ordinates become normal if we examine the daily curve of second means, which shows subordinate maxima on April 19th and April 24th.

Of the meteoric ordinates suggested by Wolf, four correspond with minima, nine with ascents, seven with maxima, and six with descents in the auroral curve. Of the six apparently abnormal ordinates, only two, those of March 31st and Nov. 19th, are on descending inflections of the auroral daily curve of second means.

There seems, therefore, good reason to look for an increase of auroral displays, soon after every meteoric shower.

PLANETARY ILLUSTRATIONS OF EXPLOSIVE OSCILLATION.

By Pliny Earle Chase.

(*Read before the American Philosophical Society, May 16th, 1872.*)

The secondary centre of gyration in an exploded gas, on its return towards the centre of gaseous mass, being, as I have shown, at $\frac{5h}{9}$ (h representing the extreme excursion consequent on the explosion), we may reasonably expect, by referring the planetary masses to similar primary and secondary centres, to obtain evidence relative to the probability of the hypothesis of molar and molecular correlations. Whether the nebular hypothesis be true or false, the planets are oscillating under the combined action of centrifugal and centripetal forces. In their continual virtual fall towards the Sun, they are subject to such disturbances as arise from their mutual interaction, and should, therefore, tend to arrange themselves somewhat like the particles of an exploded gas. I submit the following exemplifications of such a tendency, the calculations being generally based upon the hypothesis that the planets are either in conjunction, or nebulously diffused along the entire line of their orbits.

1. Mercury is near the theoretical mean excursion $\left(\frac{5h}{9}\right)$ of the centre of gravity of the intra-asteroidal belt of planets.

Mercury*	$3\frac{1}{3}\times$ .3871	= 1.2903
Venus	$25\times$ .7233	= 18.0832
Earth	$31.85\times1.$	= 31.85
Mars	$3\frac{1}{3}\times1.5237$	= 5.079
	$63.52\times$ .8864	= 56.3025

$\frac{5}{9}\times.8864=.4924$ from the centre of gravity, or .3940 from the Sun, the true distance being .3871 ; $\frac{3940}{3871}=1.0178$.

2. The actual eccentricity of Mercury's orbit : the theoretical eccentricity if the oscillation were referred primarily to the intra-asteroidal

* The values of the astronomical elements are taken from Norton's Astronomy, unless otherwise stated.

centre of gravity, nearly : : the actual : the theoretical mean excursion from that centre of gravity.

Theoretical eccentricity, $2\times(\frac{5}{9}-\frac{4}{9})=\frac{2}{9}$; $.205515\div\frac{2}{9}=.92482$.

$(.8864-.3871)\div\frac{5}{9}=.89874$; $\frac{92482}{89874}=1.029$.

3. Neptune is near the theoretical explosive centre of the centre of gravity of the three exterior planets.

$$[2847.4\times9.539+416.7\times19.182639+532.5\times30.037]\div$$
$$[2847.4+416.7+532.5]=13.472 ;\ 13.472\div(1-\tfrac{5}{9})=30.312 ;$$
$$30.312\div30.037=1.009$$

4. Neptune's orbital centre of oscillation is near the orbit of Uranus.

$$\tfrac{2}{3} \text{ of } 30.03697=20.02465 ;\ \frac{20.02465}{19.182639}=1.0439.$$

5. The orbital centre of oscillation for Uranus, is near the centre of gravity of the three exterior planets. The mean orbital radius of Uranus is about twice that of Saturn.

$$13.472 \text{ (See No. 3) } \div(\tfrac{2}{3}\times19.182639)=1.05345.$$

6. The theoretical mean excursion for an explosion from the Sun to Uranus, is near the centre of gravity of Uranus and Saturn.

$$\tfrac{5}{9} \text{ of } 19.18264=10.657 ;\ (2847.4\times9.539+416.7\times19.18264)\div(2847.4+416.7)=$$
$$10.7697 ;\ 10.7697\div10.657=1.0106.$$

7. The theoretical mean excursion for an explosion from the Sun to Saturn, is near the orbit of Jupiter.

$$\tfrac{5}{9} \text{ of } 9.539=5.299 ;\ 5.299\div5.203=1.018.$$

8. The centre of gravity of Jupiter and Saturn is near Saturn's orbital centre of gyration.

$$(\tfrac{2}{3}\times9.538852)\div\left(\frac{2847.4}{12154.4}\times4.33605+5.2028\right)=1.0226.$$

