DISCOVERING HUYGENS

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The delicacies of our conference dinner, ladies and gentlemen, may have brought you in the right mood to hear about the dinner that was served to Christiaan Huygens at the occasion of his sister's marriage – served not only to this frail little man, of course, but to forty healthy stomachs of his family as well.

What would you think of a swine's head and a hundred partridges, capons, turkeys, pheasants and hares around, all stuffed with lamb's meat and lardoon? When the aromas of the meat become too much for you, sniff then at one of those strongly perfumed candles. And when there is not enough Burgundy to rinse your throat, quell the pepper with the sugar and marzipan in that astonishing quantity of pastries. Since it's a wedding party, you bang your plate with the cutlery when two youngsters, coyly hiding behind a napkin, alternately kiss and sip from each other's glass of wine. Is it Christiaan's turn to dive behind a napkin? He is fond of young women, and being just thirty-one …

But wait a moment. Despite his merrymaking – Christiaan uses this word (*réjouissances*) when he writes a learned friend the other day – it is already clear to him that he is not a man to raise a family. And to others for that matter. They all sense it, the young women he pays attention to, sends letters and little presents, asks to sit for him and let him draw their portrait: beautiful Marianne Petit, or Haasje Hooft, and not to forget the affective Suzette Caron who will inherit half his capital – to mention only these. They know that his mind is somewhere else, that he is bound to become a single, absent minded uncle who, much to the amazement of his nephews, is able to talk about nothing in particular …

The letter Christiaan is writing to a learned friend on that 22nd April of 1660 is of some consequence, however. He addresses Ismael Boulliau, the foremost astronomer of his time, who, becoming old already – he is fifty-five by now – is ready to defend his, Christiaan's, ingenious solution to the problem of Saturn's ears. He thanks for the congratulation with his sister's marriage, adds in one breath that he regrets a bit the time he lost to these solemn follies (*ces folies solennelles*), and then comes to the important point that he soon will have the pleasure to meet him, Ismael, in Paris. The Hague is not a place for science … They need to talk about the equation time and Saturn's inclination.

Why is Ismael Boulliau, estimed statesman in the Republic of Letters, spokesman of everyone important over there (prince Leopold de Medici

in Florence, Johannes Hevelius in Danzig, and who else) – why is he interested in seeing our fellow? It is because he recognizes genius. Much impressed by what he saw already from the hand of this handsome, long nosed fellow with haughty and intensely private look – more than once they met – he wants to pave Christiaan's way to Paris, the very seat of learning. To that end he has been counsellor and broker in the quarrels about rights Christiaan is claiming as inventor of the pendulum clock and as discoverer of Saturn's moon and ring.

The moon came first. There is no report, but with the drinks we had it is not too difficult to fancy what Christiaan did when his first telescope was ready. Its lens is preserved – we still can study it and see the flaws of his grinding of the ordinary grey-green plate glass, two inches in diameter and a focus at twelve foot. Go five years back in time, which is a lot when you are young. One winter's evening in March 1655, Christiaan opens the attic window of his father's monumental house on The Place (*Het Plein*) in The Hague, slides the tube holding lens and eyepiece out, balances these four meters on the window-frame – his hands must nearly freeze – and starts to gaze at planets in the sky.

There we are. Does he see the moon that brought us here together? He sees no doubt a starlet next to Saturn, but the sky is full of stars. Back in the comfort of the warm house he sketches what he saw. On the 25th March he draws the planet Saturn for the first time, with faint ears, very faint indeed, and without starlet. He is suspicious though. All clear nights in the springtime he is checking positions and, lo and behold, the starlet is going to and fro, it got to be a moon. After four swings he is certain and sends John Wallis in London and Gottfried Kinner von Löwenthurn in Prague the puzzle of Ovid's verse "Faraway stars move towards our eyes (*Admovere oculis distantia sidera nostris*)" plus seventeen loose letters.

Is he making public on that day, the 13th June of 1655, that he found a moon of Saturn? No, his addressees may have known a lot of Latin – more than most of us – but not the clue they need to solve the puzzle. His message is "Saturn's moon goes round in sixteen days and four hours (*Saturno luna sua circumducitur diebus sexdecim horis quatuor*)" and at the same time he wants to conceal that message. He might be wrong … So he substitutes publication with an anagram, encodes in cipher what needs further study. But he is elated! Recalling the discovery when he is sixty-five, he writes (in his *Cosmotheoros*) that everyone can think how great the joy of heart must be of him who sees things first.

