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The Photoelectric Effect (Extract from the novella)

für Ellen Miller

In the beginning was silence and agitation and the question, why does an iceberg not sink. I'm not surprised that it took them so long to solve the puzzle, although I already thought much earlier, now they're about to get it. but man must err while still he strives, and the striving of him who waits is especially droll. I, too, believed for a long time, I must discover the key event, in order to tell the whole story properly, the event that was the turning point on the way to a solution, and then tell it around this event in circles or spirals or in many voices and contradictorily or without any order at all. But I was hardly able to decide on a particular event and still less against the others. Until I noticed that the story had no unambiguous direction at all, but was subject to the eternally changing desires of everyday life. As everything, as I am.

I am the agitation.

On one of those days, on which everything could have turned out differently, Hamburg with its one hundred thousand inhabitants was the largest German city. Some, however, did not count it among the German cities, for despite the railways it had less communication with Berlin and Munich than with Amsterdam and London with its several million inhabitants, which was the largest city in the world. When it rained in London and simultaneously in Hamburg, four hundred and fifty miles to the northeast, one may call that coincidence, although naturally it often happens. I'm talking of 22nd February 1857. There was a strong wind blowing in London, almost a storm.

At Albemarle Street Sarah Faraday was standing at the window and watching the gusts of wind driving the water before them, painting patterns and wavelets on the puddles and discarding them, before starting from the beginning again. The window rattled in its frame. In futile attacks the rain threw itself against the panes. Michael Faraday was sitting by the fireplace.

He stared into the fire and no longer asked himself how water in severe frost could conjure up these regular patterns on the window, or why very cold metal left burn wounds on the skin. That had interested him forty years before. Now he was dozing, perhaps he was running after an idea, which yet again was faster and more fleeting than he was. Perhaps he was trying to sleep, and if he was doing that, then not deliberately.

Supposedly he had to remain relaxed, was to wait for sleep to come and fetch him for ten or twenty minutes. And remaining relaxed wasn't easy. Faraday was sixty two. At thirteen, when light, or English light at least, was still made of particles, which came flying from the sun fairly straight and fast, he had left school. He carried highly taxed newspapers from subscriber to subscriber, was allowed to learn the trade of bookbinding and to read the books as he bound them. He had always dreamt of a better life. He believed that it would be better, if one knew more about it. In the end it was he and not the great scholars of Europe, not Humboldt, not Ampère, not Volta and nor his great patron Sir Humphry Davy who had made one out of electricity and magnetism: electromagnetism.

And he had achieved something even bolder. He had proven what no one thought possible: that light was magnetic. Faraday had never doubted it, on the contrary he was certain: All was one.

Only he was not at one with himself. He lacked more than the final connection, the one that would also have freed me, the connection between light and electricity, and at 20 Poststrasse in Hamburg, which as

so often lay within the same area of low pressure, Heinrich Hertz, surrounded by his family, was gasping for air. That was nothing unusual. No more than every second child survived birth, of the mothers every fifth, tenth or twentieth died, no one knew precisely, but imprecisely everyone did, including Gustav Hertz.

Behind Faraday Sarah stood at the window.

She had learned to concentrate on the moment. She could now have sent children and dog to Green Park for an hour. The wind would have blown the children's hair about their ears, they would have stuck out their tongues to taste the rain, their voices would have been broken up by the wind as they called for the dog, its barking carried off in four directions. When they came home she would have had a towel ready and dried their heads at the door. They would have pulled off their shoes, would have made a noise in the kitchen, on the hob there would be a potato soup with bacon, the smell of which filled the kitchen along with the noise. Every day Sarah heard their voices, and at night, voices, always.

She glanced over towards the cold kitchen and then looked down. Don't think about it now, she demanded of herself, she also had practice in discipline. In the morning Michael had mentioned his heartburn without complaint, and how weak he was, as a result of which they had decided not to go to the Sandemanian service. He feared the two three hour sermons and between them the long dinner together, because there was nowhere he could lie down and close his eyes. He couldn't listen anyway, in closed rooms his attention span was less than two minutes. And yet he and Sarah hardly ever failed to be present, because that always meant a silent day. It made clear, that he now only let time pass, even though it was working against him.

The way Faraday was sitting in the armchair now, the heartburn hadn't eased, and even if it had, there remained the headache, which was

sometimes oppressive, sometimes throbbing, sometimes a glowing blade from top of the spine to the eyeball. There remained the toothache and the ill-humour which dwelt within him, like a black-clothed former friend, who simply would not go. The irritability remained, which he himself hated most of all and about which he never spoke, as little as he did about the children who weren't there. The permanent rotary vertigo remained, which seen from above always went clockwise and so surely but slowly increased his pace, without ever changing his direction.

