

As Cassini moved closer to Saturn in May 2004, its narrow angle camera took two images that were combined to create this amazing picture of the ringed world. Dotted around the planet are tiny dots of some of its moons, including Mimas and Enceladus.

Image courtesy: NASA/JPL/Space Science Institute.



Carolyn Porco: the biggest, baddest team leader of them all

By **Barry Shanko**

The leader of the Cassini imaging team herself: Dr Carolyn Porco. Image courtesy: Carolyn Porco.

The Cassini spacecraft is the orbiting successor to Voyager's Saturn fly-bys. Its clear pictures of the planet, rings and moons are not only scientifically valuable but are so striking that they should be hung in art galleries. As soon as Cassini's images arrive on Earth, previous ideas are rethought and new ones created.

A connecting link between both missions is Dr Carolyn Porco. As a graduate student, she studied the mysterious spokes in the rings first seen by Voyager 1. Now with a PhD thanks to Voyager, she holds a crucial position in the mission of its successor, as Cassini's imaging team leader.

This interview discusses the Cassini results, her interests and how she deals with being the leader of a team in which she is the solitary woman.

Cassini at Saturn

How does Cassini's Saturn differ from Voyager's Saturn?

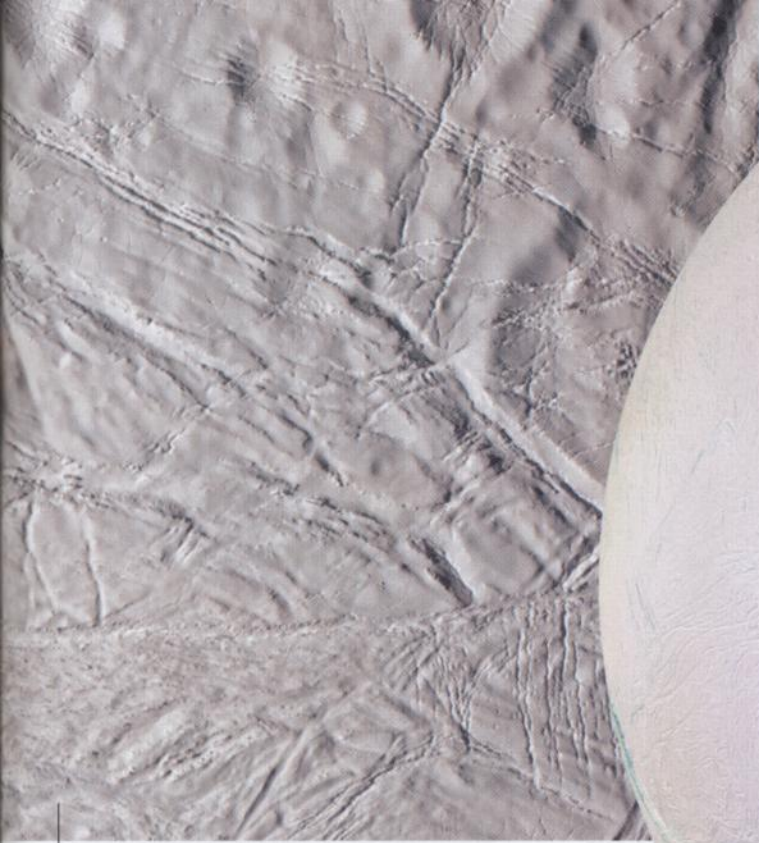
We arrived at Saturn with Cassini knowing more or less what to expect, because it wasn't our first visit. But the instruments are so much better on Cassini, and we have the luxury of extended observation because we are in orbit. Cassini's cameras have greater fidelity in reproducing different levels of reflected light, so the images are clearer than Voyager's. The exotic and spectacular have become commonplace. This is exploration at its finest.

What have been the most significant findings from Cassini so far?

Where do I start! How about these?
– Phenomena throughout the rings

that we didn't know existed.

