A Fourier analysis of historical sunspot data suggests that planetary gravitational and magnetic forces influence the sunspot numbers

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Abstract

A Fourier spectral analysis of the 400 years of recorded sunspot numbers generates multiple peaks indicating multiple forces are responsible for the sunspot cycles. Interestingly, many of these spectral peaks correspond to the orbital periods of the planets orbiting the sun. Analogous to the generation of our ocean tides from the lunar and solar gravitational forces, similar forces from the planets on the solar photosphere create plasma tides that apparently influence the sunspot numbers. An integration over these individual forces towards the sun could prove useful in predicting future sunspot cycles but such calculations are sufficiently complex enough to require a high speed mainframe supercomputer.

FIGURE AND TABLE CAPTIONS

Figures 1-2. These two panels show the recorded sunspot data recorded since 1610. The recorded historical data are averaged over one month periods to cancel out the rotational motion of the sun's visible surface. These historical data are recorded at a number of sites including NOAA. Arrows indicate significant events that occurred over the 400 years of data to orient viewers to the timeframe shown.

Figure 3. This figure shows the number of people that either perished or emigrated during famines since 1610. Those afflicted, i.e. perished or emigrated, are plotted against the average sunspot number during the famine. The data suggest a tread towards higher survivability rates as the sunspot numbers are higher.

Figure 4. This figure shows the Fourier spectral analysis of the historical sunspot numbers. Peaks from various planetary influences are indicated. The two largest peaks are centered at 0.615 years and 10.8 years. Jupiter's orbit is 11.86 years long and possibly obscured by the 10.8 year peak if this peak is due to an intrinsic plasma process. Jupiter's peak could be split because Jupiter not only has a pronounced gravitational force but a magnetic force as well. This latter force reverses every 10.8 year solar cycle when the solar magnetic force reverses in sign. The rotational motion of the sun likely shifts this peak as well. A detailed solution to the Equations of Motion interacting with a plasma could explain these peaks but such equations are complex and would likely require a supercomputing mainframe to solve.

Tables 1-2. Tables of the planetary orbital data and planetary masses. All data in Table 1 are referenced against the background stellar reference frame. These data are used to calculate relative gravitational tidal forces from the following equation

$$\vec{a}_t\,(axial) \approx \pm\,\hat{r}\,2G\Delta r\frac{M}{R^3},$$

where a_t (axial) is the tidal acceleration along the line connecting the planet and sun,
$r^\wedge$ is the unit vector pointing towards the planetary body,
G is the gravitational constant,
Δr is the cylindrical coordinate radius of the sun,
M is the mass of the planetary body, and
R is the distance to the planet.

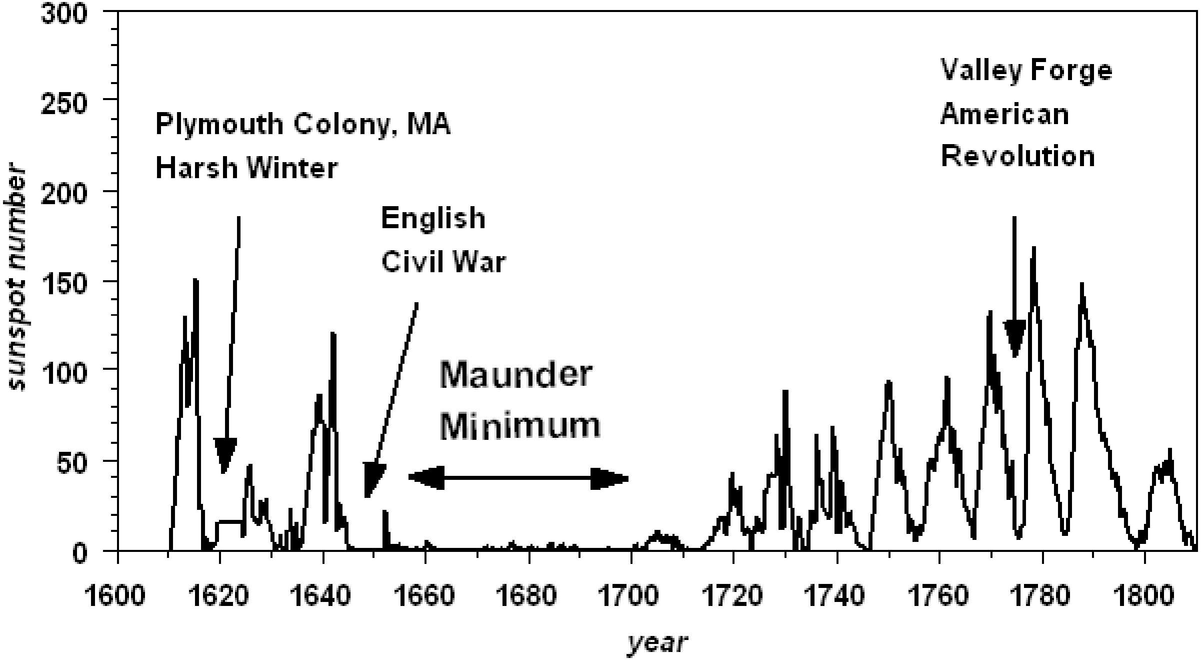
Table 3. Table of the relative tidal forces observed at the surface of the sun from the various planets and the largest asteroid Ceres orbiting the sun derived from the equation given above. The forces are shown relative to the force from the earth which has been normalized to a value of one. This decision was made in part by a general lack of knowledge in the plasma density in the solar photosphere, a lack of

