

# The Hunt for Planet X

Govert Schilling

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New Worlds and the Fate of Pluto



**Copernicus Books**

*An Imprint of Springer Science+Business Media*

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Published in the United States by Copernicus Books,  
an imprint of Springer Science + Business Media.

Copernicus Books  
Springer Science + Business Media  
233 Spring Street  
New York, NY 10013  
www.springer.com

*Library of Congress Control Number:*  
2008937482

Translation from Dutch: Andy Brown  
Author photo: Hans Hordijk  
Springer acknowledges the translation subsidy by  
the NLPVF: Foundation for the Production and  
Translation of Dutch Literature

Dutch edition: De jacht op Planeet X, Fontaine  
Publishers, the Netherlands 2007, ISBN 978-9-059-56194-6

Manufactured in the United States of America.  
Printed on acid-free paper.

ISBN: 978-0-387-77804-4

e-ISBN: 978-0-387-77805-1

*For Margreet, with whom I shared a  
fantastic journey of discovery of a  
completely different kind during the writing  
of this book*

# Foreword

In August 2006, Pluto was disqualified as a planet. According to the International Astronomical Union the solar system only has eight planets instead of nine. Pluto, discovered in 1930 during a comprehensive search for the mysterious Planet X, now has the second-rate status of a dwarf planet.

The popular belief that astronomy is a rational science that leaves no room for emotion is a misconception. The news of Pluto's demotion made the front pages of newspapers around the world. Everyone had something to say about it, and emotions had rarely run so high in astronomical circles. But, of course, the new planet classification was founded on scientific fact and insight. In the early 1990s, what had been suspected for many years now proved indisputable – Pluto was only one object in an enormous population of small ice dwarfs in the outer regions of the solar system. One of them even turned out to be slightly bigger.

This book traces the history of exploration and discovery in the outer solar system. Running through that history like a red thread is the hunt for Planet X – a hypothetical celestial body that has remained elusive. That the hunt continues is not surprising: astronomers perpetually speculate on what is just beyond the reach of their telescopes. Every new discovery is incorporated in our evolving picture of the solar system, and each one opens up possibilities for a new Planet X.

Science is practiced by living, breathing people, and that is also true of the search for objects billions of kilometers from the Earth. It is a journey of discovery that has been under way for many centuries, a journey that has been marked by sweat and tears, and sometimes even a little blood. And, just as in any thrilling story of adventure, the hunt for Planet X has seen passion and dedication, success and failure, vanity and suspicion, and – above all – limitless curiosity. *The Hunt for Planet X* is not a dull schoolbook, but a scientific detective story.

And it is a detective story that is played out closer to home than you might think at first glance. The discoveries in the outer solar system may have cost us a planet, but they have provided many new insights into the origin and evolution of the planets. And into our own place in the cosmos.

No area of scientific endeavor can be covered exhaustively in a popular-scientific book. During the writing of *The Hunt for Planet X*, it was necessary to omit certain parts of the story. It was also impossible to devote attention to all those scientists working in the field of solar system research. If that has resulted in an unbalanced presentation of the subject matter, it was not my intention and I take full responsibility.

I owe many thanks to all the astronomers who consented to be interviewed during the research for this book: Mike A'Hearn, Charles Alcock, John Anderson, Fran Bagenal, Rick Binzel, Alan Boss, Mike Brown, Marc Buie, Robin Canup, Andy Cheng, Jim Christy, Dale Cruikshank, Imke de Pater, Martin Duncan, Dan Durda, Julio Fernández, Brett Gladman, Dan Green, Will Grundy, Piet Hut, Dave Jewitt, Nick Kaiser, Charles Kowal, Hal Levison, Jack Lissauer, Jane Luu, Renu Malhotra, Brian Marsden, Bill McKinnon, Bob Millis, Alessandro Morbidelli, Richard Muller, Max Mutchler, Keith Noll, Joel Parker, Venetia Phair-Burney, David Rabinowitz, Paolo Santos-Sanz, Dava Sobel, Myles Standish, Andrew Steffl, Denise Stephens, Alan Stern, Dave Tholen, Chad Trujillo, Tom Van Flandern, Larry Wasserman, Paul Weissman, Iwan Williams, Eliot Young and Leslie Young. Their impassioned accounts have made *The Hunt for Planet X* an exciting read.

Govert Schilling, summer of 2008

# Contents

<b>Foreword</b> .....	vii
<b>1 A Larger Solar System</b> .....	1
Pea .....	3
Conjunction .....	4
Fuzzy Star .....	7
<b>2 Eleven Planets</b> .....	11
Quest .....	13
Point of Light .....	14
Fragments .....	16
<b>3 The Writing Desk Planet</b> .....	19
Orbital Deviations .....	21
Mathematical Genius .....	21
Not on the Map .....	23
Loss of Face .....	25
Search .....	27
<b>4 ‘I’ve Found Your Planet X’</b> .....	29
Another Planet? .....	30
Lowell’s Hunt .....	32
New Searches for Planet X .....	33
Tombaugh’s Dedication .....	36
<b>5 The Kid Planet</b> .....	39
The Pluto Breakfast .....	41
Cartoon Figure .....	43
Scrapbooks .....	45
<b>6 A Strange and Wonderful Week</b> .....	47
Missed Opportunity .....	48

