

PLANETARY SCIENCE

Cassini's science still has secrets to spill

The spacecraft is dead, but its data could help to reveal the age of Saturn's rings and the origin of its magnetic field.

BY ALEXANDRA WITZE

At 4:55 a.m. California time on 15 September, hundreds of scientists watched their life's work go up in flames. The Cassini spacecraft disintegrated in Saturn's atmosphere in a mission-ending move meant to keep the probe from contaminating any of the planet's moons, including Titan and Enceladus, that could harbour signs of life.

Cassini's final images, transmitted in the hours before its death, included a sequence showing Enceladus setting behind Saturn, as well as a close-up look at some of the planet's rings.

The spacecraft's last radio signal died as planned when the probe entered Saturn's atmosphere at about 113,000 kilometres per hour, roughly 10 degrees north of the planet's equator. As Cassini plunged to its death, it sent back a burst of data from its Ion and Neutral Mass Spectrometer. This instrument measures the chemical composition of gases, and provided scientists with their first direct taste of Saturn's atmosphere. Those data "will be the most exciting result scientifically" from the end of the mission, says Ralph Lorenz, a planetary scientist at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland.

Many discoveries about Saturn's moons, rings and interior are likely to emerge in the coming months. From April until its death, Cassini carried out a series of 22 orbits, looping between the giant planet and its rings — a perspective never before captured.

During these orbits, Cassini's Cosmic Dust Analyser, which looked at the size and composition of small particles, directly measured the composition of material in Saturn's main rings for the first time, says Sascha Kempf, a space physicist at the University of Colorado Boulder. "The data set is rich and surprising," he says. "Stay tuned."

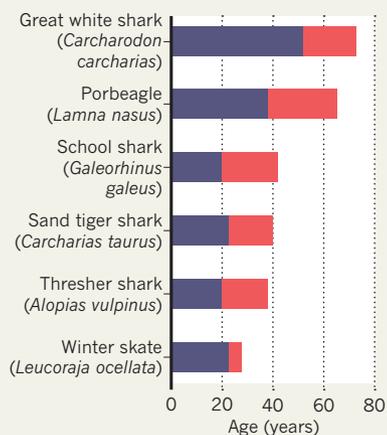
The dust data could answer a long-standing question: how old the rings are. By studying how dust falls onto the rings' icy particles and dirties them, the team can estimate their age. Some scientists argue that the rings are billions of years old, whereas others think that they are of the order of 100 million years old or younger. Kempf says that his team should have an answer soon, and that the knowledge will help researchers to narrow down how the rings formed.

Cassini's gravity measurements are helping scientists to pinpoint other key information. By analysing the gravitational effect of the rings on Cassini — a force best measured as the probe ▶

LONG IN THE TOOTH

Many shark and ray populations are living longer than conventional ageing methods suggest*.

■ Apparent maximum age
■ True maximum age



*Data for great white shark, thresher shark and winter skate populations from northwest Atlantic; sand tiger sharks from South Africa; school sharks and porbeagle sharks from Australia/New Zealand.

look at otoliths, lumps of calcium carbonate in the inner ear that build up layers throughout the fish's life. But cartilaginous sharks and rays don't have otoliths, so researchers often use sections of vertebrae instead. Sometimes, when sharks stop growing, so do their vertebrae, which means that counting the rings can make an animal seem younger than it is (see 'Long in the tooth').

Harry's paper looked at two ways of checking whether estimated age is correct: chemical marking and bomb-carbon dating. In the former, researchers inject an animal with fluorescent dye that is taken up by its spine, making a permanent mark. When the animal is recaptured, they count how many bands have formed since this known date. In the second method, scientists check animal specimens for traces of 1950s nuclear-bomb tests, and use these to estimate age.

Harry has done "a very nice job", says shark scientist Steven Campana of the University of Iceland in Reykjavik, who has worked on more than 100 ageing studies in sharks and rays, as well as in bony fish. "I fully agree with his conclusions."

