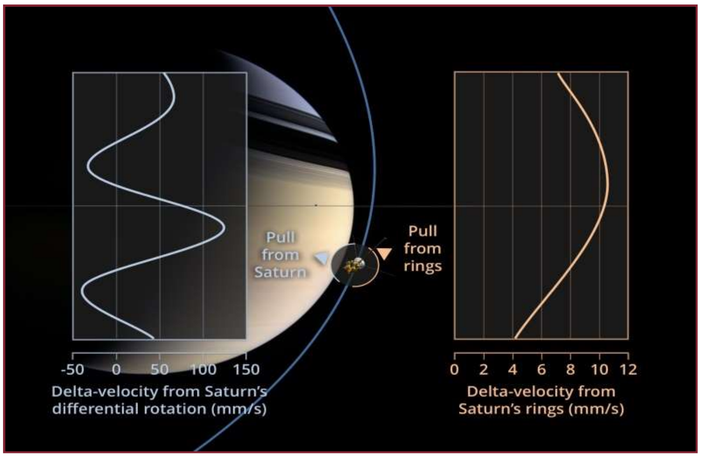
DIMA
DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Newsletter – January 2019

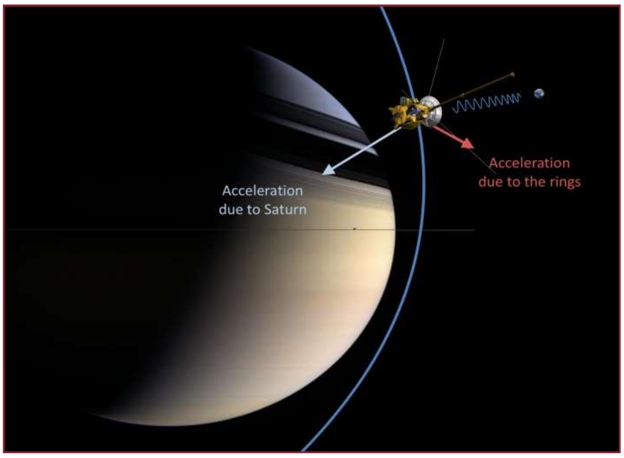
HIGHLIGHTS

Saturn Formed First, and Rings Came Long After

Saturn's rings formed only 100 million years ago, when dinosaurs roamed the Earth. The new findings of Sapienza's researchers, now published on Science online edition, are the last gift of Cassini before its final plunge in atmosphere of Saturn. Gravity measurements of Saturn and its rings measured by NASA's Cassini spacecraft before its deliberate plunge into the gas giant have revealed that the winds of the planet extend downwards by 9000 km and that the rings formed, at most, 100 million years ago. The results of this research, coordinated by Luciano Iess of the Mechanical and Aerospace Engineering Department at Sapienza University of Rome, will be published on January 17th in the online edition of Science. The rings have long been Saturn's most iconic feature, but the measurement of their mass carried out by researchers at Sapienza shows that their origin is quite recent. In fact, Saturn formed in the early stages of the Solar System, about 4.5 billion years ago, whereas the rings' origin could date back to a time when the dinosaurs roamed the Earth. The results have been obtained from measurements made in the final phase of the mission, during which Cassini carried out 6 spectacular dives very close to the planet, between its atmosphere and the rings. The spacecraft's velocity, measured with a precision of a few hundredths of a millimetre per second using a radio link between Cassini and ground antennas of NASA's Deep Space Network and the European Space Agency, allowed the disentangling of the tiny gravitational pull of the rings from the much larger effect of the planet. But what is the relationship between the mass and age of the rings? Measurements taken by other instruments on board Cassini had shown that the rings are 99% ice and the remaining 1% is composed of microscopic silicate particles, or perhaps organic material. Cassini had also determined the flux of contaminant particles present around Saturn. Measuring the mass of the rings has made it possible to estimate the amount of deposited impurities (the silicate particles) and therefore determine the time necessary for this to accumulate: between 10 and 100 million years. "The mass of the rings was the last piece of the puzzle. The small mass we measured with Cassini indicates a young age", explains Luciano Iess. "There were already clues from Voyager and Cassini measurements that the rings had not formed with Saturn, but now we have a much more concrete evidence, which was only possible to obtain during the final phase of the mission, called the Grand Finale. The rings could have been formed from the shattering of one of Saturn's moons following an impact with a comet, for example, or from collisions between moons on intersecting orbits. Alternatively, they might be the remains of a comet-like body that strayed close enough to Saturn to be tidally disrupted.



