{C}$ (erg/g/*K)	$\bar{T}$ (*K)	L_g (erg/s)	L_i (erg/s)
Sun	1.99(33)	6.96(10)	−1.91(15)	⋯	−2.0(13)	−9.57(15)	5.00(−16)	2.09 ± 0.8(8)	9.5 ± 3(6)	2.0 ± 1.2(33)	3.9 (33)
Mercury	3.30(26)	2.44(8)	−9.00(10)	−2.21(13)	−2.0(13)	−4.23(13)	2.21(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	1.8 ± 1.1(19)	
Venus	4.87(27)	6.05(8)	−5.37(11)	−1.19(13)	−2.0(13)	−3.30(13)	1.72(−18)	1.26 ± 0.5(7)	2.5 ± 1(3)	2.7 ± 1.5(20)	
Earth	5.98(27)	6.38(8)	−6.25(11)	−8.54(12)	−2.0(13)	−2.98(13)	1.56(−18)	1.26 ± 0.5(7)	2.5 ± 1(3)	2.9 ± 1.6(20)	4.0 ± 0.2 (20)
Moon	7.35(25)	1.74(8)	−2.81(10)	−8.54(12)	−2.0(13)	−2.86(13)	1.50(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	2.8 ± 1.8(18)	7.0 ± 0.5 (18)
Mars	6.44(26)	3.39(8)	−1.27(11)	−5.64(12)	−2.0(13)	−2.58(13)	1.35(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	2.2 ± 1.4(19)	
Jupiter	1.90(30)	6.92(9)	−1.83(13)	−1.65(12)	−2.0(13)	−5.83(13)	3.05(−18)	1.18 ± 0.5(8)	9.0 ± 5(3)	6.2 ± 4.0(24)	3.4 ± 0.3 (24)
Saturn	5.69(29)	5.73(9)	−6.54(12)	−9.00(11)	−2.0(13)	−3.40(13)	1.77(−18)	8.1 ± 3.0(7)	6.0 ± 3(3)	4.9 ± 3.0(23)	8.6 ± 0.1 (23)
Uranus	8.74(28)	2.57(9)	−2. 27(12)	−4.47(11)	−2.0(13)	−2.50(13)	1.31(−18)	3.8 ± 1.5(7)	4.0 ± 2(3)	1.7 ± 1.1(22)	0.3 ± 0.4 (22)
Neptune	1.03(29)	2.53(9)	−2.78(12)	−2.85(11)	−2.0(13)	−2.58(13)	1.35(−18)	3.6 ± 1.5(7)	4.0 ± 2(3)	2.0 ± 1.3(22)	3.3 ± 0.4 (22)
Pluto	6.6 (26)	2.90(8)	−1.52(11)	−2.17(11)	−2.0(13)	−2.05(13)	1.07(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	1.8 ± 0.7(19)	
Sirius B	2.1 (33)	5.0 (8)	−2.7 (17)	−7.0 (11)	−2.0(13)	−5.4 (17)	2.8 (−14)	3.0 ± 1.5(6)	2.0 ± 1(7)	3.6 ± 2.4(33)	0.4 − 10^3 (33)

The values for the model parameters are determined as follows. For all celestial bodies considered here, the gravity potential is calculated relative to a background value of $\phi_{gal} = (-2 \times 10^{13} - \phi_{gc})$ $cm^2 \cdot s^{-2}$, which includes the gravity potential contribution of the galaxy, galactic cluster, and supercluster. The value ϕ_{gc}, which is of the order of 6×10^{13} cm^2 s^{-2}, cancels out when L_g is calculated; see Eq. (7). The average internal gravity potential ϕ_g for the Sun is estimated to be five times its surface potential, $5\phi_0$, plus ϕ_{gal}, where $\phi_0 = -M_\odot k_g/R_\odot$. The internal gravity potentials for the planets, including the Earth and Moon, are calculated as $\phi_g = 2\phi_0 + \phi_{sun} + \phi_{gal}$, where $\phi_{sun} = -M_\odot k_g/r$ represents the contribution from the Sun's gravity potential field at the planet's heliocentric distance r. The individual gravity field contributions for the planets, $2\phi_0$, are about 2 1/2 times smaller than that for the Sun, since the planets have comparably smaller density gradients. Note that ϕ_g values for the planets are dominated primarily by the galactic component. In the case of Sirius B the potential is calculated to be $\phi_g \sim 2\phi_0$.

