A Spokesman for Saturn's Rings

SETI THURSDAY

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This article is another reminiscence I'd like to share—how I got the topic for my dissertation on the rings of Saturn. I had obtained my M.S. degree in Astronomy and gotten a job with the Jet Propulsion Laboratory in Pasadena, California working with the space image processing group whose job it was to put digital images together that came back from the planetary spacecraft, enhancing them for certain features, making maps, etc. We were thus often the first people to see new discoveries.

One of my first tasks had been to false-color Jupiter images, to bring out cloud features. Some folks in our group got the nickname "Easter Bunny" because a lot of the time the results frankly made Jupiter look like a psychedelic egg. I got a call from NASA Headquarters wanting a color picture of Venus. I said, "What color would you like it?" and my office mates waved at me—I had to backtrack when the voice on the other end said, "What?" since apparently our credibility for realism was on the line. Really, however, in those days, no planet's actual color was safe in our lab.

I had a call from the boss one day: someone from the FBI wanted a ring picture enhanced. Since I had been assigned to work on Voyager I and II Saturn ring images, he was sent to me. I didn't ask any questions as we shook hands and he asked, "So you can enhance ring images?" I nodded and he handed me a small 9-track tape. When I brought up the image, it was a man patting a black dog. He asked if we could zoom in on and enhance the man's hand and the ring he was wearing so they could identify him. It was no problem and he was very satisfied with the result but I found myself smiling and shaking my head through the experience.

Then one day Rich Terrell of the Voyager Imaging Team came in with an interesting assignment. On the processing sheet were picture numbers with the request, "Enhance for radial features." Hmm, radial features? Rich said that Jeff Cuzzi had thought he noticed radial features going outward from the rings. Carl Sagan and Dave Pieri joined us at the computer screen as I loaded up the images. After a quick look at the brightness histogram, I did a contrast stretch and suddenly these massive radial features jumped out at us. "This is going to make someone a great dissertation," was the first comment from Carl Sagan. Hmm, I thought… why not me?

Thus I began saving images of Saturn's rings that showed different colors and aspects of the rings. Eventually I was to wind up doing my dissertation in Germany with Eberhard Gruen at the Max Planck Institute in Heidelberg, whose interest in these radial features—now called the "spokes"—tended from his interest in interplanetary dust. From the way light scattered off the spokes we knew that they must be small particles (i.e., near the wavelength of light). One way to know this is that they became brighter when looked at in the direction of the Sun, but became darker when looked at with the Sun at one's back; over Voyager's shoulder, one might say. This is exactly the same effect that happens with dust on a car windshield. One cannot see the dust very well while the Sun is at one's back, but at a certain angle, as one turns into the Sun, the dust brightens up and one sees nothing but dust. This angle (called the "phase angle") at which the "forward diffraction lobe" of the tiny particle skips light toward your eye, can actually measure the size of the particles doing the light scattering in terms of the wavelength of light (in this case, sunshine). This became the basis of my dissertation: to use multicolored images of Saturn's rings from as many sun angles as possible to measure the size of the spoke particles in Saturn's rings.

I thought I had been there when the spokes were discovered, but some research showed that as early as the late 19th Century these

features had been spotted in the B-ring of Saturn (the B-ring is the middle ring and has most of the mass of Saturn's rings in it; the mass of all the rings is about that of Saturn's moon Mimas). In the 1930s some folks had thought they had spotted the ring-spokes again, but by the 1960s no one could see them and they had pretty much been relegated to the realm of illusions the eye plays, like the canals of Mars. But what were the spokes? And how did they form so quickly (some as rapidly as ten minutes or so)? Why did they form radially outward when the ring particles move around the planet in a more-or-less circular orbit? All good questions, and a great subject for a dissertation.

Theories were soon being proposed, but the most promising was that the spokes were the result of meter-sized meteor impacts onto the rings. As they hit, they produced a plasma of charged particles made from the regolithic surface of the B-ring particles. These spoke particles were therefore charged and while trying to rotate with the rings were pushed into a perpendicular direction by the magnetic field of Saturn. Neat, huh? An important parameter became their sizes since they would have to be big enough to "catch" electrons but small enough (i.e., light enough) to hover due to electric charge levitation. Theorists were coming up with an expected size, so I went after the observations and radiative transfer modeling that could give the actual measurement of the size of these particles, based on the forward diffraction lobe effect mentioned earlier. (There is an old saying in science that a theory is something that no one believes but the person that formulated it, and data is something that everybody believes but the person that took it. So, with apologies to the theorists, I picked a "data" dissertation.)

Using Voyager images from different angles and in different colors, I finally came up with a size—just about the size of red visible light at 0.6 microns, with a very small size distribution around this particle radius. Unknown to me at the time, the theoretical size of about 0.12 microns had been revised and the new theoretically expected size was more like 0.6 microns! This was great too, because the theorists had not been aware of my results when they submitted their paper, and I had not been aware of their new results when I had measured this size for the particles. Great when things match up!

Soon after this, we (Luke Dones, Jeff Cuzz, and I) also used the images of the B-ring itself to measure the brightness of the large boulders at different Sun angles. The rings were very bright and if they had been out in all the meteoritic "rain" since the origin of the Solar System, they should have been much darker than we measured them to be. We even tried hiding the meteoritic material underneath the surface of the boulders of the B-ring themselves, but to no avail. The conclusion we were being guided toward led directly to a very young age for the rings of Saturn, since they could not have been out in the "dark rain" for very long. We estimated something less than 100 million years and likely even as young as ten million years. If the dinosaurs had invented telescopes, they would likely not have seen the rings of Saturn because they would not have been formed yet. They are likely the result of a moon somehow getting too close to Saturn and breaking up due to tidal forces sometime after the Cretaceous period.

A few years after publishing these results, I got a letter from Clyde Tombaugh, the discoverer of Pluto. He said he had spotted the spokes in Saturn's rings from the ground using his 16-inch telescope. We corresponded a bit but I had already decided that I was not going to argue with the discoverer of Pluto. But he also could pinpoint where they were and I became scientifically convinced (and not just historically impressed) that he had indeed spotted them. A few years after this, observations done with the Hubble Space Telescope also confirmed a narrow size distribution, and everyone was looking forward to the Cassini spacecraft's arrival to get better imaging data on the spokes as well as other features.

Well, nature always has something surprising, and when Cassini got to Saturn there were no spokelike features to be seen in any of the rings! They were gone! I guess it isn't often that one's dissertation topic disappears (unless one works on supernovae or such things). But that's what had happened. It was suggested that it might be an effect of the angle of the rings toward the Sun. Or perhaps the meteor flux at Saturn had changed. But their disappearance might perhaps explain the skepticism about the spokes in the 1960s when they really could not be seen in the rings, because they actually do come and go.

Well, I wish I had a good ending of this story for you. But as of today we don't know what happened to the spokes in Saturn's B-ring.

Jeff Cuzzi of NASA Ames and his colleagues are making predictions as to when the spokes should reappear. At their earliest prediction the spokes did not reappear, but there are other predicted times too, based on modifications of the theory. I'd like to see them reappear suddenly someday soon.

The rings of Saturn are so beautiful already that I would expect them to become a favorite spot for future space-faring honeymooners. And if they are accompanied by the sudden-burst formations of mysterious-looking cloudy radial features shooting thousands of miles across the rings like a silk handkerchief pulled from a magician's sleeve, to then drift along softly and settle back into the majestic rings to await another burst of plasma, well, it can only add to the experience. Until then, I hope it's a matter of months or years rather than decades or centuries before they reappear. I'll await their announcement like news of an old friend returning home.