- Unique structures on the dark, previously uncharted side of Iapetus and no evidence whatsoever of volcanic resurfacing and flooding.
- The dizzyingly contorted surface of Enceladus, accompanied by heat and water vapour preferentially coming out of fractures in the southern polar region; those tell of this small moon's very complex geological history.
- Seeing the surface of Titan with our cameras and with the cameras on the Huygens' probe. That one Huygens image of the dendritic drainage patterns, on the shore of a large, dark low-lying region that speaks of flowing liquid on the surface... the sight of that was like being hit over the head with a frying pan. I was



Enceladus exhibits a "dizzily contorted surface" with fractures and building-size blocks that have left the planetary scientists stumped. Image courtesy: NASA/JPL/Space Science Institute.



Cassini's fly-bys of Saturn's moon Enceladus has provided some of Carolyn Porco's favourite imagery from the mission so far. This picture is a mosaic made up of 21 narrow-angle camera images and is a false-colour view, combining some images taken at ultraviolet and infrared wavelengths. The variety and complexity of Enceladus' icy terrain is clear to see. Image courtesy: NASA/JPL/Space Science Institute.

stunned, speechless and walking around in a daze for several hours afterwards.

What aspects of the Cassini mission still to come are you looking forward to?

Getting into those orbits from which our view of the planet and its rings will be very different than what we have seen over the last year. In the middle of the tour, we will be looking at Saturn closer to full-phase, and so more of the planet and the rings will be illuminated. We'll be making atmospheric movies during those orbits that will be wonderful to watch.

Towards the end of the tour, we will crank the spacecraft's orbit up to high latitude, and look down and see Saturn literally like no one has ever seen Saturn before, with the rings laid out, like a bull's eye pattern below us.

You made your scientific mark by studying the mysterious ring spokes. Cassini has recently seen them. Is there anything new to report?

The spokes become visible when the concentration of electrons released from the rings by sunlight is lowest. This happens on the dark side of the rings, where we have seen the spokes, and on the lit side when the Sun's elevation above the rings is low. We expect to see them there soon.

What is your favourite object seen by Cassini so far?

I think the images that captivate me the most at the moment are those of Enceladus. They are so crystal clear, that I imagine I'm flying over the bewildering patterns of folds and criss-crossing fractures, and marvelling at all those torturous twists and turns of a once fluid surface.

You first got interested in astronomy by seeing Saturn through a telescope. Your doctorate came through your work on rings. With Cassini, do you feel like you've come home?

You bet! To go back to Saturn was like arriving back in the land of my youth. I was a graduate student when Voyager got to Saturn and made my first scientific discoveries there. I feel like I grew up there. After Voyager was over, I very much wanted to go back. I'm at peace knowing that I did.

When you see Saturn in the night sky now, what goes through your mind?

How so very far away it is, how truly bold, daring, imaginative, hopeful, and far-reaching we are to have attempted such an ambitious adventure. We have

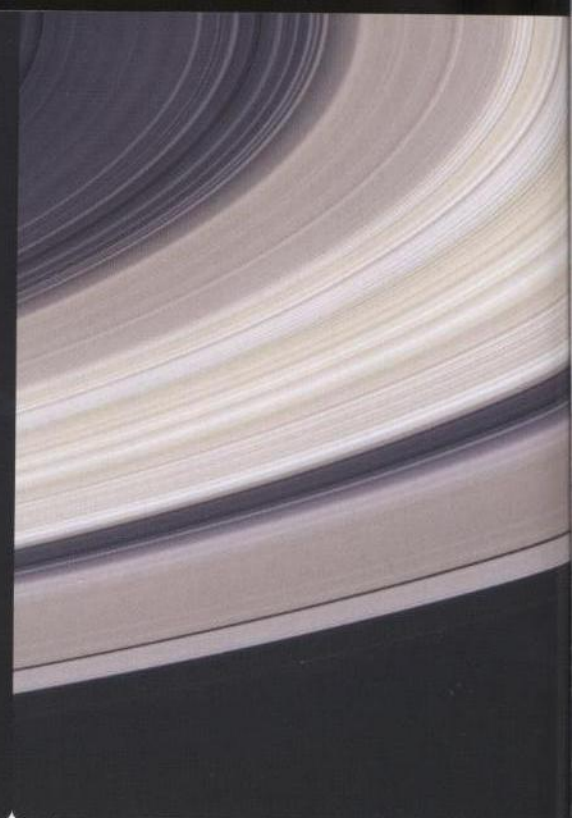
firmly arrived in the outer Solar System, and because of that, the Solar System has become a much smaller place. And WE did it. No generation of humans living on this Earth before us could have said that. You don't get much luckier than that.

