Chapter 2
Regnér’s Attacks on Olbers’ Hypothesis

Just 1 year after Olbers disseminated his hypothesis to the scientific community, it came under the scrutiny of Lars Regnér (1746–1810), Professor of Astronomy at Uppsala University in Sweden. As no biography of Regnér exists in English, a summary from Swedish sources follows.

He was a student in Uppsala 1767 and earned his “fil. magister” (Ph.D.) there in 1776. Regnér was promoted in 1780 to Docent in Physics and in 1785 to Adjunkt in the same subject area. He became Assistant Professor in Astronomy in 1796, and in 1798 advanced to “astronomie observatory.” In 1799 he was appointed “ordinarie” (full) Professor in Astronomy.

Regnér interested himself not only in his own scientific discipline but also other branches of science. To the benefit of the students at the university he started in 1785 publishing Introduction to Science, which was intended to include not only mechanics, physics, meteorology and astronomy but also knowledge about living and organized bodies. One publication of this series on science, in 1797, covered astronomy. In this is revealed the independent scientific mind of the author, as in the detailed treatment of the question of the stability of the Solar System, which refutes the reasons advanced in a 1772 work by his fellow Swedish astronomer Daniel Melanderhielm (1726–1810) against this stability. (His name is also spelled Melanderhjelm in his 1800 paper mentioned in Chap. 3 of this book.)

Throughout his career he used the format of a pamphlet in Latin to dispute the contentions of other astronomers. Regnér treated astronomical questions in most of his published academic disputations, about 30 in number, and in some shorter essays included in Zach’s Monthly Correspondence and Bode’s Berlin Astronomical Yearbook. One of his disputations in 1797 about the Sun’s parallax was the target of sharp criticism by professor of surveying (later professor of mathematics) Jöns Svanberg (1771–1851). This pamphlet of 1808 was written in Latin. An equally sharp answer was delivered by Regnér in the same year in the pamphlet Anmärkningar vid professor Jons Svanberg’s Observationes nonnullae in disquisitionem de parallaxi solis, till Kongl. Vetenskaps Academines in bedömande öfverlätne (Remarks … to the Royal Science Academy in Stockholm judgment conveyed). The two
Fig. 2.1 Title page of the 1803 treatise on the asteroids by Regnér (Courtesy of Uppsala Observatory)

adversaries also battled in columns published in *Stockhols-Postens*. (Sources for this biographical sketch: Nordisk Familjebok (1889); Svenskt biografiskt handlexikon 1906).

The 1803 Treatise

It was in such a publication of 1803 that he first refuted Olbers’ hypothesis (Fig. 2.1). In this and the following pamphlet he marshals a suite of arguments to thoroughly delegitimize the hypothesis of Olbers. The pamphlet also gives him a platform for
making a shocking attack on Herschel. This author’s analysis of his text highlights the rhetorical devices developed in ancient times that he employs to great effect, made natural by his use of Latin.

Concerning
the Newly Discovered Planets
Ceres and Pallas

Up to the year 1781 all Astronomers abandoned the hope of finding anything in the sky, which should be memorized above all else; they believed that optical instruments had already achieved their ultimate perfection; and, if they were able to determine the locations of the fixed Stars more accurately, to observe the mutual perturbations of the bodies of the Solar System, and to summon more refined calculations, they hoped for the science to be perfected for the future. Now, however, Dr. Herschel has unexpectedly announced that he has detected a new planet, and with this discovery he has in essence established a new epoch for astronomy; for the belief is born of still more undetected bodies, and together with this the hope of investigating them.

We know from observations that the orbits of the planets are not quite full circles, and that the Sun occupies a common center of all of them; and, as is known from the theory of attraction, that the more remote planets are moved more slowly by the Sun than those that are nearer. Let \( a \) signify the medium distance of a certain planet from the Sun, \( t \) its periodic time, and \( c \) its speed; this becomes \( t = a^{3/2}; \) and therefore, since the peripheries of the circles are in direct ratio of the radii, it should be \( c = a / a^{3/2} = 1 / a^{3/2}. \) Thus, when the spaces are traveled through at the same time they decrease in an inverse ratio of the distant square roots, and the body, where it is moved more slowly, is disturbed more swiftly by the motion; if the mutual distances of the orbits of the planets were equal, it is clear that the most remote planets, by the force of mutual attraction, would be disturbed as much as possible and would be delayed by the motion, and at last would collapse. In fact, when the Astronomers began their investigations, they found the distances between the orbits of the planets to be greater the further they were away from the Sun; so that if the distance of the orbit of Earth from the orbit of Venus were signified by unity, the distance of the orbit of Mars from the orbit of Earth would be 1.89, Jupiter from Mars 13.29, Saturn from Jupiter 15.67, and Uranus from Saturn 34.8.