Omen . . . . . 50

Charon . . . . . 53

**7 Fortunate Circumstances . . . . . 55**

Atmosphere . . . . . 56

Mr Pluto . . . . . 58

Pure Luck . . . . . 59

Odd Man Out . . . . . 61

**8 Nix and Hydra . . . . . 65**

Hubble Photos. . . . . 66

Double Discovery . . . . . 68

Confirmation. . . . . 69

Names . . . . . 71

Quibbling. . . . . 72

**9 The Unauthorized Planet . . . . . 75**

Painstaking Work . . . . . 76

Rhadamanthus . . . . . 79

Centaur . . . . . 80

Forbidden Zone . . . . . 81

**10 Uranus: Problem Solved? . . . . . 85**

Speculation . . . . . 86

Humphrey . . . . . 87

Exit Planet X. . . . . 88

A Pinch of Salt . . . . . 90

**11 Mysterious Forces . . . . . 93**

Explorers . . . . . 94

Precision Measurements . . . . . 96

The Pioneer Anomaly . . . . . 97

Planets Aplenty . . . . . 98

**12 The Hunt for the Death Star . . . . . 101**

Dinosaurs . . . . . 102

Nemesis . . . . . 104

Questions. . . . . 106

A Remote Planet X . . . . . 107

**13 The Secret Planet. . . . . 111**

A Ready Pen . . . . . 112

Conspiracy . . . . . 113

Zetas . . . . . 114

Mayas . . . . . 116

- 14 Vulcanoids and Earth-Grazers** . . . . . 119
  - Vulcan . . . . . 120
  - Astronomy by Fighter Jet . . . . . 121
  - Earth-Grazers . . . . . 123
  - Apophis . . . . . 124
  - Danger of Impact . . . . . 125
  
- 15 The Kuiper Connection** . . . . . 127
  - Beyond Neptune . . . . . 129
  - The Kuiper Belt . . . . . 130
  - Enormous Legacy . . . . . 132
  
- 16 Comet Puzzles** . . . . . 135
  - The Oort Cloud . . . . . 137
  - Roving Comets . . . . . 138
  - Wriggling Dots . . . . . 140
  - Simulations . . . . . 141
  
- 17 Smiley** . . . . . 145
  - Uncertainties . . . . . 146
  - White Mountain . . . . . 149
  - Lucky Strike . . . . . 151
  
- 18 Family Portraits** . . . . . 155
  - Plutinos . . . . . 156
  - Speed Blinking . . . . . 158
  - Mini-Feud . . . . . 161
  
- 19 The Migrating Planet** . . . . . 165
  - Odyssey . . . . . 166
  - Migration . . . . . 169
  - Resonances . . . . . 171
  
- 20 Icy Treasure Troves** . . . . . 175
  - Pitfalls . . . . . 177
  - Pholus . . . . . 179
  - Variety . . . . . 181
  
- 21 The Big Five** . . . . . 183
  - Large Field of View . . . . . 185
  - Quaoar . . . . . 187
  - QUEST . . . . . 189
  - Sedna . . . . . 192

**22 The Tenth Planet** . . . . . 195  
 Xena . . . . . 197  
 Tenth Planet . . . . . 199  
 Lila . . . . . 201

**23 The Spanish Invasion** . . . . . 205  
 Google . . . . . 208  
 Typing Error . . . . . 210  
 IP Addresses . . . . . 212  
 Secrecy . . . . . 213

**24 Pas de deux** . . . . . 217  
 Big Whack . . . . . 219  
 Icy Duos . . . . . 221  
 Confirmation . . . . . 222

**25 Model from Nice** . . . . . 225  
 Strange Pair . . . . . 226  
 Migration and Resonance . . . . . 228  
 Bombardment . . . . . 231

**26 Planet Under Siege** . . . . . 235  
 Demotion . . . . . 236  
 Pluto Soap Opera . . . . . 238  
 Wanted: A Definition . . . . . 241

**27 Planetary Elections** . . . . . 245  
 Dwarf Planets . . . . . 247  
 Rebellion . . . . . 249  
 Foul Play . . . . . 250

**28 The Continuing Story** . . . . . 255  
 Eris and Dysnomia . . . . . 256  
 Buffy . . . . . 258  
 A Hundred Thousand Ice Dwarfs . . . . . 260

**29 A Thousand Planets** . . . . . 265  
 Indirect Clues . . . . . 266  
 Origins . . . . . 269  
 Mysteries . . . . . 271

**30 New Horizons** . . . . . 275  
 Pluto Fast Flyby . . . . . 276  
 A Fresh Start . . . . . 278  
 Souvenirs from Earth . . . . . 279

Contents	xiii
<b>Table: Details of a Number of Large Ice Dwarfs</b> . . . . .	283
<b>Chronology</b> . . . . .	285
<b>Glossary of Terms</b> . . . . .	291
<b>Bibliography</b> . . . . .	295
<b>Index</b> . . . . .	297

# Chapter 1

## A Larger Solar System

Jelte Eisinga jumped with alarm as the front door of the house, *De Ooijevaar*, slammed loudly. A moment later his father came storming into the kitchen and angrily threw the latest edition of the *Leeuwarder Courant* onto the table. Not even noticing his 6-year-old son, Eise stamped up the stairs to the attic, still mumbling to himself. Jelte started to cry and, when his mother came in from the yard to see what all the commotion was about, he hid himself in the folds of her dress. Pietje was all too familiar with her husband's moods, but recently, now his life's work was nearing completion, he had seemed to be more content. What could have upset him so much?