This indirect expression of a strong emotion is followed by – and bear in mind that it is forty years later when he writes it: "One of Saturn's moons, more brilliant than the others and the outermost but one, came to my eye, and I was the first to see her in the year 1655 with my telescope

of barely twelve foot." By then four further moons have been discovered by Giovanni Cassini – he calls him Dominique – two in 1671/1672 and two in 1684. Dominique starts to number them, 1 for the moon closest to the planet and 4 for the first discovered moon. For a century this is a good practice, but in 1789 William Herschell will discover still more moons, closer to Saturn than number 1.

Imagine his dilemma. What should he do? Number these new moons in order of discovery or, as before, in order of their distance from the planet? In the latter case all known moons have to get a new, higher number, while the order of discovery would give (when counting from the planet) 7 – 6 – 5 – 4 – 3 – 1 – 2. Although this is disclosing the logic of discovery, such numbering would still more confuse the practicing astronomers. Avoiding revolutionary changes in a year that is already full of violence against the *ancien régime* (it is 1789), William Herschell decides for a mix and numbers 7 – 6 – 1 – 2 – 3 – 4 – 5. The compromise is not satisfactory, however.

Half a century later, in 1847, John Herschell, the son, suggests to put an end to the confusion in the numbering. He proposes to name the then known seven moons after individual gods associated with the mighty Saturn, and argues as follows:

"As Saturn devoured his children, his family could not be assembled around him, so that the choice [*i.e.* John Herschell's choice] lay among his brothers and sisters, the Titans and Titanesses. The name of Iapetus seemed indicated by the obscurity and remoteness of the exterior satellite, Titan by the superior size of the Huyghenian, while the three female appellations (Rhea, Dione, and Thetys) class together the three intermediate Cassinian satellites. The minute interior ones seemed appropriately characterized by a return to male appellations (Enceladus and Mimas) chosen from a younger and inferior, though still superhuman, brood." [End of quote.]

This romantic proposal is received with enthusiasm. For the next century new moons – even when their existence is not certain – get names like Hyperion, Phoebe, Themis, Janus … instead of numbers. Only the recent space research of Saturn, whose neighbourhood appears to be filled with tens of new moonlets, has stopped the naming game.

Our era is sceptic rather than romantic. We know more, and are more critical as well. Can we still be enthusiastic about Titan as name for the moon discovered by Christiaan, a name concocted centuries *post factum*? To be honest: No. Titan is not even the name of an individual god. Titans form a collective: a bunch of old gods that in the Greek myth created our world. A non-existing single Titan has no role in this creation. Moreover,

the *Theogony*, to which the intellectual John Herschel refers, is not just an innocent intellectual discourse. As a matter of fact you may be grateful to the organisers of this conference that they deferred the table speech until after the consummation of the dinner. For the myth is a ghastly story of swallowing and vomiting, of abortion and castration, incest, blood and sperm …

Why had the very first god Saturn (Kronos for the Greek) to devour his children? Because it was told to him that he was fated, strong as he was, to be subdued by his own son. That son was Jupiter (Zeus). His mother Rhea, whose first four children were already consumed by their father in order to avoid the unbearable fate of subjugation, was lucky when she could conceal the birth of number five, this Jupiter, and provided Saturn with a stone when he suspiciously inquired when and where … Well, fancy the rest of the story yourself.

The point in referring to the *Theogony*, this primitive theory of cosmic forces, is that we now can see that the "Huyghenian" moon, this most conspicuous companion of Saturn, could better be called Rhea: a true single Titan, or Titaness rather, outstanding lust object, prolific mother of strange life. Rhea might even feed the current speculations of organic creatures in the methane over there. But why myth? Why not stick to the name the discoverer himself gave to that moon?

In December 1672, when Domique Cassini has asked him to come to the Paris Observatory and convince himself that there is another moon, he makes two sketches. Each shows the planet with its ring edge-on, and next to it a starlet of two crossed lines with the word *novus*, then next to it another starlet of three crossed lines with *min|* – obviously an incomplete word. The same *min|* appears in a Saturn drawing of 1683, where he is not certain to have seen Cassini's *novus*, as it "was much darker than ours (*multo obscurior erat nostro*)". This use of *nostro* – Christiaan is then in the company of a brother and neighbours – makes it almost certain that *min|* is short for *mijne* or *mijnes*, old-Dutch for "mine". But when he wants to say that this moon is his, why isn't he using *meus*, a word that everyone would have understood? Why is he hiding his intention? Afraid of being laughed at when he dares to name what he discovered by his own name Huygens? Yet he writes verses like

Ingenii vivent monumenta, inscriptaque coelo
Nomina victuri post mea fata canent,

saying that this and other discoveries remain signs of his sagacity, and that the names he wrote across the heavens still will echo his fame when he is dead. It's to us to give the name as yet and call the "Huyghenian" Huygens.