It was easy to see that the increasingly growing intervals of the planets were ordained to be thus by the Wisest Creator unto the very end, so that the planets would be disturbed by one another as little as possible; but the interval that lies between the orbit of Jupiter and Mars, even if we take into account the immense mass of Jupiter before the mass of Mars, leads astronomers to suspect that there may be an as yet undiscovered planet dwelling between these orbits. Indeed the algebraic equation found seemed to confirm the conjecture, which, although a physical reason is hidden, mimics as closely as possible the known distance of the planets from the Sun *).

*) Perhaps by chance and by some game of natural talent someone found that the medium distances of the planets from the Sun could nearly be expressed in this sequence: 4, 4 + 3, 4 + 2.3, 4 + 2^1.3, 4 + 2^2.3, 4 + 2^3.3, 4 + 2^4, 3; From whence it is deducted from Do. WURM, unless I am mistaken, is the general equation for the medium distance of any planet from the Sun \( d = a + 2^{-n} b; \) where \( a = 4, \) or more rightly = 0.387, with evidently the supposed medium distance of the earth from the Sun = 1, signifies the distance of Mercury; \( b = 3, \) or more correctly = 0.293, the difference of the distances of Mercury and Venus, and \( n \) the number, signifying the calculated order of the planet from the Sun. If \( n \) signifies the fifth planet from the Sun, it is found that the distance of this = 2.731, which falls into the interval of the orbits of Mars and Jupiter, and its periodic time = 4.513 years, or 1648 days. It is amazing how close this equation is to nature, not only if you look at the planets but also their Satellites. Mercury alone departs a little way from it. [End of footnote by Regner.]
The Heavens were often examined with these reckonings and continuously arranged in the catalogues of the Stars, and at last, after countless fruitless struggles, on January 1, 1801, Dr. Piazzi, a Sicilian Astronomer, happened to be gazing at a star, which, because of its remarkable motion, he did not hesitate to co-opt into the ranks of the planets, under the name Ceres, which it has retained since. Yet many called the ‘planetism’ of this object into doubt, and, alas, at this time it was situated so close to its own conjunction with the Sun that, precisely on the 2nd of February of the same year, when it had only moved about 9 degrees in its course, concealed by the rays of the Sun, it vanished. Astronomers anxiously awaited its return, but when it was due to appear again, it was not found. And so, searching these regions of the sky again and again in vain, everyone said that the Piazzi’s star was a comet, passing through its own perihelion, and in every instance they ceased in this useless venture to find it; and if not for the work and skill of Dr. Gauss it may have been lost and cast into perpetual oblivion.

This man, most perspicacious in Geometry, undertook to call Piazzi’s observations into a more exacting discourse, and it was with such a happy success that he was able to determine more accurately the place where, at the established time, the sought-after star would return, and indeed on the 7th of December of the year 1801 Dr. Baron von Zach actually saw it; but, hampered from continuing his observations by bad weather, it still remained in doubt until Dr. Olbers could add to the certainty of its discovery on January 1st of the following year. After this time it was observed with the greatest repetition by many people, and written among the number of the planets; and it is not inappropriate to say that its theory may be determined as accurately as that of the other planets. The following table shows its elements as recently corrected by Dr. Gauss*):

* Monthly Correspondence of Freyh. von Zach. Nov 1802 [end of footnote]

| 1803 Epoch at Seeberg meridian | 233° 37′ 35.″ 3 |
| Aphelion | 326 37 40 |
| Ascending Node | 80 55 1 |
| Inclination of the orbit | 10 37 55.2 |
| Semimajor Axis | 2.767556 |
| Eccentricity | 0.0788236 |
| Daily Motion | 770°. 7951 |
| Periodic Time | 1681. d. 9. h. |

Astronomers were able to bring praise to themselves so much more for this recent victory, because the orbit of this star held its place, which, between the orbits of Mars and Jupiter, the recently produced equation had predicted as nearly as possible. And soon they rejoiced among themselves for having interrupted the series of planets from the Sun out to Uranus, since they had thoroughly concluded that, if ever a new planet were to be discovered in the future, it ought never to have been looked for on this side of the orbit of Uranus.

Truly it is not surprising that they did not trust in the announcement concerning another new planet, in the vicinity of Ceres, which Dr. Olbers discovered on the 28th of March of the past year, and to which he gave the name Pallas, as if foreseeing that there would be a need for the shield of this Divinity, if he were to defend the place he assigned for it. From the established observations, Dr. Gauss deduced these following elements for this star*).
1802 Epoch at Seeberg meridian, 31 March 162° 55′ 6″.8
Aphelion 301 38 41
Ascending Node 172 26 31
Inclination of the orbit 34 36 59
Semimajor Axis 2.770113
Eccentricity 0.243888
Daily Motion 769°.726
Periodic Time 1711.6 day.