Stroking Jelte's back, Pietje picked the newspaper up from the table. Almost immediately, she saw a report that both excited and alarmed her. She felt the blood rush to her head and involuntarily glanced across at the door to the living room, which for many years had practically been forbidden territory to mother and son. In England, on March 13, 1781, William Herschel had discovered a new planet, way beyond the orbit of Saturn. In one fell swoop, the solar system had doubled in size. Pietje thought about the ceiling in the living room, the box bed, the attic and, above all, her husband's passion. She wouldn't survive another 7 years living in all this mess.

Little Jelte had just been born when Eise Eisinga told his wife about his dream: to construct a moving scale model of the solar system. It was the spring of 1774, a relatively calm time in their wool-combing business in the Friesian city of Franeker. Pietje remembered as if it were yesterday how Saturn had twinkled high in the evening sky, in the constellation of Leo. 'Look,' Eise had said, 'that is the furthest planet, with the largest and slowest orbit. That one will have the largest wheel, with 538 teeth.' Saturn's enormous orbit would of course have to fit into the living room, so the scale had to be modified to one in a billion. He was 30 years old, a man with a mission and with his sights set far beyond the horizon. How could she ever have resisted him?



Eise Eisinga, painted by Willem Bartel van der Kooi in 1827 (Courtesy Royal Eise Eisinga Planetarium)

So *De Ooijevaar* was transformed into a workplace. Shafts were turned on the lathe, wooden wheels sawn into shape, hoops bent into circles, and nails forged. A ceiling was removed here and a wall knocked down there. At one point, the pendulum of the main clockwork mechanism nearly ended up in their box bed, but Pietje put her foot down just in time. An attic full of cogwheels, circular slits in the ceiling, and more dials on the wall than you could find on the church tower in Franeker – that was all bad enough, especially as they also had to keep the combing business going.

Eise said that he would need 7 years to complete the project and she had to admit, he had kept his promise. But it had been 7 years of sawdust, frustration, and sleepless nights. And years in which the planets received a great deal more attention than little Jelte, who grew up amidst a solar system in the making. And now, at the very time that the final touches had been made to the impressive orrery, the walls painted and the planets

polished, with the first curious visitors coming to take a look, this Herschel had made a discovery that had rendered the whole masterpiece obsolete. Pietje could hear Eise stamping around above her head. How awful he must feel! She laid the *Leeuwarder Courant* back on the table and started shelling the peas.

## Pea

If you imagine the Earth the size of a large pea, the Moon would be a pinhead 20 centimeters away. The Sun, the size of a beach ball, would be 75 meters away. Somewhere between the Earth and the Sun, there will be two other peas in orbit: Mercury and Venus. And beyond the orbit of the Earth is Mars, the size of a bead. The giant planets Jupiter and Saturn are larger – rubber balls about 6 or 7 centimeters in diameter – and are much further away. Jupiter would be in orbit just under 400 meters from the Sun, while Saturn would be almost 1,500 meters distant. A beach ball, two rubber balls, three peas, a bead, and a pinhead distributed over an area the size of 150 football fields – that is the solar system as Eisinga knew it.

This was much different from the cosmos of the ancient Greeks. They had no idea that they lived on a pea in orbit. They thought the Earth was the hub of the universe, a stationary central point around which the celestial bodies rotated. They knew of seven moving bodies: in addition to the Sun and the Moon, there were the ‘wandering’ stars (Mercury, Venus, Mars, Jupiter, and Saturn) which traced loop-shaped courses among the ‘fixed’ stars. Our word ‘planet’ comes from the Greek word for ‘wandering star.’

When, 200 years before Eise Eisinga was born, Polish astronomer Nicolaus Copernicus announced his revolutionary theory that the Sun did not revolve around the Earth but vice versa, the Sun and the Moon were no longer seen as planets. Now, the Earth itself was one of the six planets circling the Sun, halfway between the orbits of Venus and Mars, substantially larger than Mercury, but much smaller than Jupiter and Saturn. And, as four moons had been discovered around Jupiter and five around Saturn since the invention of the telescope in the early seventeenth century, there was also a chance that a new planet might one day be discovered.

Astronomers did regularly discover new comets in the firmament. They were impressive celestial bodies with curved tails, moving through the solar system in strange, elongated paths. No one could have imagined at the time that these mysterious tailed stars were icy remnants of the formation of the solar system. And it is logical that they would strike fear into the hearts of ignorant farmers and everyone else, countryfolk, and townspeople alike. Unexpected phenomena in the heavens, such as eclipses, conjunctions, meteor showers, and comets appeared to mock the order and regularity of the cosmos. They could only mean trouble.

No one was more conscious of that fear than Eelko Alta. And if the people of Friesland were not already afraid of strange cosmic phenomena, it was always possible to make them afraid. Eelko Alta was a clergyman, and there is no more fertile ground for faith and devotion than fear of the Almighty's wrath. It may not, however, have been entirely a matter of opportunism on Alta's part. Shortly after the middle of the eighteenth century, apocalyptic omens were the order of the day and it is not inconceivable that the Friesian clergyman really was convinced that the Day of Judgment was at hand.

In the fall of 1754, at the age of 31, after preaching for 9 years in Beers, Alta was transferred to the small village of Bozum, a few kilometers to the northeast of Sneek. Just over a year later, the world suddenly moved violently. On November 1, 1755, a powerful earthquake set all the water in canals, rivers, lakes, and ponds in Holland and Friesland in motion. Ships were thrown against quaysides and anchor chains broke. One of Alta's older colleagues, Johan Georg Muller, who was a clergyman in Leeuwarden, promptly published a booklet entitled *Voortekenen van de nabijheid van het vergaan der wereld* (Signs that the end of the world is nigh.)