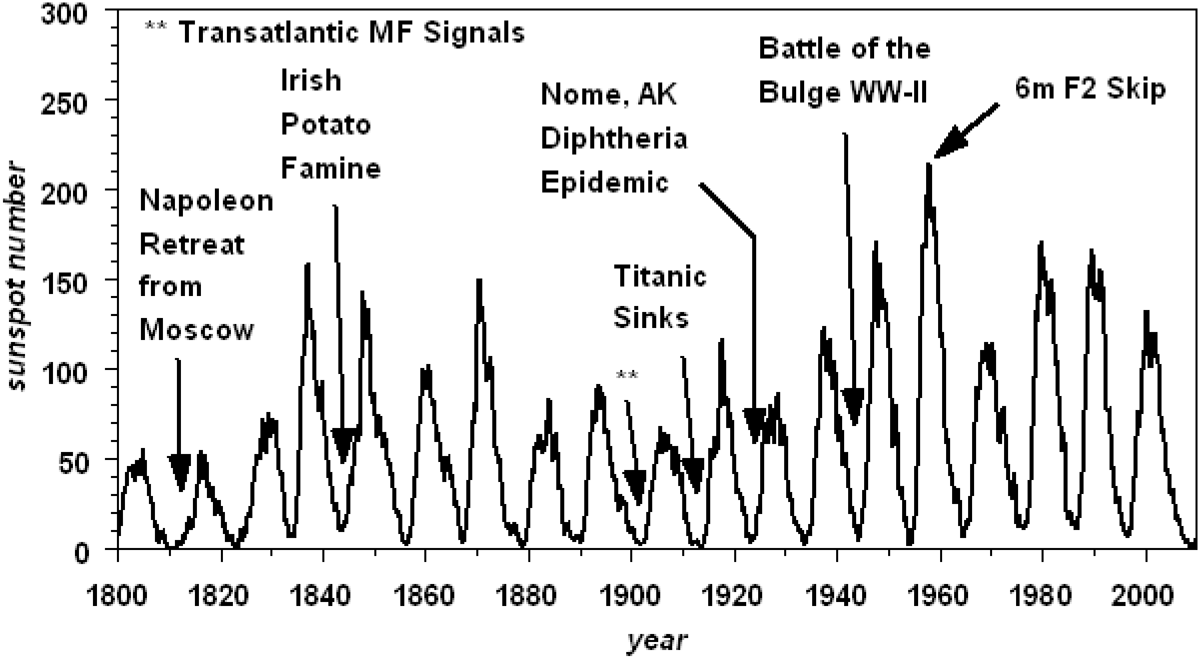
knowledge of the depth of the average sunspots dating back 400 years as well as relative lack in the relative distribution of sunspots with solar latitude, all of which can influence the exact values of Δr. Nonetheless, general trends in the sunspot numbers against planetary tidal forces will be shown to occur in the following sections.