It is unbelievable how much this new and unexpected companion of the planets has annoyed and continues to annoy the temperament of the Astronomers, not only for the reason that it dwells on this side of the orbit of Uranus, but especially because its medium distance from the Sun equals the medium distance of Ceres. And so, the law, which nature has continuously observed among the other planets, and equally so in the distribution of the perihelia of the comets and of the orbits of the satellites, does not tally with Ceres and Pallas. It would seem that this is because the intervals of the orbits increase the further the bodies are from the center. Because of this aberration, and indeed also because of the extremely great inclination of Pallas, which is like that of comets, Dr. Olbers wanted to conjecture that these two were originally nothing else than a single planet, into which some comet smashed a long time ago casting out one piece that now exists as Pallas.

Regnér begins his refutation not with a dispassionate statement but with what constitutes a personal attack on Olbers; it is quickly followed by a lemma on comets.

We were scarcely able to take this interpretation seriously, if we had not found it published in the scientific literature with the permission of its author, and actually endorsed as true by many first-rate astronomers. – For, if a comet were to approach a planet and strike it, nothing is more certain than that the one would cling to the other in one unique body, by force of attraction, and each would be reduced; and if a planet were so fragile that it was able to be smashed and broken into pieces, there is no doubt that, whatever fragment were to fall headlong into the comet, no trace, not even the least, would remain in space of so great a catastrophe. And so we are as thoroughly persuaded as possible that astronomical observations of this type would never indicate the destruction of celestial bodies, and would give no opportunity, unless a false one, of portending the world going to its ruin, and of one heavenly body becoming the doom of another. Which is why we do not at all hesitate to believe that Ceres and Pallas were hardly the remains of some fractured planet but were ever as they now seem to be to us. But will these very bodies, due to their remarkable proximity to each other, approach closer and closer to each other, by force of attraction, and in this way provide an example of the future destruction of the world at some time? We respond to this without any hesitation.

For, since the line of the nodes of the orbit of Ceres stand nearly perpendicular to the line of the nodes of the orbit of Pallas, it would seem that the longitude of the ascending node of Ceres is found to be 80° 55′ 1″ and that of Pallas 172° 26′ 31″; it is clear that the inclination of the orbit of Pallas at the orbit of Ceres does not differ much from its inclination towards the ecliptic. It = 35° 44′ 40″. The great mutual inclination of the orbit brings it about that both of these bodies approach each other as rarely as if the inclination were lesser, and, if both were to approach at the same time on the same node, that this very dangerous situation would quickly pass.
The residence of these in the same node is not so dangerous as might seem at first glance. From the reported elements we have found the true anomaly of Ceres, as long as it dwells in the intersection of the two orbits, or in the node, to = 10° 21' 50" and that of Pallas to = 37° 43' 52". And so the radius vector of Ceres in the near aphelion node becomes = 2.845018, and in the opposite node = 2.689948; and the radius vector of Pallas = 2.945351 in the prior location, and = 2.569710 in the latter location. Now let it be known that the medium distance of the Earth from the Sun is equal to 399 times the medium distance of the Moon from the Earth. If the radii vectors that we have found of the two planets are multiplied by 399 and the one is subtracted from the other, a difference of 43.6 arises in the near aphelion node, and of 47.9 in the opposite node. And so the distance of Pallas from Ceres in the node is 43.6 greater than the medium distance of the Moon from the Earth, and in the latter node 47.9; wherfore their mutual attraction is so scant that it would barely be possible to notice the disturbance in their movement. But when the lines of the apsides and the nodes of these bodies, just like the other planets, continuously change place among themselves, let us assume that that place is able, after the course of many centuries, to be altered, so that the line of the nodes stands perpendicular to the lines of the apsides, in which case, if both dwell together in the same node, they might approach each other as closely as possible. But, even in this case, which will never happen exactly, the difference of the radii vectors in the node becomes notable and = 0.01667, or the mutual distance of the planets 6.6 greater than the medium distance of the Moon from the Earth; and thus their mutual attraction only 1/43 of the attraction of the Moon towards the Earth, if their masses are assumed equal to the mass of the Moon; the effect of this negligible attraction is particularly weakened by the speed of the planets, or the quantity of the motion, in the vicinity of the perihelion.

All these things demonstrate enough that not only are the orbits of the planets not born by chance in some accident, and the bodies themselves not destined to bring about mutual destruction to each other; but also what is more, having diverse eccentricities and inclinations of orbits, they are able to be whirled at the same medium distance from the sun without danger.

In the next paragraph Regnér employs two rhetorical devices. First, a simile to compare comets with soldiers. He then states the proposition that there is ‘nothing preposterous to the laws of nature’ in the motion of Ceres and Pallas, and follows this with an aparithmesis by confirming his own proposition that the new objects are nothing new but merely a ‘separate community of planets.’

