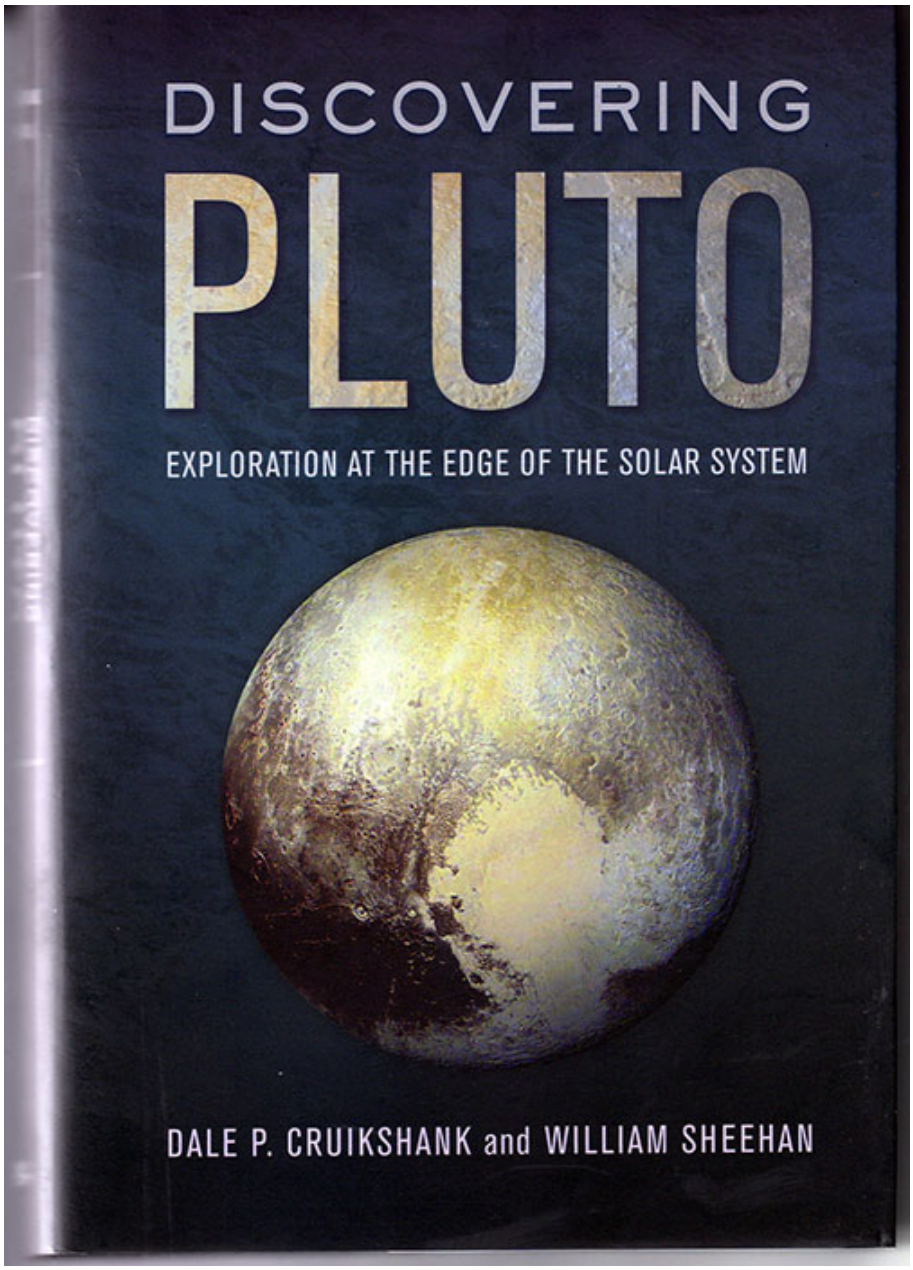

Discovering Pluto: Exploration at the edge of the solar system. Dale P Cruikshank and William Sheehan. **The University of Arizona Press, February 2018 . ISBN-13: 978-0-8165-3431-9. Hb 475 pp 54 ill. +8 colour plates. c£32.**

In June 2015 the successful flyby of Pluto and Charon by the New Horizons planetary probe completed the first ever exploration of the solar system by spacecraft, begun in the 1970s. As the late astronomer and philosopher, Carl Sagan has written; in all the history of mankind, there will be only one generation that will be the first to explore the Solar System, one generation for which, in childhood, the planets are distant and indistinct disks moving through the night sky, and for which, in old age, the planets are places, diverse new worlds in the course of exploration. We are that generation.