The discovery shortly afterwards of a new comet, and the fact that the Earth moved again on February 18, 1756, must have made a great impression on the readers of Muller's booklet. Was the End of Days really imminent? Was the blood-red eclipse of the Moon on January 24, 1758 a new omen? And what about the comets that appeared in the sky in 1759 and 1760? Or the strange dot that moved across the face of the Sun on June 6, 1761 and which, according to the professors at the University of Franeker, was the planet Venus – but now pitch black instead of white? And what of the ring-shaped solar eclipse on April 1, 1764? Was it perhaps a coincidence that, at the end of the 1760s, there was another mysterious outbreak of disease among Friesian cattle?

## Conjunction

On February 19, 1774 Eelko Alta, now 50 years old, opened the *Leeuwarder Courant*. His attention was immediately drawn to a press report from Dresden. German astronomers had calculated that, in the early morning of Sunday, May 8 there would be a rare conjunction of Jupiter, Mars, Venus, Mercury, and the Moon in the constellation of Aries. If that wasn't a portent of the Last Judgment, then what was? Alta's thoughts went back to the earthquake of 1755 and Muller's booklet. That same evening, he started writing and, less than 2 months later, the same *Leeuwarder Courant* announced the publication of his book.



Drawing of the planetary conjunction of May 8, 1774 by P.Y. Portier (Courtesy Royal Eise Eisinga Planetarium)

It was a very long announcement. Not because there was so much to say about the book, but because it had an unusually long title, which certainly deserves to be quoted in full: *Theological and Philosophical Contemplations on the Conjunction of the Planets Jupiter, Mars, Venus, Mercury and the Moon, due to occur on the 8th of May 1774, and about the Possible and Probable Astronomical and Physical Consequences of this Conjunction. From which it can be ascertained that it may have an impact not only on the Globe, but on the entire Solar System, to which we belong, and which could be a preparation for or a beginning of the Dismantling or Destruction thereof, in part or in whole. By a lover of the Truth.*

Eighty-eight pages of doom and disaster, embellished with nearly a hundred Biblical quotes, tried to persuade the reader that May 9 would probably never see the light of day. The Friesland Provincial Executive tried to prevent undue panic by confiscating all the printed copies and not releasing them until May 9, but this did little to put the public's mind at rest. Perhaps Pietje Eisinga–Jacobs was worried too: she was about to give birth, and a year earlier her little daughter Trijntje had died when only a few weeks old. This time she wanted to give Eise a healthy child, so she could do without bad omens from the heavens. But May 8 came and went, the conjunction was hardly visible in the dawn sky and, on May 15, Alta was back in his pulpit in Bozum as usual.

For wool-comber Eise Eisinga the commotion around the conjunction of the planets was the direct cause of his decision to build an orrery. Ever since his boyhood, Eise had shown a keen interest in mathematics and astronomy. At the age of 17, he had observed the transit of Venus with great fascination and had written his first astronomical treatises. Two years later he made detailed calculations of solar and lunar eclipses. Wouldn't it be fantastic if he could build a

scale model to show everyone just how innocent an apparent conjunction of the planets really is, and how wonderful the regularity and predictability of the solar system? Three weeks after the conjunction, Pietje gave birth to a healthy son – who they named Jelte, after Eise’s father – and he ventured to discuss the idea with his wife. Seven years later, in 1781, his dream came true and today, the Eise Eisinga Planetarium is the oldest working mechanical orrery in the world.



Interior of the Eise Eisinga Planetarium in Franeker, the Netherlands, completed in 1781. On the ceiling is a moving scale model of the solar system (Courtesy Royal Eise Eisinga Planetarium)

## Fuzzy Star

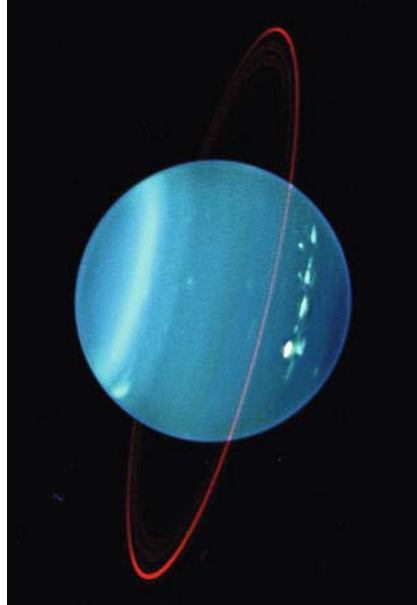
The year 1781 was then also the year in which the solar system suddenly doubled in size with the discovery of a new planet. While Eise Eisinga was hard at work in Franeker doing calculations, forging nails, and sawing grooves to capture the firmament in a moving model, across the North Sea in Bath, England, William Herschel could be found every clear night directing his self-built telescopes at that same firmament. He charted star clusters, recorded binary stars, and catalogued nebulae. His telescopes were among the best in the world, so an enormous undiscovered territory lay at his feet – or rather, above his head. It was only a matter of time before Herschel would come across the planet Uranus.