Among comets it may be that it is not rare for many to hold an equal, or nearly equal medium distance from the sun, and not to differ from each other except in the eccentricities of their orbits and in their mutual positions; and surely would it not seem very close to truth if the comets, whose dispersions in space seem so disorderly to us, were more often distributed in the way of soldiers marching together, and the intervals among these troops, just like among the planets, to increase the more they are distant from the planets? And so the discovery of these two planets, when we foretold they would be very much the same, showed only a slight variation from nature in their distribution, nothing preposterous to the laws of nature. Truly we can rightfully consider these two small bodies as a separate community of planets, substituted in the place of one larger body, and representing it; and hence it is evident that the series of planets more distant from the Sun, which is so nearly imitated by the equation $a + 2 = 2b$, was hardly interrupted by the unexpected discovery of Pallas, as many astronomers assert, and will not be interrupted even if more should be found afterwards at the same distance from the Sun.

It would be very tedious to bring all the inquiries of astronomers who have either located these bodies among the number of the planets, or who wanted to exclude them from it; indeed it would seem useless, since nearly all have long ago recognized the planet Ceres,
and there are very few who are still in doubt about Pallas. The particular reasons why they do not want this planet are the eccentricities of its orbit, which are greater than the other planets, and its great inclination towards its ecliptic; but that is too small to fashion the orbit of a planet; and this does not constitute a known family obligation to a planet.

Regnér then employs the most blatant apophasis by saying ‘unjust’ while pretending not to say it. He was clearly no fan of Herschel or the term asteroid. In a metonymic interpretation of this passage we see that Regnér assigns the same symbolic value to Ceres and Pallas as he does to Jupiter and Mercury. Thus, they should be ‘among the ranks of the Planets.’

But Dr. Herschel, who has used the highest (let me not say unjust) influence to draw both Ceres and Pallas from the rank of the planets, besides these reasons, produces the notable meagerness of their volumes, and proposes the name Asteroids.

These two bodies are admittedly very small. Through revised dimensions, Dr. Schroeter has found that the diameter of Ceres, at the medium distance of the earth from the Sun = 3."44 or = 1/5 of the diameter of the earth, and truly it is somewhat lesser than the diameter of the Moon. Yet this greatly overcomes the magnitude of Pallas, whose diameter, measured by Dr. Herschel, is found only to = 0".265, at the medium distance of the earth from the Sun; and truly it is about 1/18 of the diameter of the earth, or 1/18 of the diameter of the Moon, or about = 18.5 milliaris Secuans. Yet these micrometric observations are truly uncertain, and both of the most experienced astronomers of our time, Drs. Herschel and Schroeter, differ too much from each other in this matter. [Herschel & Schroeter were often at odds about observations: see Cunningham & Orchiston, 2015]

If the nature of the planets may be diverse, by reason of their diverse magnitude, and a truly new name would indicate new and particular characteristics, perhaps it would not be useless to adopt the denomination and division proposed by Dr. Herschel. But we plainly excuse this. And moreover it would then also be necessary to divide these five bodies that are already known by the name of planets for two thousand years into other classes: for Jupiter is far greater in size than Mercury, and Mercury than Pallas.

At last, since these bodies are whirled around the Sun, they should dwell continuously within the distances of the Planets from it, and they should remain visible under the entire course of the periodic times, with the times of the conjunctions with the Sun excepted; all of these things are characteristic to Planets: Certainly we see no reason why they should not be received among the ranks of the Planets. Perhaps it could happen that Pallas might lose itself to the sight of astronomers in the greatest distance from the earth and the Sun; but since this eclipse arises rather from its own scantiness than from the magnitude of its size, clearly it shows nothing against its qualifications as a planet. Concerning the other [Ceres], it is more than plain that it might also appear in this position; for on the 21st of September of the preceding year, although there was no difference of the right ascension of it and the Sun except 30° 53′.5 and for this reason its light was hardly weakened at all in the vicinity of the Sun, Dr. Messier was still able to observe it.

The aspect of Ceres is so variable in its magnitude and light that it can often scarcely be recognized from night to night, and it might easily lead the observer into doubt as to whether it might be the same star as was seen before. It always appears encircled by a cloud in the likeness of comets, the altitude of which equals about 2/3 the radius of the planet, and which sometimes obscures it so that its margins are discerned with difficulty; but sometimes it is observed to be clear and distinct. The reason for these changes is for some future hunting expedition. Pallas always gleams with equal brilliance, and does not seem to undergo the other variation, which arises from the diversity of its distance from the Sun and the Earth *).

The 1803 Treatise
At last let us say something that seems to be true, that other planets may orbit in this same medium distance from the Sun in which Ceres and Pallas whirl; Yet the future discovery of these will in no way confirm the hypothesis of Dr. Olbers about their origin.

*) It is agreed among astronomers to designate Ceres with a scythe and Pallas with a weapon. [End of the 1803 pamphlet.]

We see in this final passage from 1803 that the Swede subscribes to the erroneous belief Ceres has an extensive atmosphere that causes its light variability. He ends on a declamatory note, saying no matter how many other objects are discovered between Mars and Jupiter, the fallacy of Olbers’ hypothesis remains unshakeable.

