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The discovery of Juno and its effect on Olbers' asteroid explosion hypothesis[1]

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Abstract
In 1806, two years after the discovery of Juno, the asteroid explosion hypothesis made famous by Wilhelm Olbers was effectively demolished by the Swedish astronomer Lars Regner. His work has received virtually no attention, likely because it was written as a poorly-circulated pamphlet in Latin. This paper looks at both Olbers' and Regner's reaction to the discovery of Juno.

Keywords: asteroid, planet, explosion

1 INTRODUCTION

The year 2004 marks the two hundredth anniversary of the discovery of the third asteroid Juno. After the discovery of Ceres in 1801 and Pallas in 1802, many astronomers expected to find additional small planets between the orbits of Mars and Jupiter, so the finding of a third member of the group was no surprise. The main historical interest in the discovery of Juno lies in its impact on the validity of a hypothesis promoted by Wilhelm Olbers (discoverer of Pallas) to explain the existence of Ceres and Pallas.

2 OLBERS' HYPOTHESIS

Within weeks of the discovery of the second asteroid, Pallas, on 1802 March 28, Olbers had formulated a hypothesis to explain the existence of the asteroids. Recent archival research has revealed that Olbers got the idea from his friend and amateur astronomer Ferdinand von Ende. On 1802 April 6, Ende wrote to Olbers suggesting that the "two small planets had formed a bigger one; at least a comet shock (impact) is not more unlikely than throwing a comet against the Sun causing the planets to splinter off." (von Ende, 1802). Olbers never credited Ende with the original idea. He broached the concept to Carl Gauss in a letter of 1802 April 23 and on May 17 he wrote about it with some trepidation to William Herschel in England:

> The similarity in the period of their revolution, of their long axes, and the remarkable position of both orbits in relation to each other, have suggested to me an idea which I hardly dare to put forward as a hypothesis, and about which I should much like to have your, for me, weighty opinion. I mention it to you in confidence. How might it be, if Ceres and Pallas were just a pair of fragments, or portions of a once greater planet which at one time occupied its proper place between Mars and Jupiter, and was in size more analogous to the other planets, and perhaps millions of years ago, had, either through the impact of a comet, or from an internal explosion, burst into pieces? I repeat that I give this idea as nothing more than, hardly as much as, a hypothesis. (Olbers, 1802).

3 OLBERS' REACTION TO THE DISCOVERY OF JUNO

Less than a month after the discovery of Juno on 1804 September 1, Olbers was ready to abandon his hypothesis, as he relates in a letter to Gauss on September 30:

> The fact that in all probability Juno's orbit will also have the same orbital period and major axis as that of Ceres and Pallas, appears to me at least to totally topple my theory. This fact was questionable already with Ceres and Pallas, but could have been coincidental. However, since it is now also confirmed by the 3 asteroids, then one must reject a theory which not only doesn't explain precisely this curious situation but rather contradicts it. The disintegration of a planet would have necessarily imparted very different velocities to the various fragments. These new velocities must have been considerably influenced by the former tangential velocity because the orbits, considering their eccentricities and inclinations, differ so much from each other. (Olbers, 1804).

Upon sober reflection, Olbers reversed himself. In a letter to Baron von Zach in October (published in the November issue of the *Monthly Correspondence*), Olbers does his best to save his now beleaguered theory by invoking the aid of Jupiter.

> The entire situation of Juno's path has nothing which would not be compatible with my hypothesis (which, by the way, I do not wish to pass off as anything more than a hypothesis). Its nodes with the path of Ceres fall some 24 degrees from the node of the path of Pallas. But with the inclinations of the paths that differ so greatly, the nodes must move non-uniformly through the force of attraction of Jupiter. Presently, in its descending node, Juno's path lies on the path of Ceres, to which the path of Pallas is very close, far within the path of Ceres. But since the aphelia of all these paths have a very different movement than the nodes and the positions of the apsides-lines therefore always change against the nodes, and since these paths have almost the same major axes but very dissimilar eccentricities, it follows that these paths will intersect at certain times and will have done so in the past. (Zach, 1804)

4 REGNER'S ATTACK ON THE HYPOTHESIS

In 1806, Lars Regner, professor of astronomy at Uppsala University, launched a broadside against Olbers' hypothesis. The complete Latin text and

English translation of his treatise can be found in Cunningham (2004). At the beginning of his treatise, Regner expresses astonishment that the hypothesis was being seriously considered. It was, he thought, mentioned "purely for the sake of a joke."

Regner states that the hypothesis may be very easily tested because, if true, all of the fragments of the explosion "should penetrate the descending node of the orbit of Pallas in the orbit of Ceres." The discovery of Juno, Regner says, has now provided the means to test the hypothesis. He uses two main arguments.

(1) *The Major axis*: Regner claims that if the hypothesis is correct, the major axis of the orbit of Juno would surpass the major axes of Ceres and Pallas. "In fact, however, the observations indicate it to be somewhat smaller than these: and what is more, by the same reasoning the periodic times of these bodies would be dissimilar, and yet we know that they differ very little from each other."

(2) *The Eccentricity:* Based on the great difference in the perihelia of Juno and Ceres, Regner considers the difference in eccentricity. "If these two bodies were projected into space from the same location and with the same speed, the eccentricity of the orbit of Juno would be about three times greater than the eccentricity of the orbit of Pallas; in fact, the observations show that it is only greater by 0.019".

Regner is scathing in his conclusion:

> Therefore, it is now proven by these facts, if the descending nodes of these three orbits also were to assemble in one and the same moment, or if it were possible to be demonstrated that they had once assembled – which is the chief principle of Olbers' hypothesis – thence it still ought not to be concluded in any way that they were of the same family, that these three named planets were the thrust out pieces of some greater planet, unless indeed it were shown that their masses were equal and the eccentricities of their orbits were in the ratio of the mutually distant perihelia. And so it seems thoroughly amazing to us how, despite all of the arguments, and indeed every appearance of its likelihood stripped away, this opinion was able to thrive for just under four years now, and not only blindly commended by the foremost astronomers of our time, but also, as a portent of its ingenuity, to be extolled with the loftiest praises. Now, even if we are plainly lacking valid reasons, which we have already used to vanquish Olbers' hypothesis, nonetheless it will justly remain absurd.

5 CONCLUSION

Even though Regner did not address himself to the suggestion that Jupiter's gravity caused the nodes of the asteroids to move in a non-uniform way, his refutation of the hypothesis was conclusive. It did not, however, end the controversy. In fact, Regner's work was not referred to by any other writer on the subject, but by mid-century most agreed with the verdict of Walter Mitchell (1866): "The destruction of Olbers' planet is generally consigned to the limbo of hypothesis, as no better than a mere philosophical dream."

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7 NOTES

1. A German-language version of this paper was presented at the Juno 200 conference in Bremen, Germany in 2004.

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Clifford Cunningham is contributing editor of *Mercury* magazine; his Annals of Astronomy column has been appearing there since 2001. He has written five books: *Introduction to Asteroids* (1988); *The First Asteroid* (2001); *Jousting for Celestial Glory* (2004); *The Collected Correspondence of Baron Franz von Zach*, Volume 1 (2004); and *The Origin of the Asteroids* (2004). A graduate of the University of Waterloo, Canada in both physics and ancient history, his articles have appeared in many magazines and journals including *Annals of Science*, *The Canadian Aeronautics and Space Institute*, *Sky & Telescope*, *Spaceflight*, and *Space Education*. He writes the Spaceflight section for the annual publication Astronomical Calendar. In 1990, asteroid 4276 was named Clifford in his honour by the Minor Planet Center.