When had the vertigo begun, Faraday sometimes asked himself. Twenty years ago? What were twenty years? The children would have been a boy and a girl, at least, but Sarah's only child was Michael, and his child was knowledge, and knowledge had begun to take its leave of him.

It was close to midday. As he entered and brushed the rain from his wet coat the Hertz' family doctor joked, that one could surely have waited until morning, but just at that moment the master of the house came into the hall, nodded his thanks to the servant, so that the latter would withdraw, and ignored the physician's remark.

"Please," said Hertz dryly: "This way."

The doctor obeyed.

Was the midwife there?

"Naturally."

Hertz was a man with a broad forehead, high cheekbones and dark eyes. At the age of seven he and his parents had been baptised in St. Thomas' Church in Leipzig and his first names changed from David Gustav to Gustav Ferdinand. Subsequently his father had been able for thirty marks to acquire Hamburg citizenship. Gustav Hertz had calm, determined eyes and was used to making decisions. He opened the door to the room of his wife Anna Elisabeth who, her hair wet with sweat, was glad to see "Herr Doktor". The birth pangs which at no constellation of the heavens Sarah

Faraday had stopped dreaming about were already coming at intervals of less than two minutes and each time caused Anna Hertz to lose consciousness.

The doctor was almost inaudible as, washing his hands thoroughly, he said something to himself about “very late” and was told that this situation had already been continuing for a while.

“How long?”

“Three quarters of an hour.” The midwife exchanged glances with the doctor who, after he had asked the master of the house to turn around, and before he ordered “chloroform”, inspected the birth canal, but then said to the midwife: “I’ll do it, prepare the forceps.”

He requested hot water and a fresh cloth, which no one must touch.

Anna Hertz writhed in pain once again and uttered sounds never heard before. A maid brought boiling water in a metal bowl, which she held with towels. The forceps were dipped into it. Gustav Hertz left the room, without looking at his wife again, and walked up and down the hall smoking until, because of the sounds coming through the door, he decided to sit in the drawing room and stare into the fire.

The next two hours, during which Faraday thought about how he had once broken the sunlight in a prism and projected it onto a copper plate – the sunlight of which at that moment only very scattered vestiges penetrated the cloud cover and the undulating glass of the window panes – lasted an eternity.

Although Faraday’s memory was not simply just bad, but at the stage of dissolution, and he would have been unable to name either year or decade, he knew exactly how he had wanted to make electricity out of light for the first time. On the enforced and unceasing retreat into an ever-smaller world he had chosen his work as a refuge, what else.

Then, on 26th September 1828, I was as tense as never before in the recent history of the universe, because Faraday had connected the copper plate to a simple galvanometer. It didn't react, however. Nor did it when he dipped the plate in dilute sulphuric acid or projected the whole spectrum of sunlight onto it. The experiments, wrote Faraday in his laboratory notebook, had been conducted very crudely, and perhaps, while Heinrich Hertz was fighting for his young life in the birth canal, Faraday in his nerve-racking suspense had once more hoped to have a saving inspiration. Perhaps he was close to it.

Or perhaps not.

Not until the 1920's did the Berlin chemist Alfred Stock, in his article about the dangers of mercury vapour, with which Faraday had worked daily, remark, "How it tugs at one's heartstrings, to read in the letters of the great scientist, that he had consulted his medical friend to complain, that he can't remember any names, that he's losing touch with his professional colleagues, that he's forgetting his own studies and notes, no longer knows how to spell words."

"The organ affected," Faraday had concluded at some point, and he would now not have known when that was, but Stock quoted him, "is my head. The result is loss of memory, lack of clarity and vertigo." Stock knew from his own experience what Faraday meant. He called it dulling of the mind.

Wood crackled in the fireplace. Faraday had to let yet another surge of caustic gastric acid rise up his gullet, almost to his throat, raw from the eternal fungal infections. Sarah saw him silently clasp the armrests of chair in order to swallow, then the hands let go again.

What, he asked himself numbly, had his doctor actually advised for heartburn? Dry toast, a small hot brandy and water? Or was that for the eternal queasiness and nausea? He asked Sarah for the brandy, it would at

least wash away the pains in jaw and head, as if they were the traces of bird claws or sand worms in the gentle undulations of the summertime beach at Dover, where Sarah, after long hesitation, had consented to marry him.

“Let us go to Brighton,” he suddenly heard her say from behind him.

“You need fresh air.”