This excellent book is the story of discovery; of the outer planets beyond Saturn by William Herschel who accidentally found Uranus in March 1781; Neptune, predicted mathematically in 1845 by Urbain le Verrier in France and John Couch Adams at Cambridge and picked up at the Berlin Observatory in September 1846 and then Planet X, suspected to exist beyond the orbit of Neptune by several astronomers especially by American millionaire industrialist Percival Lowell and Harvard astronomer William Pickering and finally identified photographically from Lowell's own Flagstaff Observatory, Arizona, long after he had died, by Clyde Tombaugh in January 1930. The first seven chapters of the book are expertly covered by Sheehan's knowledgeable accounts of these major discoveries.

There follows an in-depth description, mainly by Cruikshank, of the development of planetary science using instruments and detectors developed during and after the second world war that were later deployed on the world's largest optical telescopes to study the surfaces of these remote icy worlds and their satellites. By the end of the twentieth century it was acknowledged that only direct observation by robotic spacecraft would answer some of the growing list of questions about the far reaches of the outer system beyond Neptune but NASA, after the success of the Pioneer and Voyager missions to Jupiter, Saturn, Uranus and Neptune using gravity-assisted transfer orbits between these giant worlds during an extraordinarily opportune, once in a lifetime, alignment of the planets in the late 20th C, was reluctant to finance an expensive one-off mission to Pluto.

After a decade of mission proposals and rejections, with compromises and conditions from both sides, the New Horizons mission to Pluto was finally agreed. Eventually launched in January 2006, New Horizons sped past Jupiter only thirteen months later; its speed boosted by a gravity-assisted sling-shot from Jupiter to 50,400kph, it was flung on the final 3.5billion km long haul to Pluto, arriving eight and a half years later in July 2015. After its 4.8billion kilometre journey from Earth to Pluto, via Jupiter, New Horizons arrived 88 seconds *early* and within 45km of its targeted time and position.

Because of on-board power constraints and the vast distance from Earth weakening the signal, data is slow to trickle in from the New Horizons spacecraft following the Pluto-Charon flyby and will take years to study. This double system currently ranks as comprising the first and fifth largest among the Kuiper Belt Objects. In the meantime, New Horizons is heading for another rendezvous, 1 January 2019, with another KBO, 2014 MU$_{69}$. One and a half billion kilometres beyond Pluto, it was discovered only in 2014 and designated 486958 by the Minor Planet Centre in 2017. It will be the first object to be visited by a spacecraft that was not even known when the mission was launched.

Discovering Pluto is a very competent study of the discovery and exploration of the outer planets; attractively presented, easy to read and superbly informative, it is highly recommended. But there are some quibbles. Considering the uniqueness of the Pluto flyby, there are not many colour plates, although more were available at the time of its writing, and the layout of the monochrome diagrams and illustrations occasionally breaks up the flow of the text in the earlier chapters. But it's the small typographical errors that niggle most, tripping the reader. These typos have been corrected for the paperback edition due for publication in January 2019*.

About the authors: Dale Cruikshank is a planetary scientist working in the Astrophysics Branch at NASA Ames Research Centre, specializing in the spectroscopy of planets and small bodies in the Solar System. He was a coinvestigator with the New Horizons mission team and was involved with developing the initial proposals for the project. William Sheehan is a recently retired psychiatrist living in Flagstaff, Arizona, a frequent visitor to the UK (and to the Society for the History of Astronomy), a noted historian of astronomy, prolific writer and amateur astronomer.

* At the request of one of the authors (Bill Sheehan) pending publication of the paperback edition, 33 typing errors were identified by the present reviewer. They have been corrected in pencil in the reviewed copy of *Discovering Pluto* available for loan in the MAS library.