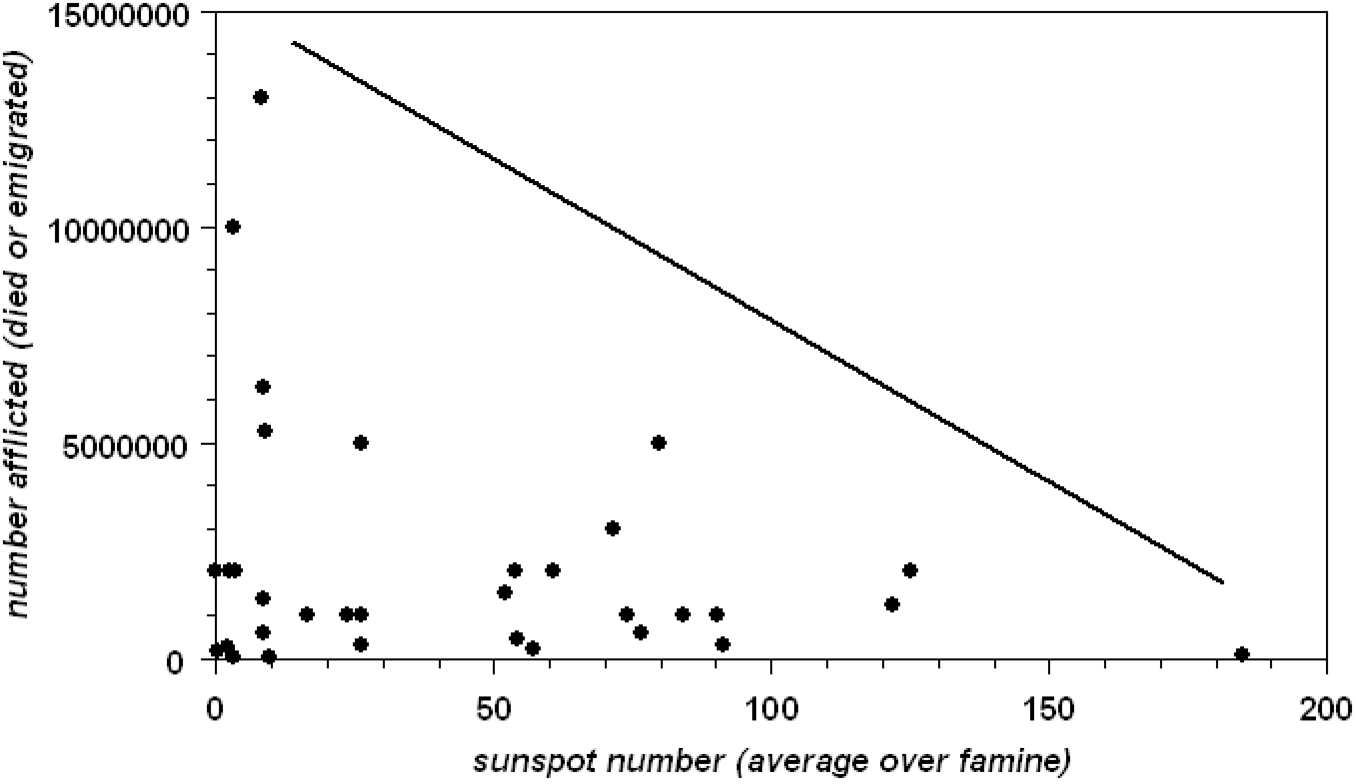
Figures 5-6. These figures show images of the solar system during two representative sunspot cycle peaks. The first figure indicates the relative positions of the planets seen from 5 Astronomical Units above the sun on 15-Dec-1957 and the second figure indicates the relative positions of the planets from the same location on 15-Nov-1804. These calculations were made with the Starry Night software package and such images were used to calculate the tidal forces on sun's photosphere for each of the 24 historically recorded sunspot cycle peaks.