Ladies and gentlemen! In more than one respect this name is fitting. For the discovery of "Huygens" is but one stone in the solid edifice our man erected, only the first in a row. Soon thereafter, in 1656, came number two, his identification of Saturn's changing ears with a tilting ring, and almost simultaneously came number three, his invention of a pendulum clock, which because of its precision in time keeping was of enormous practical importance. In all three cases he continued Galileo's innovative practical and mathematical research program of natural phenomena.

When Galileo died, Huygens was thirteen years old. Only a few years later he started reading Galileo's *Discorsi*, and he understood them so well that they became central to his thinking. Cries of plagiarism resounded when he came forward with his own results! To silence these cries he needed to publish, still in the 1650's, the detail of his work in *Horologium* and *Systema Saturnium*. And, as said before, he needed knowledgeable, understanding friends like Ismael Boulliau. Huygens's fame in the seventeenth century rested largely on his clock and on his astronomical discoveries.

But we, in the twenty-first century, will point at two more fundamental stones he dug up in 1656 and 1659: *De motu corporum ex percussione* (a first complete and correct collision theory that is implicitly based on the conservation of momentum and kinetic energy) and *De vi centrifuga* (a first correct theory of force as acceleration, with the famous formula v^2/r). We have found them back in Newton's shadow. Not Isaac Newton, thirteen (almost fourteen) years younger than he, dug them up. Christiaan Huygens did.

There is a third fundamental finding, and this one was never ascribed to someone else: his principle, the Huygens Principle. He formulated it in 1677. It says that each point in a wave front [of light] is the centre of a secondary wave and that these secondary waves add up in their envelope.

Today, the 14th April of 2004, it is 375 years ago that our man was born. For us it is three days after Easter, for him, then, one day before. For the father, a pious Calvinist, the proximity of Easter was significant, but for this son it didn't have a special meaning.

In his notes and correspondence he shows himself to be an agnostic, much to the regret of his family, for sure. "Admit", he writes in his old days, "that it is beyond man to have an idea of God." And in his youth, shortly after his sister's wedding, he writes to a Jesuit mathematician who wanted to convert him: "You come up only with books, as if these on their own are authoritative arguments, books of which the text can be falsified and written by people who can be mistaken. How far this stands from the power of persuasion afforded by mathematical proofs!"

His father, a genius in his own right, diplomat and counsellor of the House of Orange, more than once addressed his son's incredulity in the poetry he wrote (and still is famous for), for instance in the admonition

"Remember all your cognizance
Comes from God alone –
Let not your work betray the Master."

In the presence of his father he could duly pray, and go to church, but in his absence he didn't care for clergymen. When ill, or delivered to feelings of loneliness and melancholy, he abhorred them. At his deathbed, when the family asked permission to call a vicar, he cursed and raged.

He lived from 1629 to 1695, was born and died in The Hague, but for a period of fifteen years, starting in 1666, he had an apartment in Paris where he held the position of dean, or principal member, of the Royal Academy of Science. In this position he finished his two major works *Horologium oscillatorium* (with a thorough mathematical theory of the pendulum clock) and *Traité de la lumière* (with his speculative wave-theory of light). Gottfried Leibniz came to see him here in order to learn advanced mathematics, and here he had his icy correspondence with that other young man, Isaac Newton, about light.

The French often think that Huygens was a Frenchman, and for some time he also thought he was. Didn't he exchange the "y" in his name for an "h", so that "Huygens" would be "Hughens" – at least a name that the French could pronounce? But in the 1680's it became Louis XIV's policy to purify his Kingdom and chase all heretics, including Calvinists, thus also the number one in learned Europe, "Hughens". In fact he was fired, so politely though, that it took years before this naïve genius understood that he, also he, had become *non grata*.

In his Parisian years he was more or less a courtier. It was the King's Academy, since all new knowledge that might be useful had to serve the interests of the State. Look how "Hughens" is walking around: beneath his tailored coat exquisitely dressed in a black suit of cloth and a splendid silk waistcoat woven with gold, lined with East Indian crimson – golden buttons are only for the King.