**The Cometary Collision Hypothesis**

In his 1803 treatise, Regnér locks horns with the contention that a comet collided with a primordial planet. This was actually a suggestion made to Olbers by his friend Ferdinand von Ende, who wrote on April 6, 1802, that the “two small planets [Ceres and Pallas] 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.” Ende refers here to the theory promulgated by both Georges-Louis Buffon (1707–1788) and Whiston that the planets were torn from the Sun in a molten state.

The notion of a comet shock in the context of asteroid formation persisted for quite some time, but not without being rebuffed. Early in the study of asteroids, the astronomer Martin Alois David (1757–1836; 1807:189) in Prague dismissed a cometary agent in their creation. “It is strange and unlikely that a strong comet had crashed on a large planet between Mars and Jupiter, and had thrown it into smaller pieces, Ceres, Pallas, and Juno being smaller.” In a review of an English translation (by Mrs. W. Pengree) of *Ladies’ Astronomy* by the French astronomer Joseph-Jerome Lalande (1732–1807), *The Monthly Review* (1817) took her to task, saying the idea of a “planet being ‘dashed in pieces, no doubt, from its contact with a comet,’ (p.122.) is not consistent with the astronomy of the nineteenth century.” The reviewer was likely alluding to views prevalent in the eighteenth century when, for example, the English astronomer Edmund Halley (1656–1742; 1752) wrote in a posthumously published book that the “shock or contact of such great Bodies moving with such forces” was by no means impossible. But even he recoiled from the implications of a comet-planet collision, “lest this most beautiful order of things be entirely (sic) destroyed and reduced into its antient (sic) chaos.” As we saw in the Exordium to this book, Thomas Wright had no such qualms about a comet delivering a knock-out blow to the primordial planet between Mars and Jupiter.

The German Romantic philosopher Lorenz Oken (1779–1851; 1847:58–59), Professor of Natural History at Jena, expressed an even stronger opinion on the collision version of the catastrophe hypothesis, both in general terms and specifically in the case of the asteroids:
A comet can never come into collision with a planet; the fear of such an event is equally absurd with the hypothesis that a comet had produced the deluge or displaced the earth’s axis. Two planets also can never come into mutual collision, not even those that have been recently discovered, although their paths intersect each other.

Olbers only suggested the cometary impact option in the very early phase of the promotion of his theory, finding the planetary explosion much more persuasive, although he does not give a reason for this preference.

**The 1806 Treatise**

Regnér had the opportunity to put his contention of 1803 to the test with the discovery of Juno, and in 1806 he took up that challenge with relish. At the outset Regnér expresses astonishment that the hypothesis was being seriously considered. It was, he thought, mentioned “purely for the sake of a joke.” Regnér 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, Regnér says, has now provided the means to test the hypothesis. He uses two main arguments:

*The Major Axis*  Regnér 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.”

*The Eccentricity*  Based on the great difference in the perihelia of Juno and Ceres, Regnér 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.”

Shunning the opportunity to begin with parrhesia, Regnér opens the 1806 treatise (Fig. 2.2) with an all-out diatribe on the incredulity of the astronomical community. Footnotes in the original text are denoted by letters.

*Observations About the Hypothesis of the Renowned Olbers Concerning the Origin of the Planets Ceres, Pallas and Juno*

*How much are we surprised by the discoveries of these three new planets, Ceres, Pallas and Juno; so much indeed are we astonished at this, because the opinion of the unique Dr Olbers concerning the origin of these planets would seem to vindicate the faith of the astronomers in themselves. When first we heard mention of this hypothesis being made, we did not hesitate to consider this concept to be purely for the sake of a joke: and indeed, even though we saw it published many times afterwards in the scientific literature, nevertheless we were able, unwillingly and with repugnance, to convince ourselves that it was published there in sincerity a).*
But truly all reason for doubt that this opinion is seriously meant and not facetious was plainly taken from us long ago, when in the celebrated journal specially dedicated to progress in the understanding of the Heavens and the Earth it is openly declared and with many, many words that Dr. Olbers has definitely predicted on the basis of physical and astronomical principles the discovery of Juno and many other planets at the very distance from the sun at which Ceres and Pallas move.

Dr. Olbers, who, by his discovery of Pallas on the 28th of March, 1802, increased his own honor and renowned merits in Astronomy, a little afterwards fell upon the suspicion that the two planets, Ceres and Pallas, might be none other than the remnants of some other greater planet, long ago broken into parts, either by some natural internal force, or by the impact of some comet b).
a) Dissertation concerning the Planets Ceres and Pallas, new discoveries, Presenter L. Regnér; Respondent O. Hofstedt, 1803.

b) Doctor Schroeter, the most celebrated astronomer of our time, is in agreement. [Regnér here quotes from Schroeter’s book, published in Chapter 11 of this volume.]

