O, Pioneers! (part 2): The derelicts of space

March 6 2012, By Richard Corfield

Before the Pioneer 11 spacecraft could venture beyond our solar system, it had to pass through the rings of Saturn. At the time, the rings were not well characterized and some thought the spacecraft could be destroyed. Whatever happened to Pioneer 11 at Saturn's rings would affect the flight plan of the Voyager spacecraft.

I had been twelve when Pioneer 11 departed the Jupiter system. By the time it approached Saturn, I was just starting my final year at high school. During the bulk of my teenage years Pioneer 11 had been arcing high above the plane of the ecliptic, heading towards an appointment with destiny in the outer solar system. It - and its sister ship Pioneer 10 - were now the fastest moving, most distant human-made objects in the Universe.

On the other side of the world, things were running around the Pioneer mission office at NASA Ames Research Center. The glory days were over, but they were working on one final mission – the Pioneer Venus

probe. The people at Ames had come to appreciate something that their Pasadena colleagues would come to know only too well themselves – that space missions are like extended wars with long - very long - periods of boredom punctuated by fleeting moments of sheer terror. And now that Pioneer 11 was approaching Saturn, the time for Charlie Hall's swan song had come. The spacecraft was to take the first close-up look at the ringed giant planet.

And yet, worryingly, Pioneer 11's status had changed in the past six years of its journey. Now NASA was openly referring to both the Pioneer 10 and Pioneer 11 missions as "reconnaissance missions" for its much more expansive Voyager program. And this change in emphasis began to have an impact on what Pioneer 11 would do at Saturn.

The ring system of Saturn was now known to be composed of at least three concentric rings. The outermost "A", the middle "B" ring and the faint "C", the ring closest to the planet. The Cassini division separated the outer of the two rings. But less than a decade before Voyager's launch, a French astronomer named Pierre Guerin had claimed to see a fourth ring inside the third ring. A ring made of a material -- so nebulous that it could barely be discerned by the most powerful telescope of the day -- separated from the "C" ring only by a gap which some, with a sense of humor, referred to as the "French division".

This debate about the nature of Saturn's rings was not trivial for the Pioneer and Voyager mission planners; it had practical implications on an engineering level. If the particles were smaller than about a millimeter, then any incoming craft would pass safely through; if they were larger than a centimeter then in all probability the particles would be spaced sufficiently widely for the spacecraft to get through once again unscathed. But anything in-between, and the spacecraft could find itself in trouble. In 1976 the targeting of Pioneer 11, hitherto an arcane issue of celestial mechanics of interest only to mission specialists,

suddenly became a public debate.

The course adjustment would have to be made by the middle of 1978 at the latest. By the beginning of 1977 the debate had focused on the so-called "inside option" and the "outside option".

In the end the problem was focused on one thing – the existence of a fourth ring outside the others - the so-called "E ring" - which might extend for about twice the diameter of the total known Saturnian ring system. If the outer ice giants were to be a target, then Voyager 2 would have to pass very close to the edge of the “A” ring to slingshot itself on to Uranus. In other words, it would have to pass through the “E” ring.

So the question for NASA boiled down to whether to send Pioneer 11 through the debris-free gap between the innermost ring and the surface of Saturn itself, and use Pioneer's aging instruments to do what they could to image the planet; or whether to use Pioneer 11 as a guinea pig and send it through the hypothetical “E” ring and see if it sustained any damage.

The people at Ames wanted to send their plucky little Pioneer 11 out in a blaze of glory by sending it as close to the planet as possible. The “inside track” might provide valuable information about the nature of Saturn, such as the way the radiation belts and magnetic fields of the rings interacted with charged particles in the Saturnian system. With the existing Voyager flight plan this information would not be forthcoming because of their more distant flyby.

Artist's Concept of Saturn Encounter. Credit: NASA

But the Ames engineers were realists. They knew that if Pioneer 11 did not survive its passage through the rings, then their Voyager 2 colleagues would know that it was unsafe for their spacecraft to try for Uranus. It could stay in the Saturnian system doing the work that Pioneer 11 would have done.

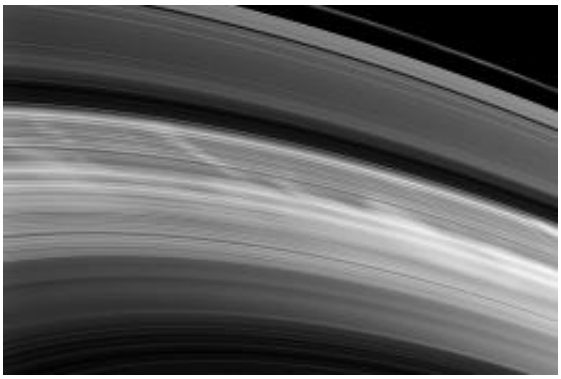
The position of the Pioneer principal investigators at this time was largely dictated by the experiments they had on board the craft. Particle and magnetic field specialists such as John Simpson and James Van Allen wanted to go with the inside track option because such a trajectory would provide evidence of whether Saturn had a magnetic field. They believed that the chance of Pioneer's destruction was outweighed by the possibility of new discoveries.

