

Story Otto and the Emptiness

Wandering the streets of the city of Magdeburg Otto was poring over something he had heard: The latest astronomical considerations that the scientific (and the non-scientific) world was contemplating: Does the Earth orbit the Sun? Isn't the Earth the centre of the universe but the Sun? Initially, this idea had been considered as absurd, not just because it contradicted Aristotle's doctrine directly, but also as the Catholic Church had accepted the Earth being in the center as the truth. On the other hand the reformation had changed the fact that the Catholic Church was the authority which it had been one hundred years ago when Nicolas Copernicus had established his world picture, and recently Galileo had produced empirical evidence in favour of the heliocentric world model. Ever since then there had been many arguments for and against that model and by now Guericke was convinced that this model described the world much more precisely than the Aristotelian one even though the movement of the Earth was not noticeable and the also question of how the moving Earth could possibly pull the moon with her remained.

Another remaining objection concerned the slowing down – if the Earth and the other planets were orbiting the Sun, the movement would have become slower constantly because the matter between the celestial bodies should be slowing them down. Aristotle had excluded that there wasn't any matter. Meanwhile the supporters of the Copernican model could indeed state that their observations matched the even much easier calculations better than the ones of the representatives of the picture that saw the Earth as the centre did. But how could a vacuum, the absence of any matter, be proven?

Guericke continued along the road as he noticed some commotion in the street ahead of him. As he approached the place he saw that there was a fire in one of the houses that were a little set back. However the fire fighters had already arrived and were distinguishing the fire with two fire hoses. Suddenly everybody became hectic and the fire fighters were shouting something. Guericke approached a little further and asked one of the fire fighters why they were so hectic. "The water tub is empty which means we can't pump any more water" the man answered. And Guericke understood: the house was about to burn down! But then another group arrived with a wagon on which they had another big tub of water. Guericke smiled because the danger was averted. But suddenly his facial expression changed: Could it be this simple? If the pump would pump the water out of the tub then air would consequently flow in. Aristotle would argue that the water could only be pumped from the tub when an equal amount of air flowed in. So if the airflow could be prevented, the tub could be sealed completely and the water would then be pumped out so that nothing could flow in – in the end – there would be NOTHING in the tub...could it be this easy?

Otto walked, no he hurried home (he didn't run because that was not proper for a man of his status). He started to think- a barrel could be sealed when it was painted thickly with pitch. And the fire fighters' pump would only have to be altered slightly in order to enable it to empty such a barrel completely. Otto was staggered; how could it be possible that nobody else had considered this any earlier? He called for one of his servants and told him to order a barrel and a craftsman who could paint the barrel with pitch. The servant hesitated shortly but after Otto had yelled at him "What on earth are you waiting for?" he ran off in order to provide for what his employer had asked him for.

The following morning Otto found a perplexed craftsman and a barrel in his courtyard. He told the craftsman to seal the barrel with pitch. The craftsman was wondering what Otto wanted to store in the barrel because barrels that would contain grain didn't have to be sealed as well as barrels that would contain beer. Otto explained that the barrel should be sealed completely and when the craftsman asked another time, Otto finally answered: "Nothing will be in this barrel!" He immediately regretted these words because now the craftsman was arguing that an empty barrel wouldn't have to be sealed at all because nothing could come out of it. Otto started to lose his patience: "If nothing is in it we have to prevent something from entering the barrel!" The craftsman was still not pleased: "But if..." "Not ifs!" Otto interrupted him. "Seal this barrel now! And seal it completely!" The man muttered something but began to work and he didn't even stop as the fire fighters arrived with their hoses and nozzles. Finally the barrel was sealed, the pump was mounted and Otto gave the starting shot.

The men started to pump. Relatively soon they were groaning because it became harder and harder to work the pump. But then the barrel made

noises, a hissing sound that wouldn't stop. Otto was wondering what that could be – when he saw that the pumping men could suddenly work the pump more easily again. The barrel wasn't sealed, air was flowing in!

Otto was very disappointed and looked at the craftsman: "I told you to seal the barrel completely. Now look at this!" The craftsman was staring at the ground and said: "Who could know what you were planning. It doesn't just work that easily." However, when Otto had asked him, he assured him to seal the barrel again the next day but this time with a thicker layer of pitch.

Very early the next morning it already smelled of pitch and the craftsman applied thick layers of hot pitch to the barrel. In the afternoon it was time for a new try. They pumped again, this time it was even harder but no hissing could be heard. Instead the barrel started to gnash and crunch until it finally broke with a loud bang. Otto was disappointed. He ordered the men to remove the remains and walked back into his house. Had he returned home fully energized and enthusiastic two days ago he now seemed tired. At night he contemplated again what could have been wrong. Initially the men were able to pump very easily and the water left the barrel but then it became harder and harder. Since there was only a few water left in the barrel it became much harder to get a hold of the vanishing water. And then – yeah then - then the barrel had been too weak! But the idea had been correct!!!

Otto thought about ways to make the barrel more solid but he couldn't find any solution. But suddenly he had an idea! Iron! A barrel made of iron! The next day Otto went to the smith's and asked him for a barrel. Of course the smith didn't have an iron barrel just lying around but he promised Otto to manufacture one. Two weeks later he was done. The barrel was brought and filled with water. The fire fighters came and began to pump. They made a big effort, pumped very hard with more and more power to still get some water out of the barrel and suddenly there was a loud bang. All attendants were startled heavily and as they dared to take a look they saw that the barrel was flat as a pancake. Otto was even more disappointed than the day when the wooden barrel had broken.

At night he decided it couldn't go on like this. This idea was a dead end. Maybe Aristotle was actually right and he should finally give up the

idea that there was something like a vacuum or that the Earth orbited the Sun. But then he remembered that so much had already been pumped out of the barrel before it broke – and the men could pump a little more out of each barrel.

And why did the barrel break at all? Otto often seemed absent minded the following days and his family and friends began to worry about him – his idea with the barrel seemed to have become a bee in his bonnet. What made the barrel break? According to Aristotle the air "wanted" to flow where matter had been removed. What if this thought was correct? What if the air was able to exert a force that was big enough to break a wooden and a metal barrel? No man was able to do this, but...

Otto continued to think: If it really was the air that squashed the barrel, then he was thinking in the right direction - then he would only have to find a body that was more solid than an iron barrel. Then he remembered one the ideas that Aristotle had established: The perfect body is a sphere! What if that was correct? Someone could build him a metal sphere... he had to try this; he had a feeling that he had come very close to a solution. He ordered the smith to manufacture him a big metal sphere.

The sphere arrived and so did the fire fighters with their nozzle and with – at least Otto thought so – a pitiful smile. They connected the pump with the sphere and started pumping. Some time later it became harder, then even harder, the men sweated while they pumped and then - nothing happened! The men were not able to move the lever any further. In the end one of the men said something that sounded like music to Otto: "We can't do anything anymore, the sphere is empty!" "The sphere is empty" Otto whispered and smiled. "The sphere is empty; there is NOTHING in the sphere!"

Otto Guericke was the inventor of the air pump and could demonstrate that a vacuum could be established. He refined his experiments and demonstrated them over and over again, most impressively in front of the emperor during the “Reichstag” of Regensburg. But that is a whole new story...

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