This man came to detest the court-life, and even more so the intrigues in the Academy, for he was scrupulous and easily hurt. He shaped and moulded the text of his letters as if he were grinding a lens. The mastery of mathematics gave him access to the physical world, while the mastery of his passions gave him access to himself. Even when angry, he was usually able to retain his composure. Nevertheless he did write quite a number of angry letters; there is one about Eustachio Divini who attacked his ring hypothesis regarding Saturn, and there is another about Robert

Hooke who contested his claim to have invented the balance spring for a watch. His rage was boundless in a letter about Catelan, who maintained that there was an error in *Horologium oscillatorium*. He wrote as follows:

"I am amazed at his attack on my theory about the centre of oscillation; nobody has objected to it in the nine years since I published it. Having looked at his so-called refutation, I wonder why the author has not withdrawn it during the seven months since its publication. Briefly, what Catelan thinks is that the sum of two line elements cannot be equal to the sum of two other lines elements, if the ratio of these elements is different. Imagine that the first two measure 4 and 8 feet, and the other two 3 and 9 feet, and see whether you can make either sum come to anything else but 12. (…) I want this to be published, so that those who are not familiar with my proof will realise that Catelan's remarks are meaningless. Should he take up the issue again, I would be obliged if you submit his views to a scholar before you publish them. This might even be good for his reputation. To tell the truth, I dislike being attacked by a blockhead." [End of quote]

Of course, there was no error in his major work. Gilles de Roberval, the only member of the Academy who had been able to judge his work, and who in fact had questioned his calculation of oscillation centres, was silenced by Huygens's reply even before the book was published. His mathematical argument had been immaculate. It may be true that he added little to the mathematics of the century, in the form of new, self-contained methods, but it is also true that he gave impressive proofs of the explanatory power of such methods in the physical sciences.

Let us end our discovery of Huygens by striking a light note. Three months after his certainty to have discovered Saturn's moon, he wrote a letter to Diderik van Leeuwen, an acquaintance in The Hague. He wrote this letter during the *Grand Tour* he made with a brother and two friends through France. He had been already in Angers to buy a doctorate in law (at the request of his father – it was cheaper than a wig), and he had also been in Paris, of course, to see mathematicians like Ismael Boulliau – but not just that … They had been so busy that he almost forgot to thank this Van Leeuwen ("Of the Lion"). He writes:

"To that most noble knight who is without fear of the Lion. Up until this day, two of your knights have failed to write to you any word of thank or recognition for the honour of your lordship's favourable reception prior to their departure. Rather like Our Lord, when he cured the ten sick men and only a sole Samaritan came to thank him, you too have every right to say: Did I not favour four knights with my courtesy and beneficence? Where

then are the other two? This similarity entered my mind while hearing the sermon that a poor friar delivered to our ambassador last Sunday:

So it comes that the undersigned confesses to owe you one thousand five hundred thanks, to be paid out in lofty words. But I beg you most humbly not to claim this debt, for you are too familiar with my inability to repay it. I would be powerless to avail myself of the elevated and florid style suited to your lordship, whose letters overflow with eloquence and wit and merit, to be printed alongside those of Balzac and Malherbe.

But let us cease the flippant, and instead, speak the truth. I must boast in always having been the first to drink to your health and that of your beloved, and to often wish for the good fortune of your presence. Also, it is my opinion that there needs be a flying horse to bring you to us in just one second, whether it be for a long trip along the Loire, or for heroic action, such as when Dame Fortune should decide who must sleep alone and who with another. Or to choose between four horses, the best one of which be blind, and more of these daunting occurrences.

I would have invited you to join our distinguished debate that took place in full counsel when we had just arrived in Paris. There you would have heard each one of us venture his reason for coming to France: the one professed to have come to learn how to behave in genteel society, another to be presented to the celebrities, yet a third wished to view fine architecture and the latest fashion, and a fourth just to be away from home. After much lengthy and heated discussion, it was decided almost unanimously that it is not worth the trouble of travelling such a great distance for all that is to be had here.

Then you might have witnessed us plunged into a debate on sovereign possession, in which there was even a greater divergence of opinion. I recall that there was one who considered that he would possess absolute sovereignty if only he were allowed to add a coach-and-four to all that he already possessed, so that he could ride to The Hague whenever he wished. You are the best to judge whether or not your presence in all this was urgently required."