What follow-up missions would you like to see?

I'd want a spacecraft that could hover, very closely, over the rings of Saturn and orbit with them, watching the individual ring particles interacting with each other, and studying their interactions. That would help us understand not only how a disc of material, like Saturn's rings, changes and evolves with time but also how such ice grains and cobbles first coalesced together to grow into the larger bodies



A simulated image constructed during a radio occultation, when Earth and Cassini were on directly opposite sides of Saturn's rings. Radio signals were beamed from Cassini through the rings to Earth, and the observed change in each signal as the rings moved in front allowed scientists to use the data to construct an image of the rings. The colour represents data regarding the size of the ring particles, with purple showing an abundance of particles larger than 5cm, and green indicating particles less than 5cm. The white band is the B-ring, which is the densest of Saturn's rings and blocked the radio signals. Image courtesy: NASA/JPL.



Cassini took this image of Saturn's intricate rings, from a distance of 6.4 million kilometres. The brightest region is the B-ring, containing thousands of narrow ringlets. The colours are a result of trace amounts of dust and carbon compounds amidst the primarily water-ice content of the rings. Image courtesy: NASA/JPL/Space Science Institute.

that eventually formed the planets.

And I'd like to see a suite of missions to Saturn's moons: one or two to explore Titan, either with balloon-borne instruments or airplanes, and perhaps one to study Enceladus.

I am woman

In these 'modern' times, it's sad the subject has to be broached, but woman scientists are still few in numbers and are particularly challenged. A female leading a team on a major science mission is even rarer still. I wanted to know from Porco what being a woman in a man's world is like.

How has the position of women in science changed since you started?

There are certainly a lot more of us than when I got started 30 years ago in graduate school. So we're not so much of a novelty any more. But the core issues are still there.

We have won the strategic battles – there are laws in place to guard against

gender bias – but the tactical battles remain. Women are more easily ignored. Many of us do not do so well in hand-to-hand combat, and a lot of scientific discourse takes place in that style.

The scientific method is based on criticism; it is essential to the process. I can criticise someone's work bluntly and it comes off harshly and takes people by surprise, because I'm not supposed to behave that way. A male acting the very same way is a 'stud' to be admired. Until these cultural expectations change, women will always have a greater struggle.

Who mentored you? Could you have gone as far as you have without them?

I had very encouraging professors in college, and frankly if they had discouraged me, I'd be nowhere now.

I also had the tremendous good fortune to meet Carl Sagan when I was in college and then come to know him better while I was a graduate student, and then again as a member of the Voyager imaging

team. He was very encouraging to me and to a lot of young scientists, especially women. It meant a great deal to me.

I have a nine-year-old niece now becoming interested in astronomy. What advice would you give her and her parents?

Nine-year-old girls rock! It's at that age that girls come into their own. They are so wonderful at that age. Yet, in many cases, after nine or ten, they become so distracted with boys and needing to conform, they come to doubt their own inner selves, and question their own judgment.

Explicitly reassure her that no matter what the world is screaming at her to do, or to become, or to look like, she is as strong, capable and intelligent as any boy and can do whatever they do, including handling abstract concepts like mathematics.

Being the only woman on the imaging team, do you ever feel isolated or different?

I grew up with four brothers, I had no sisters. So, I am very comfortable being with and working around males. But of course there are gender issues involved here. No one, not even women, in this business have an easy time with a woman in a leadership position. So, do I feel that I've had significantly greater

We have firmly arrived in the outer Solar System, and because of that, the Solar System has become a much smaller place. And WE did it. No generation of humans living on this Earth before us could have said that. You don't get much luckier than that.

It was the big questions of wonder: What am I? What am I doing here, alive, now, and on this planet? What is out there? What's the purpose of it all?

I have indeed found my place, our place, and while it is shockingly small and insignificant, it is also tremendously comforting. The very fact that we are all part of something so much bigger and grander than anything immediately around us and the fact that, as small as we are, we can know our circumstance, is itself a source of wonder, empowerment and deep spiritual fulfilment.