Credits: Background image from NASA/JPL-Caltech
During the Grand Finale, Cassini passed between the inner edge of Saturn's D-ring and the cloud top. The plots show the change in the line-of-sight velocity of the spacecraft due to the gravity pull from Saturn's differential rotation (left) and the rings (right). The small signal from the rings can be isolated from that associated to Saturn's gravity thank to the unique vantage point of the observations.



Credits: Background image from NASA/JPL-Caltech
During the Grand Finale, Cassini passed between the inner edge of Saturn's D-ring and the cloud top. This orbital configuration allowed the disentanglement of the tiny acceleration of the rings from the large acceleration due to Saturn. The two forces pull the spacecraft in opposite directions.

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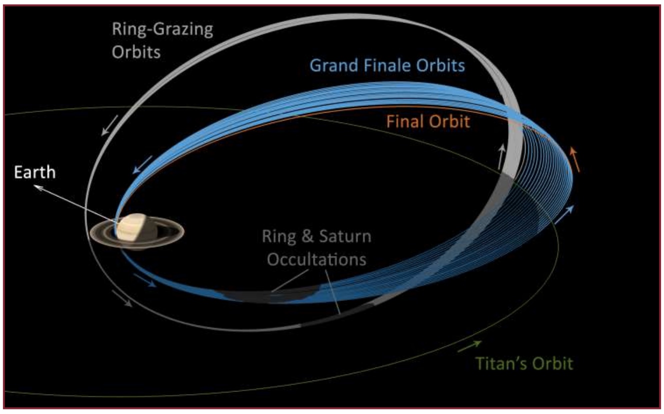
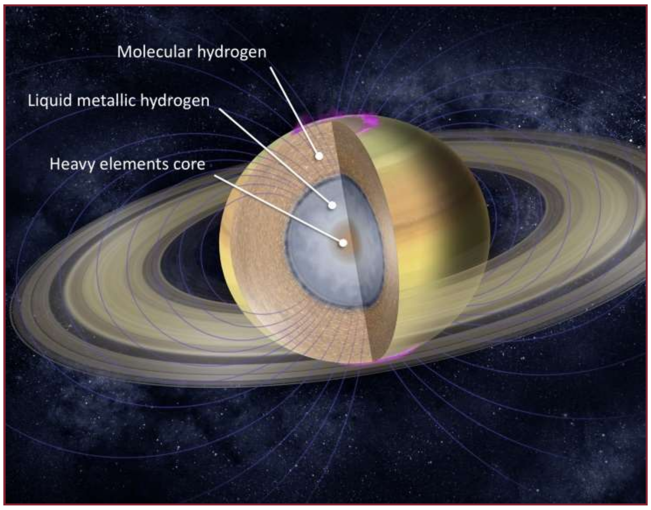
The same gravity measurements, obtained during Cassini’s close passes, allowed other questions to be answered, namely those related to the internal structure of the planet. Saturn is a gas giant with a radius of about 60000 km (about 10 times that of the Earth), largely composed of hydrogen and helium, like the Sun and Jupiter. It has long been understood that the outermost layers of Saturn’s atmosphere rotate faster than the inner layers, but by how much was unknown. Another question was at what depth the planet starts to rotate uniformly, like a solid body. “We expected that Saturn would have a similar structure to its brother, Jupiter” – says Daniele Durante, a co-author of the paper – “but when we compared the results that we obtained for Jupiter last year with these new results, the difference was surprising”. Saturn starts to rotate uniformly at a depth of about 9000 – 10000 km, corresponding to 15% of the planet’s radius. On the other hand, on Jupiter only the outermost layers, corresponding to 3% of the planet, rotate faster than those of the interior. The large depth of the differential rotation could explain why, until now, it has been impossible to determine Saturn’s period of rotation. This research also answers another question: how large is the core of Saturn? Models of the internal structure, developed at the University of California at Berkeley, indicate that the gravity measurements are compatible with a core formed of heavy elements (that is, not hydrogen or helium) equal to 15-18 Earth masses, therefore 15% of the total mass of the planet. This estimate could provide important clues about the formation of Saturn and its moons. Cassini’s mission ended on 15 September 2017, using residual propellant to carry out a manoeuver to allow it to crash into the planet’s atmosphere, to protect Saturn’s moons from possible contamination. The research group is led by Luciano Iess, of the Department of Mechanical and Aerospace Engineering at Sapienza University of Rome, with collaboration from Daniele Durante and Paolo Racioppa. Other important contributions to the research were provided by B. Militzer (Univ. of California at Berkeley, USA), Y. Kaspi (Weizmann Institute, Israele) and P. Nicholson (Cornell Univ., USA), together with researchers from scientific institutions elsewhere in Italy and abroad. The research, that will be published on 17 January in the online edition of Science, has been funded in part by the Italian Space Agency (ASI). “The analysis of Cassini data keeps surprising us”, says Barbara Negri, who leads the Unit Exploration of the Universe at ASI. “These new results are a fine addition to our understanding of the ringed planet, obtained thanks to the contribution of researchers from Sapienza University.”