This hypothesis, surpasses all others in this, as Dr. Olbers affirms, that it may be very easily tested whether it is true or not: for, if it may be true, more fragments of this kind of destroyed planet ought to be found, and they are less able to take themselves away from the inquiries of Astronomers, because it is inevitably necessary that all of those fragments, which abandon elliptical orbits around the sun c), should penetrate the descending node of the orbit of Pallas in the orbit of Ceres.

c) As a matter of fact, a lot could have flown away on parabolas, as Dr. Olbers considers. MC of von Zach, October 1804.

This desirable expectation is now satisfied. On September 1st, 1804, the planet Juno was found by Dr. Hardin d): but in truth, that Olbers’ Hypothesis, through this very fortunate occurrence, has undergone the danger of testing, concerning which, as Dr. Schroeter considers, very few hypotheses of physics are able to boast about, and has avoided the truth without controversy, as was promised by Dr. Olbers, is what we will doubt still with great endeavor, just as we have doubted all this time, e).


e) At last let us add (something that may have the appearance of truth) still more planets may whirl around in this medium distance from the Sun, where Ceres and Pallas orbit; the future discovery of which nevertheless by no means confirms the opinion of Dr. Olbers concerning their origin. See the final Dissertation concerning the planets Ceres and Pallas, cited above.

Let us look strenuously into these alleged physical and astronomical principles; and let us examine whether it might in fact deserve this name.

A natural internal force, shattering the planet, and hurling its torn pieces with violence into space, so that they might establish their orbits about the sun, and not rather, by the force of mutual attraction, that they might fall back again on themselves, scarcely, due to the vast enormity of its own magnitude, and not even scarcely be imagined merely in the thoughts of man; especially when this force would be more than that by which a greater planet would have to have been destroyed. Besides, it is evident that each of the three parts could in no way have received the same direction of movement. Inevitably, they would have begun some opposite path, and held a retrograde motion around the sun.

It is no less incompatible with nature that this ruinous catastrophe was brought about by the impact of some comet. For nothing is more certain than that a comet, if it were to approach a planet and strike it, would cling to the other, in one unique body, by the force of attraction, and each would be rendered: but if the planet were so fragile that it was able to be struck and shattered into pieces; there is no doubt that, whatever fragment would fall back headlong onto the comet, no trace, not even the smallest, of so great a catastrophe would be left in space.

But in truth let us suppose that these planets owe their origin to one of these two causes we have mentioned; let S be the sun and a the location where the catastrophe took place, where a greater planet was destroyed and its shattered pieces hurled into space (Fig. 2.3).

It is clear from the Theory of attraction, diverse bodies from the given location a, and from the given speed, project under diverse angles with the true radius at vector aS; around the common center of power S would be written the ellipses –evidently the speed given is supposed to be sufficient for establishing the ellipses – having equal major axes, and truly also having equal periodic times of the bodies f).
f) This equality of the major axes clearly follows from Prop. 32, Book 1 of Newton’s Principles of Natural Philosophy. Or rather, the beginning is, where the demonstration of the proposition is found.

Therefore, if these bodies, following different directions, but all perpendicular to the radius vector, are projected; all will actually have in the location $a$ either their own perihelia, or aphelia, just as they undertake their own orbits, either within the circle, described by the radius $aS$, or beyond it. Hence it is clear that all of these bodies assign evidently equal ellipses around the center of power; since the distance $aS$ is common to all the ellipses and furthermore the major axes of all are equal. Therefore there would be no lines of all these ellipses and apside nodes except one and the same line: Hence, all of these scattered bodies, half of them begun on a course about the sun, would also gather again and assemble at the other apex of the greater axis, opposite from the location $a$.

Because, if the directions of the projections establish diverse angles with the radius vector; it is evident that the orbits of these bodies would avoid the dissimilar elliptics; the eccentricities of these would be greater than this, and also the locations of the inferior apsides more remote from the given location $a$, where the angles of the projections are more acute with the radius vector $aS$.

It is also evident, whatever the force may be smashing some body and hurling its separate pieces into space, that it would distribute itself equally throughout the entire mass of the body. Therefore, since all the dissipated pieces would be projected with equal force, it is also clear that the speeds of these about the center of the force would necessarily have to be in an inverse ratio of the masses. Hence it follows that, if the greater axes of the orbits are equal, even now all the expelled pieces would have equal masses.

Let us now discuss the three most recently discovered planets with this simple and clear theory; We certainly believe that these planets had nothing close to so great a birth, as Dr. Olbers himself has devised, and that should be clear to everyone.
It could not happen that the directions of the projections of all three of the planets could be perpendicular to the radius vector \( \mathbf{a} \): for, in this instance, it would either have been necessary for the lines of all of the nodes to gather abruptly with the lines of the apsides, or it would be possible to clearly demonstrate that all six of these would have gathered in one place at some time. But in truth, were this ever to happen, the differences of the eccentricities and the diverse locations of the perihelia would prevent it.