And yet, this was not the view of all the Pioneer mission scientists. Dawning on them all was the recognition that deep space research was a collaborative enterprise. The heady days of the 1960s, when space science money was washing in the gutters, were long gone. They all knew that in order to survive they would have to work together. Partly this was a recognition of the duration of these deep space voyages - years piled upon years which could easily eat half your career. The only sensible way to make such a sacrifice justifiable was to be a team player.

As Commander Spock said so memorably in Start Trek II: The Wrath of Khan, “The needs of the many outweighed the needs of the few, or the one.”

The man in charge of the decision was a NASA official named Thomas Young. By any evaluation he did not have an easy choice, but in the end Young finally announced his decision; Pioneer 11 would take the outer track. It would try and trail blaze a way through the "E" ring for Voyager 2.

Young had chosen the outside option because the long range aims of solar system exploration had to outweigh the immediate preferences of an individual project. It was essential to do everything that could be done to maximize Voyager 2’s success. If Pioneer failed at the “E” ring, the Voyager 2 spacecraft would have to abandon Uranus, and that information was needed now. Once again the needs of the many outweighed the needs of the few.



The complexity of Saturn’s rings, as viewed by the Cassini spacecraft. Credit: Cassini Imaging team, JPL, ESA, NASA

And so in 1979, the year that the Voyager spacecraft reached Jupiter,

Pioneer 11 was hurtling through the unknown dangers around Saturn. Tom Gehrel's Imaging Photopolarimeter (IPP) instrument began taking images of Saturn in early August 1979. The first images were somewhat disappointing but improved as the spacecraft got closer. Soon Pioneer 11 was able to make out more details of the rings and suddenly Saturn had become like Jupiter - a place rather than a dot in the sky.

If there is a legacy to the Pioneer missions it must surely be this – they made the outer planets 'places'. By early in the morning of September 1st the IPP had identified another, previously unknown ring around Saturn. This was labeled, with dry humor, the "F" ring. At the same time the IPP sent back the images of an undiscovered moon.

And yet tension was rising in mission control because later that same morning would come the acid test – when Pioneer 11 crossed the plane of Saturn's rings. By this time the spacecraft was traveling over 70,000 mph and would pass through the danger-zone in less than a second – yet another example of the strange nature of planetary explanation – a six-year journey put at risk by a one-second encounter. And there was nothing that anyone could do about it, the round trip time for a signal to and from Pioneer 11 was now almost three hours.

At just a few minutes past nine o'clock in the morning the Ames computer screens began to flicker once again. Pioneer 11 had survived the first ring crossing.

Then Pioneer 11 swung past Saturn at a distance of only 13,000 miles, and communications blacked out as it passed behind the planet. This time it would swing back through the rings in the blackout. But once again the craft survived. Pioneer 11 had survived two ring crossings and as a direct result, Uranus and the edge of the Solar System would now be within Voyager 2's reach.

Ironically, having survived the first ring crossing, Pioneer 11 almost came to grief a few minutes later during the communications blackout while it was behind Saturn, when it almost hit one of Saturn's many moons. The 'proximity alert' was an eight second decrease in radiation detector output to virtually zero, which then abruptly returned to former values. In those same eight seconds, the magnetometer recorded major disturbances in the local magnetic field. The Mission Controllers realized that Pioneer 11 had crossed the magnetic "wake" of a moon about 200 km across, at a distance of no more than a few thousand kilometers. It was the closest the spacecraft has been to another planetary body since leaving Earth six years before. But that would not become clear until the next day, when Van Allen went over the particle telemetry data with a fine-toothed comb. It was an example of another of the strange anomalies of time in deep space missions. To a deep space craft and its controllers, there is no such thing as 'real time' – not only is there a time delay imposed by the laws of physics, (in the case of Pioneer 11, at Saturn it was 86 minutes) on top of that, it is still possible to miss things until you have trawled through the data.

Larry Lasher, a project scientist at Ames at the time, told me: "Pioneer 10 was the forerunner of all the outer planet deep space missions. It paved the way for future missions by showing that the asteroid belt was not a barrier to reach Jupiter, Saturn, the outer solar system and beyond. Further, Pioneer 10/11 was the first spacecraft to leave the planetary solar system. Thanks to that initial penetration, the Voyager mission followed and traveled past the solar wind boundary into interstellar space."

Pioneer 11, having discovered another moon and another ring as it flew past Saturn, then passed Titan on September 2nd - sending back the first close up pictures of that moon - then slid quietly out of Saturnian space and into the history books.

Chris Riley, Co-Producer of the acclaimed documentary In the Shadow of the Moon, sums up the legacy of the Pioneer probes thus: "The pioneering spirit of those early planetary missions is encapsulated in the story of Pioneer 10, so aptly named to reflect the uncertainty of its mission ahead. The route it trail blazed through the asteroid belt, and the radiation field of Jupiter and the ring plane of Saturn must surely rank along side the great journeys of human history, like Magellan's circumnavigation of the Earth."

More information: O, Pioneers! (Part 1): The motes in God's eye

Source: Astrobio.net

Citation: O, Pioneers! (part 2): The derelicts of space (2012, March 6) retrieved 27 April 2024 from https://phys.org/news/2012-03-derelicts-space.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.