THE GREAT SATURN QUANDARY

NASA officials next month must choose Pioneer 11's path by Saturn's rings, a potentially life-or-death decision—and they don't know which

BY JONATHAN EBERHART

Pioneers 10 and 11 have already done enough to live up to their name, being the first spacecraft to pass through the asteroid belt and to visit—and survive—the radiation-drenched environment of Jupiter. For Pioneer 11, however, another major goal remains: the first-ever encounter with the ringed planet Saturn. Yet it is those very rings, making Saturn one of the great spectacles of the heavens, that make next month's decision on the specific targeting of the "fly-by" a possible life-or-death matter for the doughty probe. Contributing to the tension is the fact that, until the encounter actually takes place in early September of 1979, no one will know whether the decision was the right one.

The traditionally recognized rings of Saturn are three in number. The outer ring, or A-ring, begins a little more than 60,000 kilometers from the planet's surface, extending outward for about 16,000 km. Inside the A-ring is a gap, clearly visible in earth-based photographs, known as the Cassini division, about 2,600 km wide and believed to be due to a gravitational resonance with Mimas, one of Saturn's moons. Inside the gap is the B-ring, nearly 26,000 km wide, followed immediately by the 15,000-km C-ring. Less than 17,000 km inside the C-ring's inner edge is Saturn itself.

The question for Pioneer 11 seems straightforward enough: Should the spacecraft be aimed to fly outside the rings, or should it be sent on the "inside option," to fly between the inside of the C-ring and the planet? Flight controllers at NASA's Ames Research Center in California plan to fire the probe's engine late next month to set up the pass—it must be done well in advance to minimize the required propellant—so the Pioneer 11 scientists and project officials are meeting at Ames on Nov. 1 to talk it over. The scientists will pass on their opinions to project manager Charles F. Hall of Ames, who will then make his own recommendation to NASA management, who in turn will make the choice.

For scientists and all, the decision will be a tough one. So tough, in fact, that a SCIENCE NEWS poll of the 13 principal scientists (3 of the 13 were unavailable but had previously expressed opinions) was split right down the middle: 6 for the outside option, 6 for inside, and 1 neutral. And even those views were highly qualified.

The reason is that Saturn may have not three rings, but five.

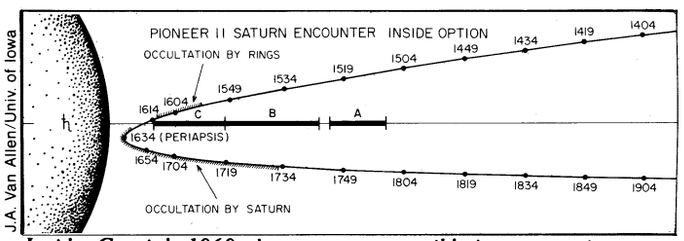
In October of 1969, Pierre Guerin of the Institut d'Astrophysique in Paris took a series of photos of Saturn using the 41-inch reflecting telescope at Pic du Midi Observatory. The conventional versions of the photos, properly exposed for the brightness of the rings and the planet, show the expected ring structure. A high-contrast negative print, however, shows what appears to be a faint additional ring *inside* the C-ring. "The new ring D," wrote Guerin in the August 1970 SKY AND TELESCOPE, "lies inside C and is separated from it by a dark lane that is equivalent to Cassini's division ...." More recently, Bradford Smith of the University of Arizona, using digital data from charge-coupled-device images, has found "excess light" inside the C-ring. Smith is part of Project Voyager (which follows Pioneer 11 to Saturn), some of whose participants hope Pioneer 11 will preview Voyager's outside path.

It is Guerin's ring that has caused most of the uncertainty, causing the project scientists to weigh the drawbacks of "half a mission"—getting wiped out by a chunk orbiting in the ring plane and losing the data from the outbound leg—against the advantages of getting 90,000 km closer to the planet. Trapped radiation belts and charged particles, for example, may exist both outside and inside the rings, but be "swept" out of circulation over the span of the rings' radius, leaving a strange, charged-particle-free gap in the shape of a thick, spherical shell. Mario Acuna of NASA's Goddard Space Flight Center says that he would rather get half a fly-by close to the planet for his magnetic-fields study than a whole one outside the rings. Other researchers opt for "the survival route."

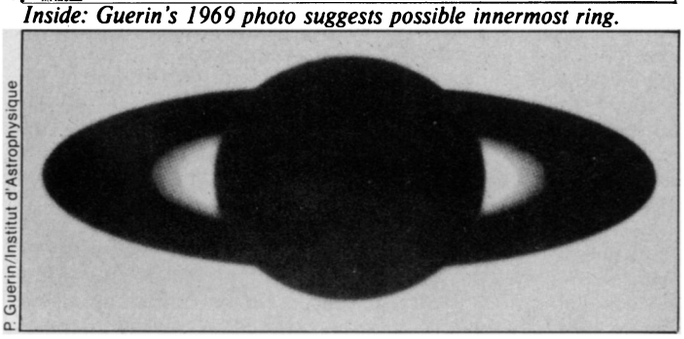
But is there one? Since the 19th century there have been sporadic reports of brightness observed *outside the A-ring* as well. In late 1966, W.A. Feibelman of Allegheny Observatory in Pennsylvania took microdensitometer scans of the rings as seen edge-on (NATURE, 214:793), and reported "a very thin extension of the ... ring system [that] extends to more than twice the known ring diameter ...."

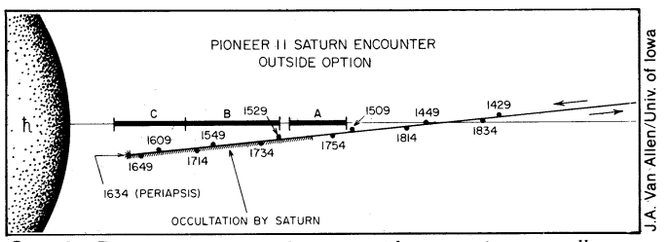
Pioneer project scientist John Wolfe of Ames thus maintains that so little is certain about the survival chances by either route that it would be better to assume survival and go for the best science.

The day of decision looms. □



Inside: Guerin's 1969 photo suggests possible innermost ring.





Outside: Densitometer trace hints at wide outer ring as well.