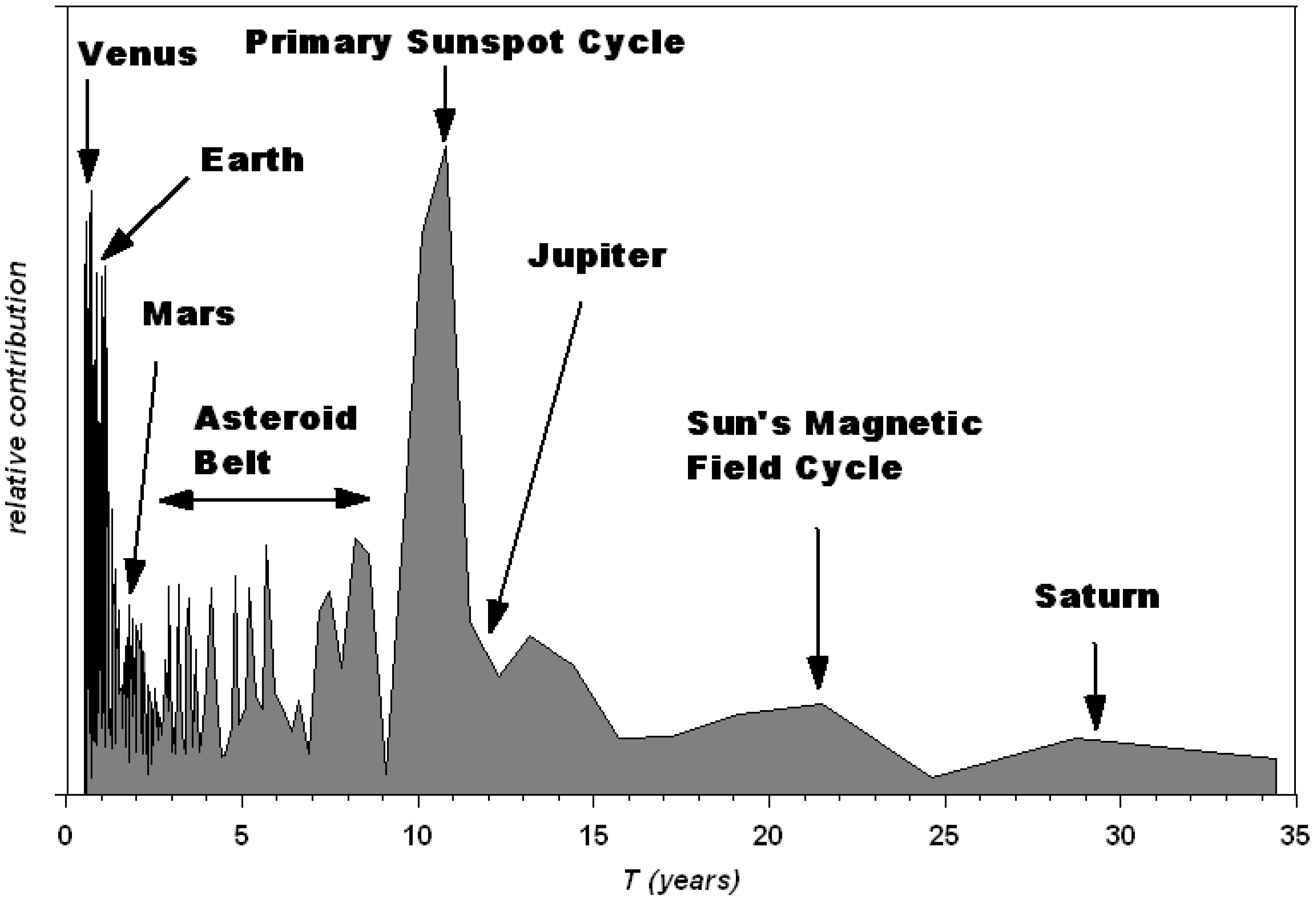
Figure 7. This figure shows the solar plasma tides calculated in the same manner as the earth's ocean tides using known planetary positions and known tidal forces. Unlike earth's tidal motions, the sun has no solid continents and the solutions are more sinusoidal in appearance as compared to the tidal motions routinely published for the earth. In each of the 24 well defined solar cycle peaks recorded in history, the data are plotted against the angles relative to Jupiter which has the most significant tidal force on the sun (see Table 3). These data are sorted into four groups: blue curves for weaker solar cycles where the peak SSN are less than 100 sunspots, solar cycles where the peaks range from 100 to 150, solar cycles where the peaks range from 150 to 200, and the most significant peaks having SSN peaks in excess of 200. The next figure takes these results and compares them to the actual sunspot cycle peaks.

Figure 8. This figure shows the peak in sunspot numbers for each of the 24 historically recorded sunspot cycle data as a function of the summed planetary tidal force calculations using data shown in previous tables and figures. This data trend against the tidal forces confirm a connection to the Fourier analysis data shown earlier in Figure 4. Unlike the Fourier analysis, data presented in Figures 7-8 give a better interpretation as to the actual physical processes involved in creating additional sunspots in the individual solar cycles. These data suggest that as the planetary tidal forces increase, existing sunspots break apart into additional sunspots by the shearing motions caused by the plasma tidal waves generated by the gravitational forces connecting the sun to the planetary bodies in our solar system.

