

| OBSERVER. | EPOCH. | θ_c | s_c | $\theta_o - \theta_c$ | $s_o - s_c$ |
|-------------------|---------|------------|-------|-----------------------|-------------|
| Burnham..... | 1880.47 | 245.8 | 1.07 | +0.1 | -0.11 |
| Hall..... | 1880.70 | 246.3 | 1.07 | \pm 0.0 | +0.01 |
| Burnham..... | 1881.41 | 250.1 | 1.03 | +2.0 | -0.11 |
| Hall..... | 1881.54 | 250.6 | 1.03 | -1.5 | -0.02 |
| Hall..... | 1882.52 | 256.4 | 0.96 | +2.7 | -0.26 |
| Schiaparelli..... | 1882.60 | 257.0 | | +9.8 | |
| Burnham..... | 1883.53 | 263.0 | 0.86 | -0.9 | -0.12 |
| Hall..... | 1883.58 | 263.3 | 0.85 | -1.0 | -0.11 |
| Schiaparelli..... | 1883.63 | 263.7 | | +11.1 | |
| Engelmann..... | 1883.96 | | 0.81 | | -0.20 |
| Schiaparelli..... | 1887.54 | 317.9 | 0.49 | +0.4 | \pm 0.00 |
| Burnham..... | 1889.51 | 358.4 | 0.57 | -0.5 | -0.02 |

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ON THE SIMILARITY OF CERTAIN ORBITS IN THE ZONE OF ASTEROIDS.

BY DANIEL KIRKWOOD, LL.D.

The occasional separation of comets into two or more fragments is no longer questioned. It may be asked, however, whether phenomena of this nature have been limited to comets, or whether indications of similar divisions may not be traced in the group of asteroids? This question, suggested some time since,* is one of much interest, but data for its discussion are still far from satisfactory. In order to facilitate the comparison of orbits so as to present at one view the most remarkable resemblances, I take a table of asteroidal elements, arranged in the order of their mean distances, and assume small, admissible limits of difference in the values of the distance, eccentricity, inclination, perihelion and node. In this comparison, however, it is to be borne in mind that the difference in longitude of the perihelion, as also in that of the node,

* *The Asteroids* (p. 48).

may have attained considerable magnitude. Adopting, arbitrarily, the following limits of difference,

$$\begin{aligned} (a - a') &< 0.005 \\ (e - e') &< 0.025 \\ (i - i') &< 2^\circ \\ (\pi - \pi') &< 20^\circ \\ (\Omega - \Omega') &< 30^\circ \end{aligned}$$

I move along the column a till I find two distances differing less than 0.005. Then, following the horizontal line through the corresponding columns, I discover by inspection what other elements fall within the assumed limits. I thus obtain the following cases of remarkable similarity :

| PAIRS. | a | e | i | π | Ω |
|-----------------------------------|--------|--------|-------|-------|----------|
| I { <i>Vera</i> (245) | 3.1039 | 0.1960 | 5 11 | 27 13 | 62 12 |
| { <i>Semele</i> (86) | 3.1015 | 0.2193 | 4 47 | 29 10 | 87 45 |
| II { <i>Clotho</i> (97) | 2.6708 | 0.2550 | 11 46 | 65 32 | 160 37 |
| { <i>Juno</i> (3) | 2.6683 | 0.2579 | 13 1 | 54 50 | 170 53 |
| III { <i>Maia</i> (66) | 2.6454 | 0.1750 | 8 17 | 48 8 | 8 17 |
| { <i>Fides</i> (37) | 2.6440 | 0.1758 | 8 21 | 66 26 | 8 21 |

Eurynome (79) and *Fortuna* (19) have also a striking resemblance.

In view of the facts here presented the division of primitive masses seems less improbable than the accidental coincidence of so many elements. The cause, of whatever nature, which has separated the tenuous matter of comets may have been operative also in the original condition of the minor planets. The fact that where the inclination, eccentricity, longitude of perihelion and of the node, are most nearly coincident, the orbits are closely contiguous, is best explained by the theory of separation.

While, then, the hypothesis of explosion, as proposed by OLBERS, is no longer tenable, the facts of observation indicate the ancient dismemberment of primitive masses in the asteroidal group.

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