William Herschel, the discoverer of the planet Uranus (From: *Famous Men of Science*, Sarah K. Bolton)

On March 13, 1781, in the constellation of Gemini, Herschel discovered a fuzzy star that changed its position slightly every night. At first, he thought he had found a new comet, but it soon became clear that the object was following a slow, practically circular path around the Sun, far beyond the orbit of Saturn. A new planet had never been found before and, after announcing his find, Herschel immediately became world famous. He received several awards, was elected to the Royal Society and was appointed Astronomer Royal to King George III. This was perhaps partly in recognition of Herschel's generous gesture in naming the new planet *Georgium Sidus* ('George's Star'). The name did not last long, however. French astronomers refused to accept a planet

named after an English king and resolutely referred to the new discovery as ‘Herschel.’ German astronomer Johann Bode solved the problem by proposing the name Uranus, the mythological father of the Roman god Saturn.



Uranus with its clouds and rings, as seen by the 10-meter Keck Telescope on Hawaii (W.M. Keck Observatory)

Herschel discovered Uranus by coincidence; he had not been searching for a new planet. And, as is often the case with coincidental discoveries, it could have happened much earlier if astronomers had been a little more attentive. In 1690, almost a hundred years before it was discovered, Uranus had been recorded by the English astronomer John Flamsteed. But he thought it was just a regular star in the constellation of Taurus and catalogued it as 34 Tauri. If Flamsteed had noted 34 Tauri’s slow change of position, the seventh planet would have been discovered more than 50 years before Eise Eisinga was born. And, who knows, Eisinga’s dream of building an orrery might never have become a reality – after all the living room in *De Ooijevaar* would simply never have been big enough.

Pietje and little Jelte did not have to live in a construction site for another 7 years. The orrery was completed according to the original design and it still provides us with an excellent model of the ‘classical’ solar system. Three years after it was completed, father and mother Eisinga had a second son, Jacobus, and 4 years later, when Jelte was just 14, Pietje died. Jelte himself only lived to be

34, to the great sorrow of his father, who had taught him the basic principles of mathematics and astronomy.

And what about Eise himself? At the end of the eighteenth century, he was forced to live abroad for some time for political reasons. During these years, he dreamed of building a new orrery. Bigger and better, under an enormous planetarium dome. And if he had enough room, he could include the new planet Uranus. Eise's new dream never became reality. The original orrery was bought by the State in 1825, 2 years before Eisinga's death, and transferred to the municipality of Franeker in 1859. It is still to be found in *De Ooijevaar* on what is now known as the Eise Eisingastraat. It is one of the most fascinating astronomical reminders of the turbulent second half of the eighteenth century, when apocalyptic superstition and scientific curiosity vied for prominence and a new planet was found beyond the limits of the known solar system for the first time. It would not be the last.

## Chapter 2

### Eleven Planets

Giuseppe Piazzi never expected to see the beginning of the nineteenth century. When he was born, on July 16, 1746, his mother had already given birth to eight children, but most of them had died shortly after coming into the world. To assure the salvation of his new-born soul, Giuseppe was christened almost immediately after his birth in the family house in Ponte Valtellina. The quick christening proved unnecessary, but Piazzi was never a healthy man, despite living a devout life as a member of the Theatine Order.



Giuseppe Piazzi, who discovered the first asteroid (Courtesy Stichting De Koepel)

And now here he was, 54 years old, on the evening of the first day of the new century, peering through the eyepiece of the meridian circle in the observatory in Palermo. Thursday, January 1, 1801 was a crystal clear evening on the north

coast of Sicily. Venus had just set in the southwest; the red planet Mars twinkled high above the southern horizon. And 9 degrees to the south of Mars, in the ‘shoulder of the Bull’ – as he himself described it – Piazzi discovered a new planet. A planet which astronomers had been speculating about for nearly 200 years.

Even stranger, it was a planet that had simply been invented, by German astronomer Johannes Kepler in 1596. Kepler not only was as unhealthy as Piazzi, but also suffered from a stutter and was the son of a convicted witch to boot. He was 25 when he published his *Mysterium cosmographicum*, a rather esoteric book in which he sought the divine idea behind the design of the solar system. Why were there 6 planets instead of 7, or 12? What system lay behind their orbital periods and the distances between them? And above all, what reason could God possibly have had for leaving such a large empty space between the orbits of Mars and Jupiter?

Like the Greek philosopher and mystic Pythagoras, Kepler was convinced that nature must be ordered according to mathematical rules. But the divine code of the solar system remained a mystery. As a last resort, he imagined a new planet in the wide, empty zone between Mars and Jupiter. That made the solar system a little more systematic, but it was still not enough.

Partly thanks to Kepler, who in the early seventeenth century established the laws governing the movements of the planets, their orbits were much better documented 200 years later. But the puzzle of the empty space between Mars and Jupiter remained unsolved. And more and more astronomers started to seriously consider the idea that, somewhere in that space, there had to be an as yet undiscovered planet.

That was largely due to an influential book by another 25-year-old German astronomer, Johann Elert Bode. Bode would later suggest the name Uranus for the planet discovered by William Herschel in 1781. He also became the director of the Berlin observatory and, in 1801, published his *Uranographia*, one of the most significant star atlases in history. But his reputation was already secured when he wrote *Anleitung zur Kenntnis des gestirnten Himmels* in 1772.