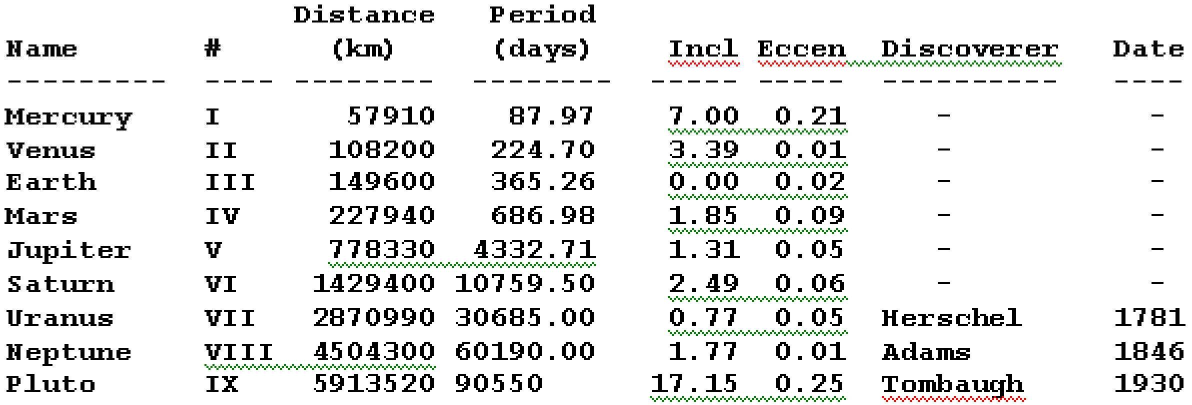

300
250
200
150
100
50
0
sunspot number
1600
1620
1640
1660
1680
1700
1720
1740
1760
1780
1800
year
Plymouth Colony, MA
Harsh Winter
English
Civil War
Maunder
Minimum
Valley Forge
American
Revolution


** Transatlantic MF Signals
Napoleon Retreat from Moscow
Irish Potato Famine
Nome, AK Diphtheria Epidemic
Titanic Sinks
**
Battle of the Bulge WW-II
6m F2 Skip
sunspot number
0
50
100
150
200
250
300
year
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000


15000000
10000000
5000000
0
number afflicted (died or emigrated)
0
50
100
150
200
sunspot number (average over famine)


Venus
Primary Sunspot Cycle
Earth
Jupiter
Mars
Asteroid Belt
Sun's Magnetic Field Cycle
Saturn
relative contribution
0
5
10
15
20
25
30
35
T (years)

