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Planetary cores, their energy flux relationship, and its implications

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ABSTRACT

Integrated surface heat flux data from each planet in our solar system plus over 50 stars, including our Sun, was plotted against each object's known mass to generate a continuous exponential curve at an R-squared value of 0.99. The unexpected yet undeniable implication of this study is that all planets and celestial objects have a similar mode of energy production. It is widely accepted that proton-proton reactions require hydrogen gas at temperatures of about 15 million degrees, neither of which can plausibly exist inside a terrestrial planet. Hence, this paper proposes a nuclear fission mechanism for all luminous celestial objects, and uses this mechanism to further suggest a developmental narrative for all celestial bodies, including our Sun. This narrative was deduced from an exponential curve drawn adjacent to the first and passing through the Earth's solid core (as a known prototype). This trend line was used to predict the core masses for each planet as a function of its luminosity.

1. Introduction

The Earth's geothermal heat flux and its origin have been of interest to geologists, geophysicists, as well as a few astronomers for well over half a century. The customary explanation for this phenomenon generally involves radiogenic heat production from radioisotopes of Uranium, Thorium, and Potassium.

The earliest heat flow measurements were taken on the Earth's surface. Planetary heat flow measurements were discussed in great detail by Axel Hagermann (other studies on this topic can be found in the reference section of Hagermann's paper) (Hagerman, 2005). The Earth is by far the most thoroughly studied, with a mean value of 65 mW per square meter (mWm^{-2}) passing through the continents and a mean value of 101 mWm^{-2} flowing through the oceans (Pollack et al., 1993). Since NASA's space probe launchings, and Moon landings by astronauts, heat flow measurements have been obtained for most solar system planets, as well as the Moon. Two separate heat flow measurements were made by the astronauts of Apollo 15 and 17 on different locations on the Moon's surface. The lunar heat flow values were 21 mWm^{-2} and 16 mWm^{-2} respectively. The latter value was subsequently adjusted by Warren and Rasmussen (1987) to 12 mWm^{-2}. Jupiter's closest satellite Io exhibits an unusually large heat flow of 2 Wm^{-2} (Morrison and Telesco, 1980). The Martian heat flow data was determined to be 6.4 ± 0.4 mWm^{-2} by Hahn et al. (2011). The Sun's known parameters were included not only for the sake of completeness, but the Sun after all is the principle component of our solar system. With the exception of Mercury and Venus, there is heat flow data for all the other planets (Spohn, 2015). By integrating the heat flow measurements over the whole surface of the planet, one can establish its luminosity.

2. Methods

A luminosity (L) value for each planetary object was obtained by multiplying its surface area (A) by its average measured heat flow value (H):

$$L = (H)\cdot(A) \tag{1}$$

This assumes that the heat flux measurements taken represent the average value over the entire surface of the planet. Table 1 is a listing of the calculated luminosities of each planet, along with some other properties.

Since stars are characterized by a mass-luminosity relationship, it was hypothesized that there could be a similar relationship among the planets. After plotting the masses versus the luminosities of each planet on a logarithmic scale, it became clear that indeed such a relationship exists.

Next, because the mass of the planet Jupiter is not far removed from that of some nearby stars, a study of the mass-luminosity relationship for those stars was of interest.

Table 2 is a listing of 39 nearby G, K, and M stars, which provides the luminosity and mass of each stellar object (List of the Nearest 100 Stellar Systems, 2012). The G, K, M stellar classification is based on the stellar surface temperature in decreasing order of temperature, the Sun being a G-type star. For completeness, 12 highly luminous stars were added later,

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Table 1
Critical properties of solar system planets.

	Radius (m)	Mean Density (gm/cc)	Mass (kg)	Luminosity (Watts)
Earth	6.378×10^6	5.5	5.970×10^{24}	3.311×10^{13}
Mars	3.397×10^6	3.94	6.419×10^{23}	9.333×10^{11}
Jupiter	7.150×10^7	1.24	1.898×10^{27}	3.4673×10^{17}
Saturn	6.030×10^7	0.62	5.685×10^{26}	9.1203×10^{16}
Uranus	2.556×10^7	1.3	8.685×10^{25}	3.388×10^{14}
Neptune	2.476×10^7	1.61	1.024×10^{26}	3.311×10^{15}

representing larger, younger, and hotter stars than the Sun. Data therefore includes a wide range of stars in our galaxy.

Stellar luminosity (L) was calculated with the solar luminosity ($L_\odot = 3.846 \times 10^{26}$ Watts) as a reference using the following equation:

$$\frac{L}{L_\odot} = 10^{\frac{2}{5}(M_{v\odot} - M_v)} \tag{2}$$

where:

$M_{v\odot}$ and M_v are the absolute visual magnitudes of the Sun and the target star, respectively.

The mass-luminosity relationship of a star, including our Sun, is subject to the following equations:

$$\frac{L}{L_\odot} = .23\left(\frac{M}{M_\odot}\right)^{2.3} \quad \text{when} \quad (M < .43M_\odot) \tag{3}$$

$$\frac{L}{L_\odot} = \left(\frac{M}{M_\odot}\right)^{4} \quad \text{when} \quad (43M_\odot < M < 20M_\odot) \tag{4}$$

Table 2
Stellar properties of 39 G, K, and M Stars within 100 parsecs, and of 12 highly luminous stars.