The values for $\bar{\mu}$ are calculated as $\bar{\mu} = \alpha\phi_g$, with $\alpha = 5.23 \times 10^{-32}$ $s \cdot cm^{-2}$. The value for α is chosen such that the calculated genic energy luminosity for the Sun is normalized to 0.51 $L_\odot$, accounting for two-thirds of the missing amount, as determined from solar neutrino observations.

Values adopted for the average specific heats assume compositions[20,23] and Boltzmann constant coefficient values[17,30] listed in Table III. The specific heats for the minor planets are taken to be equal to that of rock, 0.3 ± 0.1 cal/g/K.[31] The estimate for Sirius B assumes 2.0 k_B per heavy particle and an average of 57 amu per particle, predominantly an iron composition.

The average internal temperature of the Sun $\bar{T} \sim 9.5 \times 10^6$ K is estimated on the basis of a solar core temperature of $\sim 15 \times 10^6$ K. The temperature given for the Earth is consistent with current thermal structure models for its interior.[32] Temperatures for the Moon and minor planets have been chosen to be in this same neighborhood. The temperature ranges listed for Jupiter and Saturn are consistent with model core temperatures which range from 7200 K to 24 000 K for Jupiter and from 5500 K to 15 000 K for Saturn.[18,33] The average values listed for Uranus and Neptune are consistent with model core temperatures of 6900 K and 7100 K, respectively.[24] The uncertainties in knowing the core temperatures for these planets are comparable to those for Jupiter and Saturn. The average temperature chosen for Sirius B is consistent with a temperature of 2×10^7 K normally modeled for its core.

The luminosities predicted for Jupiter and Neptune are sufficient to account for all of their observed intrinsic heat flux. While those modeled for Saturn and Uranus fall somewhat below the observed values, they are reasonably close given the uncertainties in knowing the model parameters. The value predicted for Sirius B falls in the range of the dwarf's bolometric luminosity, which is not currently known with certainty. The soft x-ray luminosity of its corona is estimated to exceed 0.2 $L_\odot$ and could even be as high as 10^3 $L_\odot$.[34] The luminosity modeled for the Moon accounts for about 40% of the observed lunar thermal flux. The remaining 60% may reasonably be attributed to radioactive decay.

The genic energy luminosity predicted for the Earth is computed to be about 73% of the total terrestrial thermal flux, the remaining 27% being attributed to the radioactive decay of uranium, thorium, and potassium in the crust and mantle. Ganapathy and Anders[35] estimate that as much as 60% is contributed by radioactive decay. However, due to the uncertainty in estimating the uranium content of the Earth's crust, such estimates of the radiothermal contribution could be in error by at least a factor of two.[36] The portion of the total terrestrial heat flux that is unaccounted for by crustal radioactivity is believed to come from the Earth's core and is also thought to be responsible for driving convective processes that produce the Earth's magnetic field.[37] A variety of mechanisms has been suggested in the past to account for this nonfission fraction: trapped primordial heat, latent heat released as a result of the progressive growth of the Earth's solid inner core, gravitational convection induced by the preferential removal of dense alloys form the outer core during inner core crystalization, and radioactive decay of ^{40}K.[36,38] The photon energy dilation mechanism proposed here would be one other alternative to consider.

7. CONCLUDING REMARKS

In overview, it is seen that a variety of energy generation mechanisms has