Orbital and Historical Data



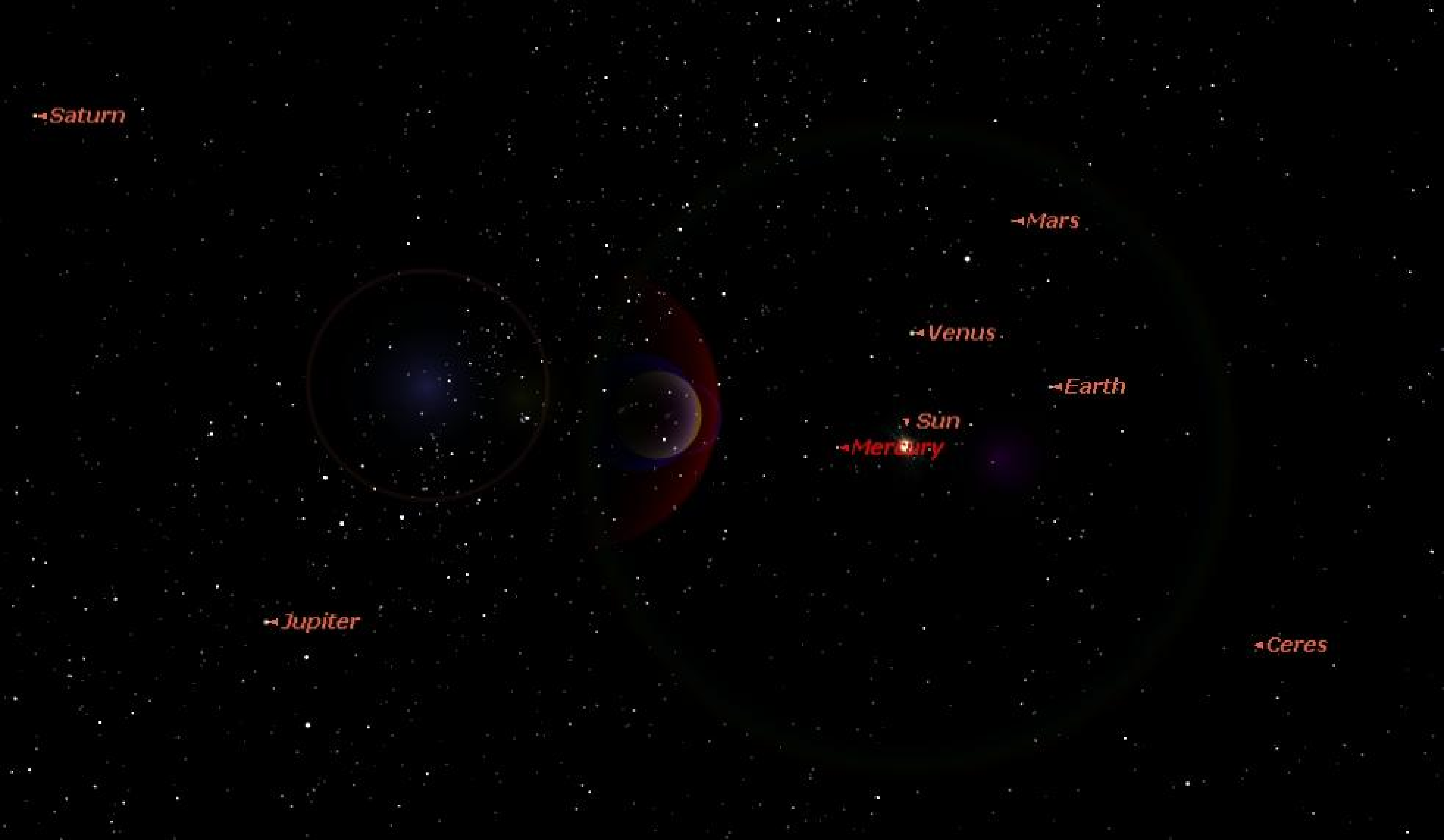
Name	#	Distance (km)	Period (days)	Incl	Eccen	Discoverer	Date
Mercury	I	57910	87.97	7.00	0.21	-	-
Venus	II	108200	224.70	3.39	0.01	-	-
Earth	III	149600	365.26	0.00	0.02	-	-
Mars	IV	227940	686.98	1.85	0.09	-	-
Jupiter	V	778330	4332.71	1.31	0.05	-	-
Saturn	VI	1429400	10759.50	2.49	0.06	-	-
Uranus	VII	2870990	30685.00	0.77	0.05	Herschel	1781
Neptune	VIII	4504300	60190.00	1.77	0.01	Adams	1846
Pluto	IX	5913520	90550	17.15	0.25	Tombaugh	1930