Credits: NASA/JPL-Caltech
This graphic illustrates the trajectory of Cassini, or flight path, during the final two phases of its mission. The 20 Ring-Grazing Orbits are shown in gray; the 22 Grand Finale Orbits are shown in blue. The final partial orbit is colored orange. Portions of these orbits pass through areas where the planet's atmosphere or rings occult, or block, the spacecraft's view of Earth. Occultations are useful for Cassini's radio science investigation, which probes signals transmitted between Earth and the spacecraft in order to learn about the properties of the planet and rings.



Credits: Background image from NASA/JPL-Caltech
Saturn’s interior is mainly composed of three layers: a deep inner core made mostly of heavy elements, with a liquid metallic hydrogen envelope, surrounded by a molecular hydrogen layer.

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OPPORTUNITIES FOR RESEARCH, NETWORKING AND INTERNATIONALIZATION

- Call for proposals for access to integrated multidisciplinary facilities for Materials and Biomaterials. CERIC-ERIC offers access through a single entry point to more than 50 different and complementary state of the art techniques and support laboratories, distributed in 9 countries, with the submission of single or multi-technique proposals. Access to CERIC is open to scientists from all over the world and free of charge. The only condition for free access is the publication of the results, with appropriate citation of the facilities and local contacts involved. Proposals should be submitted online through the Virtual Unified Office (VUO). The best projects will be selected by peer review through an independent and international panel of experts. For further information about the evaluation and how to submit successful proposals, follow this link: https://www.ceric-eric.eu/users/call-for-proposals/

- The "Intellectual Property Award 2019" competition, organized by the Ministry of Economic Development (MISE) in collaboration with NETVAL, aims to encourage innovation and enhance the creativity of the inventors of Italian universities, national research institutions and IRCCS, which use the their technical, scientific and intellectual abilities to make a real contribution to technological progress and economic growth, thus improving daily life. The winner of each category will be awarded a prize of 10,000 euros. Applications must be sent within 10 April 2019. For further information about the evaluation and how to submit proposals, you can follow this link: https://www.mise.gov.it/index.php/it/per-i-media/notizie/it/198-notizie-stampa/2039171-concorso-intellectual-property-award-2019

- The Commission starts preparing the implementation strategy for Horizon Europe – the next EU research & innovation framework programme. This goes in parallel with the legislative process in Council and Parliament. On 30 January 2019 Stakeholder workshop “Shaping how Horizon Europe is implemented” took place in Brussels. The aim of the event was to discuss the implementation of Horizon Europe with European umbrella organisations. The workshop covered the entire project life cycle, from proposal submission to efficient reporting and exploiting results. Among others the special report of the European Court of Auditors on the simplification of the H2020 measures was also discussed. Further information are available at this link: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/news

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