She was right. He too was gasping for oxygen. Hardly breathed in, than the poison took possession of him in great quantities, and the coast had for a long time been his only saving shore. He had often been able to relax in the sea air, had developed ideas, like the one that finally led him to induction: To push a magnet into a wire coil is not a simple idea.

Unfortunately, I have to say, Faraday was a little too attached to it. In 1845, for example, he conducted sun-rays into a wire coil twisted into a helix. Once he hastily made the attempt when there was a cloudless sky, once more calmly in moderate light. Of course he didn't observe any effect. One year later he had a more refined galvanometer. One year after that he used artificial light, focused it, polarised it, switched it abruptly on and off, that, too, had led to peculiarities in other cases, from which he read clues, which led him to his goal by often crooked paths. He inserted heavy glass into the helix. In May 1848 he had taken a silver plate, platinum wire, which he heated: without success. In fact he was moving ever further away from his goal. Only with the very first experiment had he been quite close to the photoelectric effect.

“We'll travel tomorrow,” decided Sarah.

The brandy was pleasant on the tongue, in the oral cavity and when he swallowed. It spread its warmth through head and chest. Astonishing, thought Faraday, how quickly alcohol reaches the brain, and after the two words light and electricity had been washed away, the doctor had saved the life of “the already half-dead boy” Heinrich Hertz. Gustav Hertz was

asked to come to his wife's room, where he looked at his "son who had come into the world shrivelled and wrapped in chiffon" and not knowing what to do immediately left again.

I took a deep breath.

But already by the next day his mother "wanted to love her Heins, to learn and strive with him, because he was to be a big and fine man and something distinguished". Then she looked out of the window at the bustle on the street. There were many women walking there with their sons, and no doubt they all wanted nothing else. Anna Hertz sighed. Heinrich Hertz did, however, turn into a good, steady lad and, as was right and proper in his surroundings, didn't get on anyone's nerves. He liked to make things, to draw, to make models and do joinery, got himself a lathe and spent every moment he could at it. The doctor was of the opinion Heinrich should become a sculptor. A teacher thought him a mathematician, and as a young man he went to Frankfurt to train as a civil engineer, he went to Dresden, where he joined a duelling fraternity, whose members dribbled red wine into their fresh wounds every day, so that the scars would swell up nicely, and had his father write a letter forbidding him to participate. He didn't present the letter, as planned, in order to resign, because in a second letter, sent at the same time as the first, his father advised him not to.

Heinrich went to Berlin to do his military service and on one day liked the discipline, on the next loathed the peremptory tone of command. He went to Munich where he wanted to become an engineer or was supposed to, but then after all discovered his true love. Except that the professor of physics, Philipp von Jolly, advised him against studying the subject.

"Why?" asked Hertz in astonishment.

“The theory of electrodynamics,” said Philipp von Jolly, cheerful, proud and grinning, as he had already said to Max Planck two years earlier, “is the conclusion of man’s search for natural laws”.

“Why?” asked Hertz in astonishment.

“What Maxwell achieved using Faraday’s ideas, that is the formula of the world,” said Philipp von Jolly, “there’s nothing more to discover.”

“Why?” asked Hertz in astonishment.

“Since the collapse of the nonsensical theory of corpuscular light,” the professor was kind enough to explain to the young man from the north, “we have reached the end of research into nature.” Although the idea of particles of light had of course not been a bad one. He was glad, however, that now the sun wasn’t losing any mass after all and that consequently the planetary orbits remained stable.

One can hardly believe it, but opinions simply are a matter of the heart.

Human beings are more suggestible than horses, and each age is dominated by a fashion, without one even catching sight of the tyrant.

Without the least sense of an inherent logical problem human beings believe a prison wall to be a protecting barrier, they believe self-interest is best for the collective good, and instead of displaying a degree of scepticism, they listen solemnly, when an especially lonely man, so one with a weakness for book-keeping goes through his routine and sings the old song with the words according to which one should shut up about what one knows nothing about. That provokes indignation of course. Not only because there’s plenty of silence to begin with and at the end there’s more silence than one can bear or should accept, without losing face, but because one anyway only pays attention to mysteries. One talks about nothing else. One tries to uphold morality and envies the cynic. One tries to find a pure heart to follow, as I did too. But Heinrich Hertz was anything but an awkward customer. As a student, even later as professor

he still wrote every week to “Mama and Papa”, continually borrowed money and obtained all kinds of permissions.

It looked pretty bad.

I had underestimated him, however. I slowly came to understand that the letters to his father asking for agreement were nothing but threats.