Therefore, if Ceres, Pallas, and Juno may be sister planets, and the progeny of some greater planet, there cannot have been directions of these projections inclined separately towards the radius vector. Let us therefore inquire to what extent their movements fit with this theory.

If it is to be confirmed that these three planets were formerly pieces of the same planet, it is necessary that their masses would be in the ratio of their volumes. And so the mass of Pallas would be following the frequently repeating dimensions of Dr. Schroeter, approximately 3.2 and of Ceres 1.5, with the mass of Juno supposed as 1 g).

\( g \) We use the dimensions of these planets calculated by Dr. Schroeter rather than those that Dr. Herschel found, since they are clearly less precise. In any case, the dimensions of Dr. Herschel favor the hypothesis of Dr. Olbers much less.

From this it is clear, since the force by which each one was hurled out from the first planet was the same, that the speeds of the projections were diverse; and truly the greatest of them all was that of Juno, and after that, those of Ceres and then Pallas. Therefore, also by the same reasoning, the major axis of the orbit of Juno would surpass the major axes of the others in magnitude; 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.

It is no less clear, as is obvious from what we have said now, and indeed will be obvious from the eccentricities of the orbits and the locations of the perihelia, that these planets were not at all projected from the same location and with the same force.

We have said that the quantities of the eccentricities are less than this, and that the locations of the perihelia from the projections are more remote than this location, than which the direction of the projection may be more oblique towards the radius vector. Therefore, if we would assume that the projection of Ceres was orthogonal – which certainly seems to differ little from the truth, due to the scant eccentricity of the orbit – it is clear that the projection of Juno, due to the great difference in the perihelia and the longitudes of itself and of Ceres, was truly oblique towards the radius vector, and much more oblique than that of Pallas, whose longitude of the perihelion was located nearly \( \frac{1}{3} \) beyond the longitude of the perihelion of Ceres. Hence it is manifest that, 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.

Moreover, if these three planets were initially thrust into space from the same location and with the same force, how could it have happened, even if the average speed of Juno was a considerable amount greater than the average speeds of the others, and in fact the speed of the projection of Juno than the speeds of the projection of the others was indeed greater, that the major axis of Juno’s orbit would still give way in size to the major axes of the orbits of the others? How this fits into Olbers’ hypothesis, we simply do not see \( h \).

\( h \) Mon. Corr. by von Zach, 1804 Nov. pag. 462
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. Their reciprocating perturbations, and likewise those which were able to be inferred from the adjacent planets, are cited in vain as a reason for the aberrations from the theory: for, through these the eccentricities of the orbits cannot be changed, unless their major axes are also changed i).

What is more, is it not necessary that these three bodies, completing their own courses around the sun, would gather again in the same location from which they were expelled, due to the equality of their periodic times, and would again crowd together through the force of mutual attraction and form themselves into one, since the positions of the nodes cannot be noticeably varied within the scant space of time? – Therefore the astronomical principle of Olbers’ hypothesis, no less than the physical principle, is false and futile.

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 4 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. Yet, there actually remains to those people, whose intellect still allows changed forms to speak into new bodies, this slight (let us not say clever) escape: these catastrophes could certainly have happened at different times and in different places.

Now, even if we are plainly lacking valid reasons, which we have already used to vanquish Olbers’ hypothesis, nonetheless it will justly remain absurd. For, is it likely that some blow or strike, the effect of which is always doubtful and vague, would hurl the three chunks of this broken planet into space so abruptly, that they began their orbits around the sun at times as equal as possible, when these times could be for other countless reasons? And that their movement would be direct, when a contrary path was equally open to them? Does this not show, do the mutual inclinations of the orbits of these bodies not show, that they should not owe their origin to this blind chance? That the same Supreme Wisdom, which arranged the times and the paths for the other planets, guided and composed such for these too? And at last, when we see that the medium distances of these planets from the Sun are as close as possible as they ought to be to the analogy of the medium distances of the others, and the famous formula \( a + 2^{n-2}b \) represents it as nearly as possible: does not this final evidence indicate that these three planets, and perhaps more that should be discovered afterwards, establish a particular Society of Planets, ordained by design in place of one grander, and not the fragmented parts of some planet, scattered by chance?

Moreover, we believe, in the strongest terms possible, that astronomical observations of the type that Dr. Olbers wanted to conjecture would never indicate the destruction of celestial bodies; and they would never give to astronomers permission to speak of the ruin of Worlds, or that one heavenly body could be the catastrophe of another.

At last, let us consider this concerning the hypothesis, for which we have related the welcome discovery of Juno: it is right that we admire it as something useful to astronomy, not that we trust it as something true to physics. [End of the treatise.]