9. The theoretical mean excursion from Jupiter to the Sun, is near the inner limit of the asteroidal belt.

$$(1-\tfrac{5}{9})\times5.2028=2.31236 ;\ 2.31236\div2.2014=1.05.$$

10. The centre of gyration of Jupiter's orbital radius is near the exterior limit of the asteroidal belt.

$$\tfrac{2}{3} \text{ of } 5.2028=3.4686 ;\ 3.4686\div3.4205=1.01406.$$

11. If all the known primary planets were aggregated at Jupiter's orbital centre of gyration, the centre of gravity of the solar system would be near the Sun's surface.

$$3.4686\times214.86=745.248 ;\ 759.46\div745.284=1.01908.$$

12. The centre of oscillation for the exterior asteroid, is near the orbit of the inner asteroid.

$$\tfrac{2}{3} \text{ of } 3.4205=2.2803 ;\ 2.2803\div2.2014=1.03584.$$

13. The centre of oscillation for the theoretical inner asteroid, is near the orbit of Mars.

$$\tfrac{2}{3} \text{ of } 2.2803=1.5202 ;\ 1.523691\div1.5202=1.0023.$$

14. The centre of oscillation from Mars to the Sun is near the orbit of the Earth.

$$\tfrac{2}{3} \text{ of } 1.5237=1.0158.$$

15. The theoretical mean excursion from Mars to the Sun, is near the orbital centre of oscillation for the Earth.

$$(1-\tfrac{5}{9})\times 1.5237=.6772\,;\ .6772\div .6667=1.01575.$$

16. The theoretical mean excursion from the Sun to the Earth is nearly midway between the orbits of Mercury and Venus.

$$(.3871+.7233)\div 2=.5552\,;\ \tfrac{5}{9}\div .5552=1.0006.$$

17. The theoretical mean excursion from Mars to the Sun, is near the centre of gravity of Venus and Mercury.

$$(3\tfrac{1}{3}\times .3871+25\times .7233)\div(3\tfrac{1}{3}+25)=.6838\,;\ .6838\div .6772\ \text{(See No. 15)}=1.01.$$

18. The theoretical mean excursion from the Earth to the Sun, is near the extreme excursion or aphelion of Mercury.

$$.4666\div(1-\tfrac{5}{9})=1.05.$$

19. The theoretical mean excursion from Venus to the Sun is nea Mercury's perihelion.

$$(1-\tfrac{5}{9})\times .72333=.32148\,;\ .32148\div .3075=1.04542.$$

20. The theoretical mean excursion from Mercury to the Sun is near the limit of the Sun's possible atmosphere (the limit at which the equatorial centrifugal force is equal to gravity).

$$[(1-\tfrac{5}{9})\times .3871]^{\frac{3}{2}}\times 365.2564=26.065\,;^{*}\ 26.065\div 25.187=1.035.$$

21. If the several planets were aggregated precisely, as they are approximately, at direct or reverse centres of oscillation, the centre of inertia of the entire planetary system ($\sqrt{\Sigma mr^2\div\Sigma m}$) would be near the orbit of Saturn.

$$(3\tfrac{1}{3}\times 1^2+25\times 2^2+31.85\times 3^2+3\tfrac{1}{3}\times 4^2+9307\times 18^2+2847.4\times 27^2+416.7\times$$
$$54^2+532.5\times 81^2)\div(3\tfrac{1}{3}+25+31.85+3\tfrac{1}{3}+9307+2847.4+416.7+532.5)=$$
$$27.28^2\,;\ 27.28\div 27=1.0104.$$

22. Notwithstanding the variations from centres of oscillation, consequent upon mutual planetary interactions, the centre of planetary inertia is still near the orbit of Saturn.

$$\Sigma mr^2(1{,}150{,}671{,}134)\div\Sigma m(13167.12)=9.348^2\,;\ 9.5389\div 9.348=1.0204.$$

23. The distance of the Moon's orbital centre of oscillation from the centre of the Earth, is very nearly a mean proportional between the limit of the Earth's possible atmosphere and the Moon's orbital radius.

$$(\tfrac{1}{3})^2 \text{ of } 238{,}800=26{,}533\,;\ (24\div 1.40937)^{\frac{2}{3}}\times 3962.818=26{,}230\,;$$
$$26{,}533\div 26{,}230=1.01155.$$

24. The *vis viva* of revolution at the Earth's surface : the equatorial *vis viva* of rotation, nearly : : Earth's orbital radius : twice Moon's radius of orbital gyration.

$$(17{,}066\div 1040.3)^2\div\left(91{,}328{,}000\div\frac{4\times 238{,}800}{3}\right)=1.00545$$

* The approximate coincidence of this period with Hornstein's magnetic cycle ($26\tfrac{1}{3}$ days. *Vienna Academy*, June 15, 1871) is noteworthy.