In that book Bode described a remarkably simple formula. Take the numerical series 0, 3, 6, 12, 24, 48, and 96, where each number is double that of the one before it. Add four to each number, so that you get 4, 7, 10, 16, 28, 52, and 100. Divide the result by 10 and you get approximately the distances of the planets from the Sun in astronomical units, where one astronomical unit (AU) is equal to the distance from the Earth to the Sun (150 million kilometers). It was amazingly simple, but there was one problem: the formula was only accurate if the fifth number (2.8) was reserved for a planet between the orbits of Mars (at approx. 1.6 AU) and Jupiter (approx. 5.2 AU).

## Quest

Bode did not discover this mathematical rule himself. Six years previously, his compatriot Johann Daniel Titius had described it in a very free translation of a French natural-scientific book. Titius, in his turn, had taken it from the German Christian Wolff, who had mentioned it in 1724, and Wolff was probably familiar with the work of the Englishman David Gregory, who had drawn attention to the extraordinary ratios between the orbits of the planets in 1702. In effect, the idea of an unknown planet between Mars and Jupiter had never really been out of fashion since Kepler's time.

But 'Bode's Law' was not really taken seriously until the discovery of Uranus. Uranus orbits the Sun at an average distance of 2.87 billion kilometers – just over 19 AU. And the eighth number in the series identified by Titius and Bode is 19.6 (192 plus 4 divided by 10)! That could of course not be a coincidence. At the end of the eighteenth century, Bode and his contemporaries were practically convinced that there must, indeed, also be another planet between the orbits of Mars and Jupiter. The big question was: how to find it?

It had to be a small, dark world otherwise it would have been observed long ago with the naked eye. There was nothing else for it but to search the heavens with a telescope for an inconspicuous speck of light moving between the stars. There was one plus point: all of the known planets move around the Sun in more or less the same plane and therefore, seen from the Earth, are always found in one of the 12 constellations of the zodiac. The quest could therefore be restricted to a relatively narrow zone.

The Hungarian nobleman Baron Franz Xaver von Zach, chief astronomer to the Duke of Gotha and director of the observatory in Seeberg, was determined to find the new planet, but soon realized that he could never do it alone. It would need a joint effort – and preferably an international one.

On September 20 and 21, 1800, six astronomers came together at the observatory in Lilienthal to set out a strategy. In addition to Baron von Zach, they were Johann Schröter, Karl Harding, Heinrich Olbers, Ferdinand von Ende, and Johann Gildemeister. They divided the zodiac into 24 equal parts and drew up a list of an additional 18 European astronomers who would join them in the detective work.

Later that year, they sent out the first letters to their selected colleagues in Germany, Denmark, Sweden, Russia, France, Austria, England, and Italy, asking them to take part. It was the most ambitious program of cooperation ever in the history of astronomy. There could be no doubt that the *Himmelpolizei* (Celestial Police), as Von Zach called the group of 24 investigators, would track down the unknown planet.

## Point of Light

Giuseppe Piazzi knew nothing of all this when, early in January 1801, he discovered a small, moving point of light about 9 degrees to the south of Mars. He had been on the list drawn up by the small group in Lilienthal, but for some reason or another he had never received Von Zach's letter. He had heard of the theories about a planet between Mars and Jupiter, but only in passing. After all, Piazzi was a mathematician and not an astronomer. He had not taken much interest in astronomy until 1787, when the Royal Academy in Palermo asked him to set up an observatory.

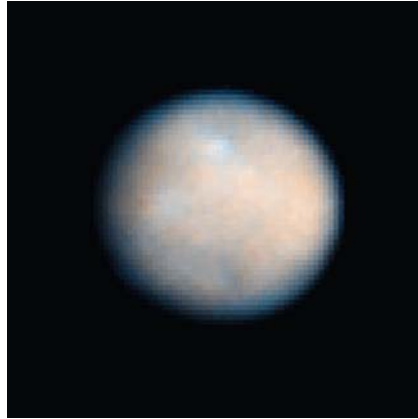
Piazzi had commissioned one of the best telescope-builders in the world, Jesse Ramsden in London, to build a splendid meridian circle for the new observatory. Meridian circles, which are always directed exactly to the south, are exceptionally suited to charting the positions of the stars. Piazzi used the new instrument to produce an accurate stellar catalogue, which would eventually be published in 1803. It was with this telescope that, on January 1, 1801, he measured the position of a large number of faint stars near the zodiacal constellation of Taurus.

It was not until the following day, when Piazzi made a second series of measurements that he realized that one of the stars had moved slightly in his field of vision. He thought that perhaps he had made an error on the first evening, but on January 3 the star had moved slightly again, and again the following night. It all seemed to point to the discovery of a new comet, but there was no sign of the nebulosity that generally surrounds comets.

Once Piazzi had assured himself that he was not mistaken, he announced the discovery of the new comet. He did not, however, give its position: for the moment, at least, it was 'his' find. Once he had made more observations, he could probably calculate the object's path through the solar system before someone else beat him to it. He was still not sure that the sharp little point of light really was a comet. Perhaps he had made an even more important discovery. At the end of January, Piazzi wrote to his good friend and colleague Barnaba Oriani in Milan: 'I have announced this star as a comet, but since there is no sign of the usual nebulosity and it moves in a very slow and even manner, I suspect that it may be something more significant than a comet.'

Piazzi did not have much luck with the follow-up observations. In January, the weather was often bad and in February, the new star was already in the south at the end of the afternoon, as the Sun set. It was impossible to conduct positional measurements with the meridian circle during twilight. To make matters worse, Piazzi became ill. The long nights staring through the telescope had affected his already weak health. By the end of the winter, he had gathered only 24 measurements.