The study has wide-ranging implications. Key processes such as growth, mortality and reproduction change with age. If age information is wrong, so are models that guide fisheries' decisions about how many animals can safely be caught. Living longer might mean that animals mature and start reproducing later in life, so are more vulnerable than has been realized. By contrast, longer lives might mean more breeding years, making a population more robust. Such effects haven't yet been demonstrated, says Harry, but "I would expect the impacts to be generally negative". ■



Cassini team members console each other as the spacecraft's final signal fades away on 15 September.

► plunged between them and the planet — researchers are refining their estimates of the rings' mass, as well as that of the planet's core, says Luciano Iess, a planetary scientist at the University of Rome La Sapienza.

The rings' mass provides a way to double-check calculations of their age: the more massive the rings are, the older they might be. Preliminary analysis of data from Cassini's grand-finale orbits have given Iess and his colleagues their best estimate of mass yet. "We cannot release any value yet," Iess says, "but this is the first indication that we have that probably the rings didn't form together with Saturn." By comparing those results with estimates from Cassini's dust analyser, researchers hope to be able to settle the question of ring age once and for all.

MAGNETIC MYSTERY

Cassini's magnetometer has already made some unexpected discoveries. Saturn's axis of rotation and its magnetic axis turn out to be almost perfectly aligned, says Linda Spilker, the mission's project scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. That has puzzled researchers, because models have suggested that there needs to be at least a slight offset between the two axes for the planet to maintain a magnetic field.

The finding "suggests that we don't really understand Saturn's internal structure and how the planetary dynamo is generated yet," says Michele Dougherty, a space physicist at Imperial College London. She estimates that it will take another three to six months to crunch through the data and understand exactly what they mean.

Other potential discoveries will require researchers to put together all of Cassini's data sets from its entire 13-year study of Saturn. That includes watching the planet and its moons change over time, given that 1 year on Saturn is about 29 Earth years. "We have a whole half-season of changes on Saturn and Titan to study," says Bonnie Buratti, a planetary scientist at JPL.

The Cassini team has another year's worth of funding to tease more secrets out of the data. But as of now, there are no US missions on the books to return to Saturn — unless researchers can persuade NASA or other space agencies to go back. ■



Islands between Japan and South Korea are the source of a long-running territorial dispute.

POLITICS

Ship name stirs up trouble

Marine scientists allege that Japanese researchers have been blocked from collaboration involving a South Korean vessel.

BY MARK ZASTROW

South Korea's flagship research ship *Isabu* seems to have sailed into a controversy with the Japanese government over its name. The incident has hindered some oceanographic research collaborations between the two countries.

The ship's name refers to a sixth-century Korean general, Kim Isabu. In South Korea, he is known for his maritime conquests, which in some historical accounts included two islets that are the subject of a decades-long territorial dispute between South Korea and Japan. Known as Dokdo in South Korea and Take-shima in Japan, the small islets are located

roughly midway between the two countries, more than 200 kilometres from each mainland. The 5,900-tonne ship launched late last year and is currently cruising the Philippine Sea. Its name was an option in a public poll held by the ship's operator, the Korea Institute of Ocean Science and Technology in Ansan.

The Japanese government has issued no formal protest over the ship's name, but four scientists in South Korea and Japan have told *Nature* that researchers at Japan's national marine-research agency have been instructed not to participate in any collaborations or cruises involving *Isabu*. An e-mail sent in January by an official at the Japan Agency for Marine-Earth Science and Technology

CHOUJIB LEE/GETTY


**MORE
ONLINE**

TOP NEWS



CRISPR reveals genetic master switches in butterfly wing patterns
go.nature.com/2w5ztmm

MORE NEWS

- Seismologists stumped by mystery shock after North Korean nuclear test
go.nature.com/2xfqmqe
- Researchers challenge *P*-value thresholds
go.nature.com/2xccu5q
- Limiting global warming to 1.5 °C still possible
go.nature.com/2x8ohau

NATURE PODCAST



Sherlock Holmes the scientist; and investigating the nanotubes between cells
nature.com/nature/podcast

PREMAPHOTOS/NPL