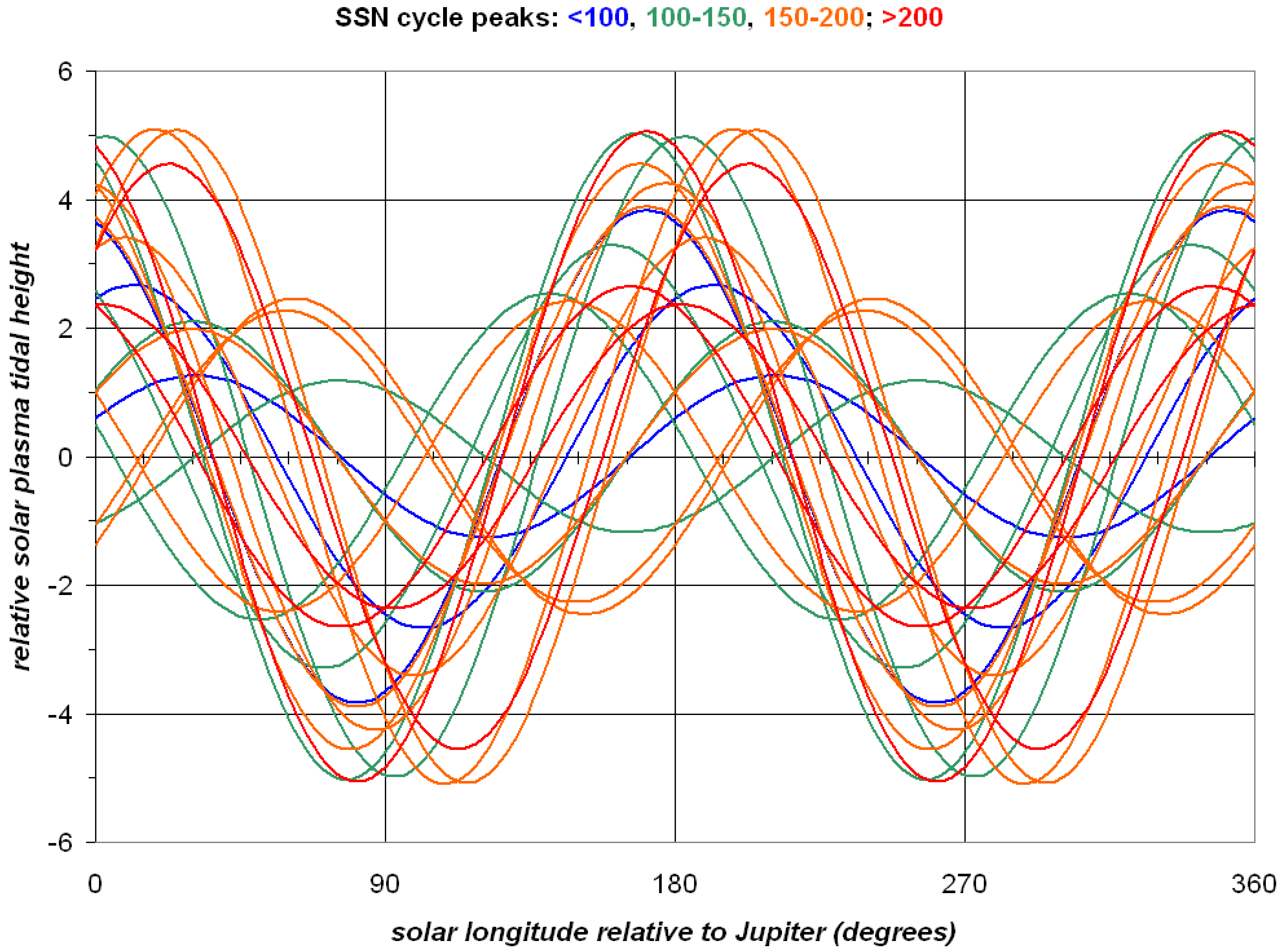
	Planetary mass × 10^6 (relative to the Sun)	Satellite mass (relative to the parent planet)	Absolute mass	Mean density
Planets and natural satellites				
Mercury	0.166 01		3.301×10^{23} kg	5.43 g/cm^3
Venus	2.447 8383		4.867×10^{24} kg	5.24 g/cm^3
Earth/Moon system	3.040 432 633 33		6.046×10^{24} kg	4.4309
Earth	3.003 489 596 32		5.972×10^{24} kg	
Moon		$1.230\,003\,83 \times 10^{-2}$	7.346×10^{22} kg	
Mars	0.3227151		6.417×10^{23} kg	3.91 g/cm^3
Jupiter	954.79194		1.899×10^{27} kg	1.24 g/cm^3
Io		4.70×10^{-5}	8.93×10^{22} kg	
Europa		2.53×10^{-5}	4.80×10^{22} kg	
Ganymede		7.80×10^{-5}	1.48×10^{23} kg	
Callisto		5.67×10^{-5}	1.08×10^{23} kg	
Saturn	285.8860		5.685×10^{26} kg	0.62 g/cm^3
Titan		2.37×10^{-4}	1.35×10^{23} kg	
Uranus	43.66244		8.682×10^{25} kg	1.24 g/cm^3
Titania		4.06×10^{-5}	3.52×10^{21} kg	
Oberon		3.47×10^{-5}	3.01×10^{21} kg	
Neptune	51.51389		1.024×10^{26} kg	1.61 g/cm^3
Triton		2.09×10^{-4}	2.14×10^{22} kg	
Dwarf planets and asteroids				
Pluto/Charon system	0.007396		1.471×10^{22} kg	2.06 g/cm^3
Ceres	0.00047		9.3×10^{20} kg	
Vesta	0.00013		2.6×10^{20} kg	
Pallas	0.00010		2.0×10^{20} kg	