I don't need to believe in God. I don't need the fantasies promulgated by formal religion to comfort me in the face of the vastness that engulfs us. Knowing that in me, and through me, the principles governing everything in the Universe exist and flow, is all I need.

ESA's Huygens lander touched down on the surface of Titan on 14 January 2005. The image shows the surface of Titan with ice pebbles strewn around. The scene left Carolyn Porco "stunned". Image courtesy: ESA/NASA/JPL/University of Arizona.

challenges than my male counterparts? You bet I do.

The very first time there was a meeting of the team, did you feel any added pressure?

I remember that meeting and I felt very, very strange. Not only because I was the only woman, but because several other individuals who had applied to be the team leader were on my team, and they were all male and all older than me, and I could sense the resentment. This was a highly coveted position and I won. That set the stage for some issues that linger till this day. But these have become part of the political milieu that I have come to learn to operate within.

'Scuse me while I kiss the sky

Those who know Porco say she has an inquiring mind, is a terrific communicator, has a keen sense of humour and is a lover of classic rock. When the journal *Nature* published the team's Titan paper the journal took Porco's suggestion to call the cover picture "Purple Haze" to describe the upper layers of Titan's atmosphere and as an ode to Jimi Hendrix. According to one of the team members, Carolyn was thrilled.

You've said that religious considerations and wanting to find your place in the Universe led you to astronomy. What were they, and have you found your place?

You're known primarily as a ring specialist. Why are you then involved in the New Horizons mission to Pluto?

I firmly believe we need to complete the initial reconnaissance of our Solar System that began nearly 50 years ago. We can't say we've visited and sampled the Solar System's great diversity until we reconnoitre Pluto, which is a member of the Kuiper Belt. I was a member of the Voyager mission, the first to really unveil the bodies in the outer Solar System. And now, I want to be among those who first see that last outpost.

Most scientists don't seem to like doing PR, yet you seem to enjoy it. Why?

I didn't start out knowing I could do it or would like to do it. But ever since I first started talking to the press about science, during the Voyager Uranus flyby, I was told that I had a talent for doing the 'Carl Sagan' thing.

I've had interviewers tell me I should try to host a science documentary, or write, or do things of this nature. I've gotten a lot of positive feedback from my 'Captain's Log' commentary on the CICLOPS website. When you get feedback like that, you take notice.

What is the best thing about being the head of the Cassini imaging team?

Being able to present our images to the public in an artistic way, and trying to be as creative as our funding will allow us to be.

Being the principal investigator for the imaging team, and leading the biggest, most visible experiment on the flagship

Beatlemania

What's the story behind the Abbey Road picture?

It was something I wanted to do for a long time – kind of a fantasy – to have the imaging team photographed crossing Abbey Road, in costume. I couldn't convince all of them to do it, but the most spirited ones did. It was a very funny undertaking. But it worked, although some of my team members aren't very coordinated so we couldn't get the legs all going correctly. But if you look clearly, the Paul's have no shoes and are carrying cigarettes. We paid attention to details.

I tell young people, who might one day want to be in my position of leading a team of scientists in a major scientific investigation, that you know you're doing a good job leading your team and that your powers of persuasion have become very well-developed if you can convince six grown men to follow you, in costume, across the most famous crossing in the world!

If I ever looked into your i-Pod what songs or groups would I find?

Of course, I'd have the Beatles: the best, most influential, creative, imaginative musical group that ever lived. Boy, was I lucky to be alive and young during the Sixties!

I'd have U2 – Bono reminds me a lot of Lennon. I'd have Bonnie Raitt and Paul Simon; I'd have African, Hawaiian, Irish music, and a lot of oldies.



Members of the Cassini imaging team follow in the footsteps of the Beatles on the famous Abbey Road crossing. Image courtesy: The Cassini imaging team.

of American missions, or as I like to say, "the biggest, baddest experiment on the biggest, baddest mission", is very much being in the hot seat ALL of the time.

If you could dispel one myth about space scientists what it would be?

That we're all brain, and no heart and soul. We're not Spock, you know!

Barry Shanko and *Astronomy Now* would like to give special thanks to Carolyn Porco for very kindly giving her time and help with this interview.