Balloons and Barrels in Space

Omnipresent, yet invisible: cosmic radiation can penetrate even rock strata that are thousands of meters thick. When the radiation was first discovered, it was difficult to measure it at all, let alone conduct extensive research into it in the outer layers of the Earth's atmosphere. Yet inventor and visionary Erich Regener succeeded in analyzing these elusive rays by sending his measuring instruments deep into lakes and to the outermost limits of the atmosphere. His balloons and measuring instruments paved the way for the subsequent study of space – despite the fact that the National Socialists practically brought his work to a standstill.

Erich Regener (below) gave his name to this steel barrel, or "Tonne," designed to protect atmospheric measuring instruments.

When Erich Regener took up a professorship in experimental physics in Berlin in 1914, a kind of "gold rush fever" prevailed in the field of atmospheric research. Cosmic radiation, discovered only two years previously by Victor F. Hess, produced ten new questions for each one it solved. Having already dedicated his doctoral and post-doctoral research to the absorption of radiation and the layers of the Earth's atmosphere, Regener, too, enthusiastically began investigating this mysterious energy.

Yet, from the outset, the pioneer of atmospheric research had to overcome considerable technical obstacles: the radiation could be effectively measured only deep underwater, not least because the background radiation at the Earth's surface made it impossible to achieve accurate measurements there. Consequently, Regener invented an ionization chamber that automatically detected the radiation, got hold of a submarine, and sent his measuring equipment down to a depth of 250 meters in Lake Constance. Despite these efforts, however, there was still only one way to carry out in-depth research into cosmic radiation, and that was to send measuring devices high into the atmosphere.

Realizing this, Erich Regener planned unmanned balloon flights into space. For his project, the passionate scientist and skilled inventor set about constructing special measuring instruments. Werner Braunbek, who worked with Regener for many years, described them thus: "Regener's registration devices are ultra-lightweight, yet highly accurate." But the scientist had to rise to various other challenges posed by the Earth's outer atmosphere: as temperatures there can be as low as minus 50 degrees Celsius, batteries do not function. The automatic measuring instruments, however, relied on battery power. Also, balloons burst above a certain height, which would have sent the sensitive measuring instruments crashing to Earth.

It was 1932 before Regener had solved all the problems: in order to maintain the instruments at 10 to 30 degrees Celsius, he enclosed them in a greenhouse-like construction. And to ensure that they landed undamaged, he fastened several balloons together. If one of them burst, the others would still allow the instruments to drift gently back to Earth – a technique that later became known as Regener's tandem technique. At last, the researchers were able to launch the balloons from the garden of the Physics Institute at Stuttgart Technical University, where Regener had been working since 1930.

The scientists soon uncovered some surprising phenomena: contrary to expectations, at more than 20 kilometers above the Earth's surface, cosmic radiation – or ultraviolet radiation, as it was still known in those days – did not intensify, but suddenly became weaker. Regener's colleague Georg Pfotzner explained the finding thus: when high-energy cosmic particles hit the Earth's atmosphere, secondary rays are produced and the number of particles speeding toward Earth multiplies. Therefore, very little primary radiation originating directly from space penetrates the lower atmospheric strata. Instead, we are exposed to the significantly stronger secondary radiation.

In order to be able to measure the primary cosmic radiation, the scientists took up an idea from Regener's assistant Erwin Schopper and hung photo plates under the balloons. Using this method, Schopper discovered in 1937 that cosmic rays contain neutrons. Physicists all over the world later used both tandem balloons and photo plates in their work.

Regener and his colleagues also used the balloon flights to measure the pressure, temperature and chemical composition of the atmosphere, and in 1934, using a special spectrograph, they were able to directly measure atmospheric ozone content for the first time. The result was surprising: the ozone content fluctuated depending on the season and the geographical latitude. In principle, the measuring methods they used to prove this are still used by atmospheric researchers today. Even then, the researchers recognized the crucial role played by the ozone layer: "The ozone layer functions as a protective layer for all living things, ensuring, as it were, a mild photochemical climate on the Earth's surface," said Regener.

"Generalanzeiger Wuppertal" newspaper from May 16, 1989

Regener-Tonne disappears after war

Regener and his colleagues developed new measuring instruments and an ultraviolet spectrograph that could register the short wavelengths of the then-uninvestigated solar spectrum located above the ozone layer 50 kilometers from Earth. The instruments were to be transported into space as payload on a rocket in a protective casing known as the Regener-Tonne. But then everything changed. From September 1944, the A4 rockets were used as long-distance missiles against London, and the Regener-Tonne was lost in the confusion of the regime's collapse.