Heinrich Hertz studied physics. For a while he even believed it would have been better to have lived in earlier age, before microscope and telescope, when there was “still so much that was new”. After completing his studies, however, he went to Berlin again where he was assistant to Hermann von Helmholtz and recognised how much light resembled a wave and that life was short and art long. Only how damned short his life and particular and how damned long his art in particular would be, he did not yet suspect. Not yet.

He fell in love, with experimenting. He was no less fascinated by mercury than the others. It shone beautifully, even in the semi-darkness of the laboratory. It flowed differently from any other fluid, because where others flow, it forms spheres, which roll away quickly and comically, even if one can squash them into smaller spheres with one’s finger. It combines with other metals to produce the most curious viscosities with which the most absurd things can be done. And above all it conducts electricity reliably and willingly round the most abstruse corners. That was the business of the hour, and the neurotoxin is often involved in the business of the hour. Its opponents say it is the great, epic trickster: Ready with incomprehensible discipline, to fulfil your every wish, playing the naïve helper with a touch of unconscious genius and a connoisseur when it comes to killing.

I don’t know if a life that can be told always requires a brilliant achievement and a central flaw. All his life Faraday was diagnosed as merely suffering from overwork and posthumously from neurasthenia

with an element of hysteria. And Heinrich Hertz supposedly made his mistake in 1881, when he himself began to take an interest in mercury. Einstein was two, Sarah Faraday, who survived her husband by twelve years, dead for just that amount of time, when Hertz vaporised any amount of the metal. He measured temperature distribution in hot mercury, the surface was much cooler than that inside the fluid, he proposed an equation for its vapour tension, and let it rise colourlessly to his nose, from where it crept directly along the olfactory nerve to the brain, without giving the least hint of its presence.

It took only a year for stomach and bowels to rebel. It was a year before, courteous as he had learned to be, he spoke of uncomfortable sensations. Until he woke at five in the morning without being able to fall asleep again. I say *only*, because Heinrich Hertz never got to the stage of vertigo and loss of memory. For that the epicure supposedly takes ten years, inclusive of the phase in which the victim ignores and denies the process. About ten years. It can vary. Say the opponents.

That year Heinrich Hertz could have taken charge of the installation of electric lighting in Berlin, as Privy Councillor von Helmholtz confusingly proposed. The capital had once again announced itself, this time as electropolis. Hertz, however, preferred to be a lecturer at Kiel University. He analysed concepts like mass, atom, ether and wave, and his writing about them was ground-breaking, but he did not publish. He tried to explain why one can stand on a slab of ice without it sinking. His explanation was absurd: the slab bends and becomes a boat. He dissipated his energies on an affair, the greatest danger to minds of whom one has hopes. He became professor in Karlsruhe.

There he fell into a panic.

“If I’m not married a year from now,” he wrote to his parents, “I shall fall into a limitless rage.”

A colleague of the same age knew a remedy. Ten days later Hertz became engaged to the daughter of another, older colleague. But the panic remained. That same evening he clutched his head, went round in circles, felt his chin, despaired, broke off the engagement again after three days so causing a scandal in Karlsruhe society. There was nothing he could have done which slighted the woman more or himself.

He cried his heart out in his letters to his parents, and I have to say that I gave him up when, after the last lecture of the semester he went to Switzerland, climbed a mountain, “but could not control himself” and immediately travelled to Hamburg. After a train journey lasting one and a half days he met his mother and sister in Hamburg. They were just about to depart for Heligoland. He joined them, but suffered “from terrible restlessness and agitation”. Back to Hamburg. There: “could not be worse, melancholy, apathy.” He took a cure at a hydropathic therapy establishment noted for its treatment of neurasthenia and got himself a sabbatical for the next semester. In relation to that, I quote: “Uncertainty, misfortune, fear of company, moroseness, hopelessness, melancholy, disgrace, curse.”

Heinrich Hertz needed a couple of years of disgust at himself and the world before he found a new bride and his life lit up once more. Although every sunbeam still shot into rooms every morning like nothing else in the world and only became visible when it encountered an object, such as for example a grain of dust dancing in the air, no one any longer believed in the photon. That didn't matter, I thought, because until a little time before no one had believed in waves in that area, but only in particles. Centuries, millennia even, had celebrated only one thing: the photon. When it comes to sound it's only waves that were protected. No one thought of us phonons. Even today the public takes no notice of us, and the photon was rehabilitated after a couple of bad decades: by Albert

Einstein. In 1886, when the Einstein Company electrically illuminated the Oktoberfest in Munich, Heinrich Hertz had found by chance what Faraday had looked for in vain: How to make electricity with light. If Faraday had used electrical tension instead of sulphuric acid, then Planck, Hertz and Einstein would certainly not have been advised against studying physics. History would have been different.

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