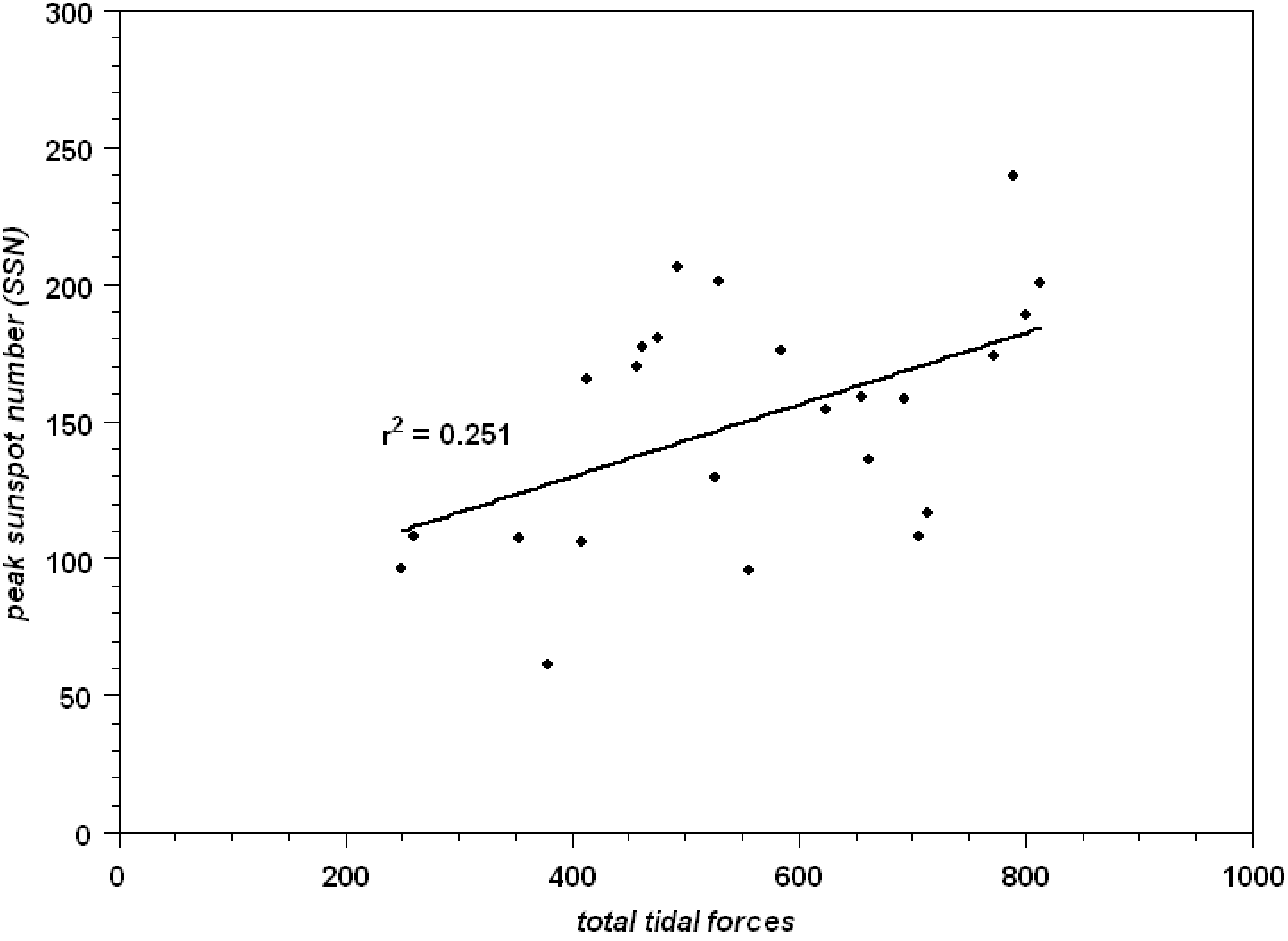
Relative Tidal Forces seen from the surface of the sun.

Planet/Asteroid	Tidal Force at Sun (if Earth = 1)
Mercury	0.9413
Venus	2.1277
Earth	1.0000
Mars	0.0300
Jupiter	2.2299
Saturn	0.1078
Uranus	2.03E-03
Neptune	6.21E-04
Pluto	3.94E-08
Ceres	4.06E-06


Jupiter
Ceres
Mars
Earth
Sun
Venus
Mercury
Saturn


Saturn
Mars
Venus
Earth
Sun
Mercury
Jupiter
Ceres


SSN cycle peaks: <100, 100-150, 150-200; >200
6
4
2
0
-2
-4
-6
0
90
180
270
360
relative solar plasma tidal height
solar longitude relative to Jupiter (degrees)



300
250
200
150
100
50
0
peak sunspot number (SSN)
r^2 = 0.251
0
200
400
600
800
1000
total tidal forces