Meanwhile, other astronomers were starting to get impatient. An important new discovery was all very well, but they wanted to see evidence. Piazzi, who was still trying to calculate the object's path, did not want to release his findings yet but, under pressure from the French astronomer Joseph Lalande, he could



Ceres, as imaged by the Hubble Space Telescope (NASA, ESA, J. Parker (Southwest Research Institute), P. Thomas (Cornell University), L. McFadden (University of Maryland, College Park), and M. Mutchler and Z. Levay (STScI))

hardly refuse. As well as being a Theatine monk, brother Giuseppe was also a freemason, and Lalande was Grand Master of the French Lodge of the Nine Sisters, and therefore not someone to argue with. In April, Piazzi sent his findings to Paris, with a copy to Oriani in Milan, but not to Johann Bode in Berlin.

Bode, who was now the director of the observatory in Berlin, had received an earlier letter from Piazzi about the ‘new comet’ and was actually quite certain that it was the planet that Baron von Zach’s *Himmelpolizei* were looking for. Twenty years after he had proposed the name Uranus for the new planet beyond the orbit of Saturn, Bode now came up with the name Juno for the new planet between Mars and Jupiter. And in April, he announced the discovery of the new planet to the press.

Piazzi was furious. How dared the Germans announce the discovery of *his* planet and give it a name? Who had discovered it in the first place? Piazzi himself had thought of calling it Ceres Ferdinanda, after the goddess of Sicily and King Ferdinand IV, the ruler of the island. Fortunately he had the support of Von Zach, who found Ceres an appropriate name, though he thought the addition of ‘Ferdinanda’ was a little excessive.

In the meantime, astronomers in Paris had been working hard analyzing Piazzi’s positional measurements and there appeared to be no more doubt at all: the wandering star that Piazzi had observed in January and February was not a comet but a planet in a more or less circular orbit around the Sun. But Lalande and his colleagues were unable to determine Ceres’ orbit with any great degree of accuracy. Consequently, no one knew where the small planet would appear in the summer months, when it would once again be visible in the morning sky. At the end of 1801, Ceres had still not been rediscovered and Lalande even

began to doubt its existence. After all, he had only a series of numbers. Piazzi was the only one who claimed to have actually seen the elusive object.

The orbit problem was finally solved in elegantly by the mathematical genius Carl Friedrich Gauss. At the age of 24, Gauss had developed a method, which astronomers still use today, of calculating the path of a celestial body from a small number of positional measurements. Using Gauss' predictions, Ceres was found again in December 1801 by Von Zach and, independently from him, by Heinrich Olbers on January 2, 1802 – a year after Piazzi's original observations.

The discovery of the eighth planet in the solar system was a fact. Admittedly, it was a small, faint planet, but just like Uranus – discovered 20 years previously – Ceres complied almost perfectly with Bode's Law. And, as a result, the solar system seemed finally to be losing some of its mystery.

## Fragments



Heinrich Olbers, the discoverer of Pallas (Courtesy George Beekman)

There was therefore great alarm and confusion when, on March 28, 1802, Olbers discovered another planet between the orbits of Mars and Jupiter. Pallas, as the new planet was named, is about the same distance from the Sun as Ceres but its orbit is a little more elongated and is at a slightly more oblique

angle with respect to the orbits of the other planets. Olbers reached a logical conclusion: were Ceres and Pallas perhaps fragments of a former planet? Could that explain why they were so small? And were there other fragments waiting to be discovered in this part of the solar system?

It was indeed curious that, even in the most powerful of telescopes, the new celestial objects remained little points of light, like stars, while all other planets were resolved as small, round disks. This could only mean one thing: Ceres and Pallas could not be more than a few hundred kilometers in diameter. And if more fragments were found, it would be quite illogical to call them all ‘planets.’ On May 6, 1802, in a presentation at the Royal Society in London, William Herschel therefore suggested referring to Ceres and Pallas forthwith as asteroids (‘star-like bodies’). And in a letter to Piazzi he congratulated him on being the first to discover a whole new class of celestial object.

Perhaps the Englishman Herschel was not too keen to share his unique status as the discoverer of a new planet with an Italian and a German. Either way, it showed great insight on his part to derive a complete new population of celestial objects on the basis of observations of only two.

Herschel’s proposal found little support among his European colleagues, who enthusiastically welcomed Pallas as the ninth planet. And when Karl Harding discovered Juno on September 1, 1804 and Heinrich Olbers Vesta on March 29, 1807, everyone was in their seventh heaven. In a little over a quarter of a century, no fewer than five new planets (including Uranus) had been discovered – and the *Himmelpolizei* would undoubtedly find more.

But that proved easier said than done. A fifth object (Astraea) was not discovered between the orbits of Mars and Jupiter until December 1845. Neither Herschel, Piazzi, Bode, Von Zach nor Olbers lived to see it. For nearly 40 years, the solar system had 11 planets, which were listed as such in all popular and professional astronomy books published in the first half of the nineteenth century. Starting with the planet nearest to the Sun, they were Mercury, Venus, Earth, Mars, Vesta, Juno, Ceres, Pallas, Jupiter, Saturn, and Uranus. The newcomers were even given stylized symbols like those that have been used to designate the ‘classical’ planets for many centuries.