Thus, in a masterful use of the rhetorical figure of questioning – subjectio – Regnér concludes his analysis by putting the discovery of Juno in its proper place as an astronomical discovery that has no implications for the realm of physics. However, his correct assertion of the primordial nature of the asteroids fails the test
of modern science as it relies not only on divine intervention but the validity of Bode’s law.

Regnér (1805) also published an abbreviated version of his views on Olbers’ hypothesis, but both it and these two pamphlets were almost entirely ignored. His 1805 paper was summarized in Allgemeine Literatur-Zeitung (1806) and a brief notice appeared in a Danish-language survey of asteroid research by Thomas Bugge (1807:260): “Professor Regnér has in Bode’s Astron. Jahrbuch 1808 pp. 234–237 listed the reasons which speak against this hypothesis, at least in the form in which it is made by its inventor.” More of Bugge’s survey can be found in Chap. 13.

Despite Regnér’s emphatic assertion that one heavenly body could not be the ‘catastrophe of another,’ modern research has shown the opposite to be true. Schmitz et al. (2016) have shown that a subset of L chondrite meteorites are derived from a single asteroid that was shattered in a collision with another asteroid some 470 million years ago.

So finally, what can one make of the divergent views of the camps of Olbers and Regnér? They were presented with the same information about the asteroids but arrived at opposite conclusions. Two philosophical tableaus hold important insights. The first was posed by Kant, as explained by Frank Thilly (1865–1934; 1898), Professor of Philosophy at the University of Missouri.

> Kant believed that a new light had flashed upon him. Just as Copernicus imagines the spectator moving and the stars at rest, so Kant tries the experiment in metaphysics, of presupposing truth, in the perceiving of objects, it is the objects that conform to the perception, and not the perception that conforms to the objects.

The objects in this case are the four asteroids, which conformed to what Olbers and Regnér were predisposed to believe. Applying this to philosophy, Thilly writes, Kant “said that we understand space, time and causal relation because the mind relates things spatially, temporally and causally.” The spatial relation of one asteroid with another (their orbital properties), their relative age (whether primordial or not) and whether or not they are linked by an explosion (their causal relationship) are key to the origin of the asteroids.

How an empirical conceptualization, such as Olbers’ hypothesis, can be understood in Kantian terms is explored by Gaetano Chiurazzi (2017), Professor of Theoretical Philosophy at the University of Torino. In the passage that follows he identifies possibility as a critical concept, one that was explored in the author’s Studies of Pallas in the Early Nineteenth Century. There we saw that Laplace defined probability in terms of equally possible causes. He concluded that “astronomy proceeded from the mathematical analysis of statistically regular empirical findings to an understanding of the constant causes that determined the phenomena of nature.” Kant’s transcendental perspective does not state a conflict between a Ptolemaic truth and a Copernican truth, but, according to Chiurazzi, “between a truth founded on perception and a truth founded on reason. The transcendental revolution is a revolution against the idea that the truth is found in perception.” Chiurazzi explains the critical concept of possibility in terms of Copernican and Kantian thought.

> Copernicus and Kant understood that we are capable of comprehending that reality is independent of our sensations and empirical conceptualizations precisely because we have concepts, because we are capable of conceptualizing experience, through inferences, uni-
versalizations, and all of those operations that correspond to what Kant calls ‘pure con-
cepts.’ Far from negating the exteriority of reality, the concept affirms it: but it affirms it
because it is capable of placing a distance between knowledge and reality, a distance rep-
resented by the transcendental concept par excellence, that of “possibility.” Possibility is
the critical concept, or even the differential concept, without which there would be no
“sense of reality.” Perception, instead, does not know – that is, it does not conceive – pos-
sibility at all. Thus it is not critical, but remains clinging to reality, as does ivy, to quote a
well-known Italian song from many years ago.

A second tableau was created by the American philosopher of science Norwood
Russell Hanson (1924–1967; Fig. 2.4). He envisions Tycho Brahe and Kepler
watching sunrise together, an event that may very well have happened.

Tycho had formulated a ‘third way’ in cosmology. Distancing himself from both
Ptolemy and Copernicus, he created his own scheme about how the Sun and planets
revolve around Earth. Kepler sided with Copernicus. Hanson (1958:5) asked “Do
Kepler and Tycho see the same thing in the east at dawn?” Hanson suggests they
would make different observations in accord with their theoretical mindsets. Is the
sun rising above the horizon, or does one see the descent of the horizon with respect
to the Sun? Do we see fragments of a primordial planet, or do we see small objects
that are in their own right primordial? Do we cling to perceived reality like ivy, or
do we apply our critical faculties to discern nature in its true form? Olbers’ pre-rationa-
logical commitment (to co-opt a phrase from current studies on Nietzschean phi-
osophy) was firmly in the camp of catastrophism; that of Regnér was in the
revolutionary camp. Like the struggle over the Copernican system, and Charles
Darwin’s theory of evolution, the ultimately prevailing side had a few early adher-
ents, but it took more than a century to arrive at a general consensus.
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