The advent of the Third Reich, however, brought an abrupt disruption to his work. In 1937, the National Socialists forced him into "provisional retirement" from his professorship at Stuttgart Technical University, as they euphemistically described his dismissal. The basis for this was the Law for the Restoration of the Professional Civil Service passed in April 1933. It was originally intended to keep all persons who the National Socialists characterized as being of non-Aryan descent – above all, Jews – from holding public posts, and was later expanded to include civil servants who the regime believed might pose a political threat.

Perhaps Regener's undoing was the fact that, in late 1936, he and 75 other physicists signed a letter to the Minister of Education for the Reich, Bernhard Rust, defending the theories of relativity and quantum mechanics, which were rejected by the National Socialists as non-Aryan theories that had been developed by Jewish physicists. And this may have been compounded by the fact that Regener had a Jewish wife. His professorship in Stuttgart was not reinstated until after the war.

But Erich Regener did not let this dismissal discourage him: in 1937, he and two younger colleagues founded a private Research Laboratory for the Physics of the Stratosphere in a house on Lake Constance. Although he soon ran into financial hardship, he was rescued by the Kaiser Wilhelm Society, which adopted his little institute as one of its research institutions. "At that time," as Otto Hahn, first President of the Max Planck Society, later explained, "our society was in a position to interpret the regulations issued by the Third Reich rather more flexibly, or even circumvent them, which was not an option for the Ministry of Culture and its subordinated universities."

In 1939, Regener was given an unexpected opportunity to research as yet inaccessible altitudes: Wernher von Braun invited him and other scientists to a conference at the German Army-Air Force rocket research station in Peenemünde. What von Braun referred to as a "day of wisdom" was actually designed to find scientists to work on his rocket project. In turn, the rocket constructors needed data from the atmospheric researchers to calculate their flight paths.

Regener's dream takes off: An A4 rocket is launched at the German Army-Air Force research station at Peenemünde; it never transported his measuring instruments.

As Regener had been dismissed by the government only a short while before, he saw the invitation as an attempt to make amends and became involved in the project, developing a new spectrograph and new instruments to measure pressure and temperature. In contrast to the slow balloon ascents, in a rocket, the instruments had to withstand the pressure of immense acceleration of more than 5,000 kilometers per hour, so he encased them in a protective steel *Tonne*, the German word for barrel, which was later dubbed the "Regener-Tonne".

The Tonne was to detach from the rocket at an altitude of around 50 kilometers and drift back to Earth with the help of a parachute – but due to the thin air, parachutes cannot open unaided at that height. "Once again, it was Regener who found a simple and amusing solution," reported Hans-Karl Paetzold, one of his colleagues. Regener suggested sewing air hoses into the parachute and then pumping them full of compressed air to open it. On a test flight, the parachute opened faultlessly, and the Tonne drifted effortlessly back to Earth, landing on target. But that was to be the end of the Regener-Tonne's career, because shortly afterward, the actual military purpose of the A4 rocket became brutal reality. From September 1944, the rocket, by then known as Vergeltungswaffe 2 (vengeance weapon 2), or V2, was used as a long-distance missile against Britain. The interest in research evaporated and all traces of the Regener-Tonne were lost, although portions of the equipment are rumored to have later turned up in the US.

As bombs had destroyed the institute building toward the end of the war, the researchers found new quarters a short distance away in Weissenau, near Ravensburg. After the war ended, Regener's institute was transferred to Katlenburg-Lindau, near Göttingen, and merged with the Institute for Ionospheric Research under the name Max Planck Institute for Aeronomy – since July 1, 2004, the Max Planck Institute for Solar System Research.

When asked his opinion of Regener, who was appointed first Vice President of the Max Planck Society in 1948, Hans-Karl Paetzold said: "Erich Regener's enthusiasm and new, exciting ideas meant he was always a role model for us younger researchers." Yet, perhaps he was so valued by the junior scientists because he respected their contributions: "He was always prepared to draw on the ideas of younger scientists and to acknowledge them without envy. For him, it was a matter of course that his assistants published their results under their own names, contrary to the practice of many other institute directors, especially at that time," said Paetzold. Erich Regener died in Stuttgart in 1955 at the age of 73.

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