After Astraea was discovered, things started to move much faster. Hebe, Iris, and Flora were discovered in 1847, Metis in 1848, and Hygiea in 1849. Five years later, the count had reached 30, and by 1868, no less than 100 objects had been found between the orbits of Mars and Jupiter. They were referred to as minor planets or – as Herschel had proposed – asteroids. And although Ceres, Pallas, Juno, and Vesta continued to enjoy a kind of *status aparte*, everyone realized that it had been a mistake to classify them as full-fledged planets.

The fact that astronomers accepted the ‘demotion’ of Ceres, Pallas, Juno, and Vesta with such little fuss was not only because those who had discovered them were no longer alive. The most important reason was undoubtedly that, in 1846, a *real* new planet was discovered. And this time it was not by accident. On the contrary.

## Chapter 3

# The Writing Desk Planet

Elaine Mac-Auliffe had no idea that what she held in her hands was the history of the discovery of the planet Neptune. It was October 1998 and, together with her colleague Nicholas Suntzeff, she was searching the house of Olin Jeuck Eggen, a staff astronomer at the Cerro Tololo Inter-American Observatory in Chile, where Mac-Auliffe was an executive secretary. In a hall cupboard near the bedroom, Elaine and Nicholas found a couple of cardboard boxes containing old books, letters, and files which, according to the catalogue stamp on the title pages, were the property of the Royal Greenwich Observatory in England. One of the bound piles of paper was entitled *Papers relating to the Discovery, Observations and Elements of Astrea, Neptune, Hebe, Iris, Flora. Colors of Astrea, Neptune*. When Greenwich archivist Adam Perkins received an email from Mac-Auliffe about the unexpected find, he jumped for joy. The Neptune File had finally been found.

Eggen was a renowned astronomer who had worked at the Royal Observatory from 1956 to 1961. The observatory had then been housed at the stately Herstmonceux Castle in southern England and Eggen lived in one of the castle rooms and had access to the library day and night. That was very convenient, as he had a great interest in the history of astronomy and was working on short biographies of George Airy and James Challis, two astronomers who had played key roles in the farcical drama surrounding the discovery of Neptune in 1846. Eggen would certainly have regularly consulted the Neptune File, a unique collection of documents about the discovery of the new planet put together by Airy. And it would have been easy for him to keep the book – and perhaps many others – in his own room.

Where is the line between borrowing something, forgetting to return it, and intentionally keeping it? Eggen will never be able to answer that question: he died of a heart attack on October 2, 1998. But a number of things are certain. In 1961 Eggen quarreled with Richard Woolley, the director of the observatory, and left embittered for California. When he left, he took with him a number of boxes containing valuable historical books. They later went with him to Australia, where he was the director of Mount Stromlo Observatory for 11 years, and then in 1977 to Chile. And when the Greenwich library asked him if he had taken the missing Neptune documents, he denied having them.



Olin Eggen (Olin J. Eggen photo collection at the AURA Observatory, Courtesy Elaine Mac-Auliffe)

After Olin Eggen's sudden death, Elaine Mac-Auliffe was initially searching his office and house on the observatory campus in La Serena for the addresses of family members. But of course, there were also piles of scientific journals and books to be catalogued. That these included historical books from one of the most famous scientific libraries in the world was remarkable enough. But it was even more surprising to find that the hoard also contained unique documents that would throw new light on the row between the English and the French about the discovery of Neptune.

## Orbital Deviations

Ever since the discovery of Uranus in 1781 there had been speculation about the existence of other planets even further away from the Sun. This was not surprising: once one new planet has been found that is so far away that it can only be seen with a telescope, it is logical to assume that there will be more. Furthermore, Uranus complied perfectly with Bode's Law, so why shouldn't there be a planet somewhere in the region of the next number in the series?

But there was an even more compelling reason to believe in the existence of a celestial body beyond the orbit of Uranus. The new planet might conceal itself like a thief in the night, but it left clear tracks in the solar system. At least, in the first half of the nineteenth century, that was the accepted explanation for an unsolved mystery: the deviations in Uranus' orbit.

Isaac Newton's laws of gravity enable us to calculate accurately how a planet circles the Sun. In empty space there is no friction and a planet never suffers from a headwind, so gravity is the only force affecting its orbit. Shortly after the discovery of Uranus, therefore, it was possible to calculate where the planet would be in the night sky in the coming months and years.

There was only one problem: Uranus refused to follow the timetable. Only a few years after it had been discovered, it became clear that its actual position increasingly deviated from the predictions. This is despite the fact that the calculations had been made using John Flamsteed's observations from 1690, which would be expected to quantify the planet's orbit more accurately.

Yet, even when astronomers included the minute gravitational effects of Jupiter and Saturn in their calculations, they could not get Uranus to play according to the rules. This complicated calculation method was first developed by the mathematician Pierre Simon Laplace, who was considered by his compatriots as the Newton of France. In 1808, Laplace's assistant, Alexis Bouvard, published new tables with the future positions of the planets, taking account of all the reciprocal effects, but Uranus continued to go its own way.

All kinds of explanations were put forward. Perhaps Uranus had recently had a collision with a comet. Or perhaps there was a sort of ether in the cosmos, which slowed the planets down a little. But in the 1830s, more and more astronomers became convinced that there could only be one feasible explanation for the deviant behavior of Uranus: there must be another planet somewhere in the outer regions of the solar system.

## Mathematical Genius

If you know exactly where all the planets are and you know how massive they are, you can use Laplace's method to calculate how they can disturb each other's orbits. But at a time when such calculations had to be made at a writing desk, using only paper and ink and logarithm tables, it was certainly no easy task. And the other way around – using measured orbital deviations to calculate