Name	Spectral type	Absolute magnitude	L (Watts)	Log of L	Mass (kg)	Log of mass
Sun	G2.0VN	4.85	3.846E+26	26.59	1.989E+30	30.2986
39 G, K, and M Stars (within 100 parsecs)						
GJ 559 A	G2.0 V	4.380	5.929E+26	26.77	2.216E+30	30.35
GJ 559 B	K0 V	5.710	1.742E+26	26.24	2.670E+30	30.43
GJ 699	M3.5 V	13.25	1.679E+23	23.23	1.304E+29	29.12
GJ 406	M5.5 V	16.64	7.396E+21	21.87	3.355E+28	28.53
GJ 411	M2.0 V	10.44	2.234E+24	24.35	5.491E+29	29.74
GJ 65B	M6.0 V	15.93	1.422E+22	22.15	4.458E+28	28.65
GJ 729	M3.5 V	13.08	1.963E+23	23.29	1.396E+29	29.14
GJ 144	K2.0 V	6.200	1.109E+26	26.05	1.458E+30	30.16
GJ 887	M1.0 V	9.760	4.178E+24	24.62	6.421E+29	29.81
GJ 447	M4.0 V	13.53	1.297E+23	23.11	1.166E+29	29.07
GJ 820 A	K5.0 V	7.480	3.412E+25	25.53	1.314E+30	30.12
GJ 725 A	M3.0 V	11.17	1.140E+24	24.06	2.999E+29	29.48
GJ 725 B	M3.5 V	11.96	5.508E+23	23.74	2.186E+29	29.34
GJ 15 A	M1.5 V	10.31	2.518E+24	24.40	5.658E+29	29.75
GJ 15 B	M3.5 V	13.30	1.603E+23	23.21	1.278E+29	29.11
GJ 1111	M6.0 V	17.10	4.842E+21	21.69	2.791E+28	28.45
GJ 71	G8.5 V	5.680	1.791E+26	26.25	1.643E+30	30.22
GJ 1061	M5.0 V	15.26	2.636E+22	22.42	5.831E+28	28.77
SCR 1845–6357 A	M8.5 V	19.47	5.458E+20	20.74	1.080E+28	28.03
SO 0253 + 1652	M6.5 V	17.21	4.375E+21	21.64	2.670E+28	28.43
DEN 1048-3956	M8.5 V	19.37	5.984E+20	20.78	1.124E+28	28.05
GJ 1245 C	M V	18.47	1.371E+21	21.14	1.612E+28	28.21
GJ 1245 B	M6.0 V	15.72	1.726E+22	22.24	4.850E+28	28.69
GJ 166 B	DA4 N	11.03	1.297E+24	24.11	4.793E+29	29.68
GJ 166 C	M4.0 V	12.75	2.661E+23	23.43	1.593E+29	29.20
G 099-049	M3.5 V	12.71	2.761E+23	23.44	1.619E+29	29.21
LHS 1723	M4.0 V	13.59	1.227E+23	23.09	1.138E+29	29.06
GJ 445	M3.5 V	12.15	4.624E+23	23.67	2.026E+29	29.31
GJ 251	M3.0 V	11.27	1.040E+24	24.02	2.882E+29	29.46
2MA 1835 + 3259	M8.5 V	19.50	5.309E+20	20.73	1.067E+28	28.03
GJ 752 B	M8.0 V	18.61	1.205E+21	21.08	1.524E+28	28.18
GJ 139	G8.0 V	5.390	2.339E+26	26.37	1.756E+30	30.24
GJ 780	G8.0 IV	4.620	4.753E+26	26.68	2.097E+30	30.32
GJ 661 B	M V	11.32	9.931E+23	24.00	2.824E+29	29.45
LHS 3003	M7.0 V	17.97	2.173E+21	21.34	1.970E+28	28.29
G 041-014 B	M V	12.99	2.133E+23	23.33	1.447E+29	29.16
LP 771-095 B	M3.5 VJ	12.58	3.112E+23	23.49	1.705E+29	29.23
GJ 2130 B	M2 VJ	12.79	2.565E+23	23.41	1.568E+29	29.20
GJ 2130 C	M V	13.79	1.021E+23	23.01	1.050E+29	29.02
12 Highly Luminous Stars						
Alpha Centauri A		4.380	5.929E+26	26.77	2.188E+30	30.34
Sirius A		1.400	9.226E+27	27.97	4.018E+30	30.60
Vega		0.580	1.963E+28	28.29	4.246E+30	30.63
Capella Aa		0.400	2.317E+28	28.37	5.110E+30	30.71
Arcturus		−0.310	4.457E+28	28.65	2.188E+30	30.34
Aldebaran		−0.630	5.984E+28	28.78	3.381E+30	30.53
Polaris Aa		−3.600	9.226E+29	29.97	1.074E+31	31.03
Bellatrix		−2.640	3.811E+29	29.58	1.671E+31	31.22
Canopus		−5.530	5.458E+30	30.74	1.949E+31	31.29
Antares		−7.200	2.541E+31	31.41	2.466E+31	31.39
Rigel		−7.840	4.582E+31	31.66	3.580E+31	31.55
Betelgeuse		−8.000	5.309E+31	31.73	1.531E+31	31.18