Galileo's Observations of Neptune

Charles T. Kowal
KOWAL1@yahoo.com

This informal narrative will describe my discovery that Galileo had seen the planet Neptune in 1612, over two centuries before Neptune was "officially" discovered. I am not a historian, and my discovery had little or no astronomical importance. Nevertheless, this was one of the most exciting and rewarding experiences of my life. I found something obvious, that historians had overlooked for over three centuries! I hope you will find this story interesting and amusing

A little background

I spent most of my career as an observational astronomer. Mostly, I used the 48-inch Schmidt telescope at Mt. Palomar to perform various surveys. My main job was to search for supernovae, but my real passion was to search for unusual objects in the Solar System – comets, Apollo asteroids, and whatever else might be out there. The 48-inch telescope was ideal for Solar System surveys, although few people actually used it for that purpose. I recovered lost asteroids and comets, and found new ones. In 1974 I discovered the 13th satellite of Jupiter, (**Leda**), and another one the following year. Encouraged by these successes, I started a full-scale survey of the ecliptic region in 1977. This promptly led to my discovery of the object **Chiron** in November of that year.

In the back of my mind during this survey, was the possibility of discovering a new planet. The only evidence that such a planet might exist were the unexplained residuals in the orbit of Neptune. Of particular interest to me was an article by Dennis Rawlins in the *Astronomical Journal.* [Astron. J. 75, 856−857 (1970)]. Rawlins described some pre-discovery observations of Neptune by Lalande in 1795. Lalande's residuals were small, but apparently significant. Clearly, more pre-discovery observations, especially even earlier ones, would be most interesting. I was on the lookout!

The occultations

The March 1979, issue of *Sky and Telescope* magazine contained an excellent article by Steve Albers, which listed mutual occultations of planets for the years 1557 to 2230. Among these occultations were two of Neptune by Jupiter, in January 1613, and September 1702. Aha! The telescope is in wide use by 1702, but who was watching Jupiter in 1613? Galileo, and no one else. Albers' article gave me the raw material I needed to search for a pre-discovery observation of Neptune. [In his article, Albers specifically mentioned that his

computed occultations could be used to find pre-discovery observations of planets. At the time, I thought this was obvious, but I was subsequently criticized for not giving him credit for that insight. I scrupulously gave him credit for his occultation calculations, but *Sky and Telescope* implied that I gave him no credit at all! Let me make it plain that my subsequent work would not have been possible without the work of Steve Albers.]

The search

I did not know if Galileo's notebooks had ever been published in their entirety. Nor did I know how extensive they might be. To find out, I went to the Hale Observatories library, and talked with Dr. Alexander Pogo – one of the most fascinating people I ever met.

Dr. Pogo was an astronomer and classical scholar, born in Russia in 1893. He talked very little about himself, but rumors of his past exploits abounded. It was said that he had helped rebuild the Parthenon in Athens. At the time I did my search he was 87 years old. He looked exceedingly frail, but he delighted in climbing ladders while onlookers held their breath. (Years later, Dr. Pogo did fall down and break his hip. He died in 1988, at the age of 95.) Pogo knew every book in that library, as well as the publication history of many of them. When I asked Dr. Pogo about Galileo's notebooks, he gave me a long account of the various editions that had been published. As it happened, the Hale Observatories library had a copy of an edition published in Italy in 1909. (This book was on a top shelf, giving Dr. Pogo another opportunity to show off his ladder-climbing skills.)

It turned out that the notebooks were indeed extensive, and contained hundreds of drawings of Jupiter and its satellites, sometimes including background stars. It was a simple matter to look at the drawings for the days around the occultation.

The outcome

I was able to compute the positions of Jupiter and Neptune for each day in December 1612, and January 1613. I simply plotted those positions, and compared my plots with Galileo's drawings. The result was stunning. Galileo had seen Neptune at least three times.

The first candidate was on a drawing from December 28, 1612. Galileo had marked a "fixed star" near Jupiter. Upon checking the SAO star catalog, it became clear that there was no star in that position, but it did match my plotted position of Neptune. I was beginning to get excited.

The next candidate was another fixed star Galileo plotted five days later. This turned out to be SAO 119234. Finally, I found the Holy Grail on the drawing for January 28, 1613. On that night Galileo drew two stars near Jupiter. Star 'A' was SAO 119234 again. Star 'B' was Neptune! Galileo made a separate drawing showing just these two stars. He also wrote a comment in Latin, which I translated as: "After fixed star A, following in the same line, is star B, which I saw in the preceding night, but they then seemed farther apart from one

another". Not only had Galileo spotted Neptune, he even noticed that it had moved from night to night!

My initial reaction was disbelief. It was all so easy, and it seemed impossible that historians had studied Galileo's notebooks for over three centuries and had never noticed these observations. Just to reassure myself, I contacted Stillman Drake, who was one of those Galileo historians. Drake became as excited at I was, and provided me with much information about Galileo's measurement techniques. He also confirmed my translation of the Latin note which indicated that Galileo had seen Neptune move from one night to the next. We agreed to write two papers about this discovery. I wrote one for *Nature,* [*Nature,* **287,** 311] and Drake wrote one for *Scientific American,*[*SciAm*,**243**,52].

The aftermath

Galileo did not indicate the scale of his drawing of stars A and B, but I still had hope of using it for astrometric purposes. All I could do was to speculate that this drawing had the same scale as the main drawing of Jupiter and its satellites. Stillman Drake was particularly eager to move Neptune around like an old piece of furniture, and I was still optimistic, so we published our speculations about Neptune's position, particularly in the *Scientific American* article. Myles Standish and Dennis Rawlins quickly pointed out that our derived positions of Neptune were impossible, since they would have moved Neptune out of its known orbital plane. No surprise there, but it did make the *SciAm* article somewhat tainted.

The article in *Nature* was badly chopped-up in the editing, and it was preceded by a ridiculous and error-filled preface by the editor. Nevertheless, the article did, I think, prove that Galileo saw Neptune. Reaction in the popular news media tended to be on the order of: "Galileo May Have Seen Neptune", "Did Galileo See Neptune?", or even "Galileo's Mistaken Discovery"! By not accepting my work at face value, the media showed an admirable restraint which I can only wish they would show when reporting the latest medical "breakthrough".

Later, I continued to look through Galileo's notebooks for mentions of a "*stella fixa".* I identified several cataloged stars, but there were a few objects that I could not identify. It is entirely possible that Galileo saw some of the brighter asteroids, but I did not pursue this. Those of you who are looking for something to do might look into this potential gold mine!

In 1982 I traveled to the Royal Greenwich Observatory, then at Herstmonceux Castle in East Sussex, England, to look at Flamsteed's notebooks from 1702. I found no evidence that Flamsteed or his colleagues had ever seen Neptune during that year's occultation by Jupiter. Of course, there were other observatories operating in Europe in 1702, and somebody, somewhere, may have seen Neptune in that year. This, too, is something that others might want to pursue.