have been expected in one who, not only in the close, but during the greater part of his matured life, had been governed in all his acts by a paramount sense *of duty.*

I met with, some years ago in a newspaper, the following lines, of which I have not been able to ascertain the author, but which seemed to me so applicable to Mr. Seybert that I gave him at the time a copy of them, which will probably some day be found among his papers :

> I slept, and dreamed that life was beauty,
> I woke, and found that life was duty ;
> Was thy dream then a shadowy lie ?
> Toil on, worn heart, unceasingly,
> And thou shalt find that dream to be
> A truth, and noon-day light to thee.

The Zone of Asteroids and the Ring of Saturn.   By Professor Daniel Kirkwood.

(Read before the American Philosophical Society, Oct. 5, 1883.)

Evidence in support of the following theses was published by the present writer in 1866–7:

I.

In those parts of the zone of minor planets where a simple relation of commensurability would obtain between the period of an asteroid and that of Jupiter, the original planetary matter was liable to great perturbation. The result of such disturbance by the powerful mass of Jupiter was the necessary formation of gaps in the asteroid zone.

II.

The great division in the ring of Saturn may be explained by the disturbing influence of the satellites, and the more narrow division discov-

ered by Encke may be regarded with much probability as the effect of a similar cause.*

The recent able and noteworthy papers of General Parmentier,† of Paris, and Dr. Meyer,‡ of Geneva, have invested these older discussions of the same subjects with fresh interest and importance. The actual discovery of chasms in the asteroid ring was the result of a previous theoretical determination of the parts where void spaces would be produced by Jupiter's influence. The definite claims of the writer then are :

(1.) To have designated the theoretical positions of gaps in the zone of asteroids ;

(2.) To have shown that these divisions actually exist ; and

(3.) To have first assigned a physical cause for the divis ons of Saturn's ring.

A restatement of the principal evidence, showing the harmony of recent discoveries with the conclusions announced seventeen years since, is given below. The portions of the ring in which the periods would be commensurable with that of Jupiter are :

1. THE DISTANCE 3.2776.

At this distance a planetary mass would make precisely two revolutions while Jupiter completes one. Hence, as has been frequently shown, a chasm in the ring would be the probable consequence of Jupiter's disturbing influence. How far is this theoretical inference sustained by facts ?

An examination of the table of distances shows

Between 3.083 and 3.220.............. ....37 asteroids
  "   3.220 and 3.357...................................... 0   "
  "   3.357 and 3.494..................................... 8   "

That is, the part of the zone just within the distance at which a planet's period would be one-half that of Jupiter, contains the extraordinary number of thirty-seven minor planets, while the next space of equal breadth (that containing the distance 3.2776), is a total blank, not a single asteroid having yet been found within it. The exterior space immediately adjacent, and of the same extent, contains eight. The confirmation of the theory is thus most striking in precisely that part of the zone where we have most reason to expect it.

II. THE DISTANCE 2.5012.

Here an asteroid's period would be one-third that of Jupiter. The order of commensurability would be less simple, but the results of perturbation would be of the same nature. The part of the zone included between the distances 2.30 and 2.80 contains 143 minor planets ; 45 within the critical

* See Proc. A. A. A. S., 1866 and 1875; Met. Ast. Ch. xiii; Monthly Notice, R. A. S., Jan. 1869; Proc. A. P. S., vol. xii, p. 163; Smithsonian Rep., 1876; London Observatory, July, 1882.

† L'Astronomie, for June, 1883.

‡ Astr. Nach., No. 2527.

distance and 98 exterior to it. The average interval between adjacent members is 0.00349, while that containing the distance 2.5012—between Thetis and Hestia—is 0.05386, or more than fifteen times the average. Or, if we take spaces adjacent to the chasm and of equal breadth with it, we find twenty asteroids in the interior and eighteen in the exterior.

III. The distance 3.70.

Here five periods of a minor planet would be equal to three of Jupiter. The distance falls in the wide hiatus interior to the orbits of Hilda and Ismene.

IV. The distance 2.82.

At the distance 2.82 five periods of an asteroid would be equal to two of Jupiter. The difference between the two terms of the ratio is three, and hence the conjunctions would occur at angular intervals of 120°. Between the distances 2.753 and 2.803 we find twenty-three minor planets. In the next space of equal breadth, containing the distance 2.82, there is but one. This is No. 188, Menippe, whose elements are still somewhat uncertain. Between 2.853 and 2.903 we find ten asteroids.

Several other gaps have been noticed, but they become less distinctly marked as the cases of commensurability become less simple. Those considered are the only cases in which the conjunctions would occur at less than four points of the asteroid's orbit.

The orbit of Hilda is doubtless nearly, if not quite, the outer limit of the zone. Its mean distance is 3.9523, and in the space immediately beyond—at the distance 3.9683—an asteroid's period would be two-thirds of Jupiter's. It may be observed, moreover, that at the distance 2.063, just within the orbit of Medusa, a minor planet would make four revolutions to Jupiter's one.

Are the Gaps in the Zone Accidental?—In 1870, before half the asteroids now known had been discovered, Mr. Proctor, the well-known astronomer, wrote :

"The question may be suggested, however, is it not possible that the gaps thus apparent are merely accidental, and their accordance with the mean distances simply another accidental coincidence? It may seem, at first sight, that we have not as yet determined the orbits of a sufficient number of asteroids to decide very positively on this point. If another hundred were discovered, it might well happen, one would suppose, that the gaps would be filled up. But, in reality, the doctrine of chances is wholly opposed to this supposition. A law, such as that exhibited in the figure,* does not present itself without a cause. Irregularity is to be observed in all chance combinations, and the figure may be said to exhibit irregularity. But irregularities resulting purely from accident, never by any chance (when a fairly large number of cases is taken) simulates, so

* Mr. Proctor's diagram was merely a graphic representation of the groups and chasms of the zone.

to speak, the operation of law. Therefore we may assume that when many more asteroids have been discovered, the law exhibited in the figure will appear even more distinctly."*

One hundred and twenty minor planets have been added to the list since this passage was written, and, as was then predicted, the chasms in the zone have been rendered the more obvious.

In three portions of the ring the clustering tendency is distinctly evident. These are from 2.35 to 2.46, from 2.55 to 2.80, and from 3.05 to 3.22 ; containing forty-three, ninety-six, and forty asteroids, respectively. We have thus an obvious resemblance to the rings of Saturn ; the partial breaks or chasms in the zone corresponding to the well-known intervals in the system of secondary rings.

The Rings of Saturn.

In the writer's Meteoric Astronomy, published in 1867, the same principle employed to explain the chasms in the ring of minor planets was shown also to account for Cassini's division in Saturn's ring ; and, in a paper read before the American Philosophical Society, on the 6th of October, 1871, the division discovered by Encke was explained in like manner. The details of these calculations need not here be repeated, especially as Dr. Meyer has quite recently discussed the whole subject, not only confirming the conclusions of the present writer, but indicating also other parts of the ring where the satellites unite in exercising special disturbing influences. So exhaustive is Dr. Meyer's discussion that "the correspondence between calculation and observation, as to the division of Saturn's rings, would now seem to be complete."

OBITUARY OF JOHN FORSYTH MEIGS, M.D.

By William Pepper, M.D., LL.D.

(Read before the American Philosophical Society, Oct. 19, 1883.)

There are many men who, in their quiet, unobtrusive course, are of incalculable value to the community, and yet who leave but scant material for the biographer. The record of their life-work is to be sought in the cherished recollections of thousands who owe what

* Intellectual Observer. vol. iv, p. 22.