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Ladies and Gentlemen,

I will tell you about a great scientist, who was an active member of numerous scientific societies and a member of many a scientific academy such as the Oslo Academy, the Berlin Academy, the Bologna Academy, the Academia Nazionale dei Lincei in Rome, the London Geological Society, the American Arts and Sciences in Boston, and the Pontificia Academia Scientiarum at Vatican. He was also an honorary president of the Royal Dutch Geographical Society, of the Council of the International Association of Geodesy and of the Nordic Geodetic Commission. In addition, he received the academic degree of honorary doctor from the University of Bonn, from the Helsinki University of Technology, from the University of Uppsala, and from the Ohio State University for major contributions to geodesy and isostasy and innovative geodetic research. Who was that man?

Life

This man, Veikko Aleksanteri Heiskanen, was born in a petty farmer's family in the small village of Harjuranta, in the lake district of Eastern Finland in 1895, the ninth and youngest son of Heikki Heiskanen and his wife Riikka Jurvanen. His birthday is in fact not exactly known. In the church records it is registered as having been on July 2nd. But when his mother saw this birth certificate, she asserted that her son was born on a hot summer day around St. James day, which is on 25th of July, and the family began to celebrate July 23rd as Veikko's official birthsday.

Veikko Heiskanen attended elementary school in his home village just in beginning of the 20th century. A couple of years later, strongly encouraged by his teacher, his parents were bold enough to send their little son as far as one hundred kilometres from home to attend secondary school – the lyceum in the small town of Savonlinna. From Savonlinna Heiskanen moved further to Helsinki to continue his studies at the University, and after less than three years of study he was awarded the degree of Candidate in Philosophy, with the highest grades in as many as five subjects: physics, astronomy, mathematics, theoretical philosophy, and political economy. In addition, he studied chemistry because he was aiming at a post of a teacher in mathematics.

Veikko Heiskanen's first post was at the Finnish co-educational school in St. Petersburg, Russia, where he tried to teach mathematics in the winter of 1917 to 1918. Finland was at that time the Grand Duchy under Russian rule. That was the time of the great socialistic revolution in Russia. In the confusion of the revolution, Heiskanen was imprisoned, but wading secretly across Rajajoki, a river between Finland and Russia, he was able to return to his homeland as a refugee.

Under the Russian rule the geodetic surveying and mapping of Finland was taken care by Russian military topographers. On July 5th, 1918, seven months after Finland had become an independent state, the Government of Finland established the Finnish Geodetic Institute. The main task of the institute was defined to be the first order triangulation with the geodetic and astronomical measurements for the purpose of national mapping. The second task was defined as pure scientific research: it was to promote the solution of problems connected with its practical work, to investigate geoid-related elements and to follow closely the development of geodesy.

The first director of the Finnish Geodetic Institute was Ilmari Bonsdorff, an astronomer who returned to Finland from the Pulkovo Observatory close to St. Petersburg. Soon after the appointment, Bonsdorff started to search

young talents for the Institute. In this he succeeded excellently, as he managed to catch e.g. Yrjö Väisälä, an astronomer who later became famous for the interference comparator developed for standard baseline measurements and the stellar triangulation for worldwide transcontinental triangulations. Soon also Veikko Heiskanen wandered in, becoming in September 1921 a civil servant at the Institute. In the Institute Heiskanen had to learn many new skills, and he had to take part in the field work. Later he recalled in his past memories that he preferred to spend his summers by building triangulation towers rather than carrying out time-consuming observation work, because then he had more free time for his own research.

In 1931, Heiskanen was appointed as Professor of Geodesy at the Helsinki University of Technology. The handling of responsible official duties at University in no way interrupted Heiskanen's research programme, which featured, in addition to the study of isostatic problems, also prominently research in the field of physical geodesy. Around his research assistants and young scientists supported by grants, an actively operating research institute was established. In 1936 it received from the International Association of Geodesy the official status and name of Isostatic Institute. Under the name of this institute, until 1965, 49 publications were published.

When Professor Bonsdorff retired in 1949, Heiskanen succeeded him as the director of the Finnish Geodetic Institute. At that time, in the aftermath of the Second World War, financial resources were very limited in Finland, and in addition, it was difficult to get maps necessary for isostatic research and extremely difficult to obtain gravimetric data financed by private industry abroad. Therefore, Heiskanen turned to the United States of America for help.

His inquiries gave an unexpectedly positive result: a suitable post was found at the Mapping and Charting Research Laboratory of the Ohio State University. In 1951 Heiskanen was appointed a research professor at this laboratory and supervisor of the global gravimetric mapping project. He had to start practically from scratch, furnishing his new department with instruments, curriculums, teachers and students. After his very first months in Columbus, Heiskanen was asked to arrange courses of lectures in advanced geodesy and related subjects. This kind of combination had never been available at any American university. American geodesists had until then, like Heiskanen himself, received their specialized education only at research institutes as well as in the actual practical work.

In 1951, the Institute of Geodesy, Photogrammetry and Cartography was set up at the Ohio State University. Heiskanen was its scientific director, and since 1953 also its executive director, until the institute was incorporated into the independent Department of Geodetic Science founded in 1961.

Not only from the United States of America, but also from numerous other countries, talented geodesists were invited to the Ohio State University to help Heiskanen in research as well as in teaching. Many of them settled permanently in Columbus and took care of teaching and research work after Heiskanen. Thanks to them, the Ohio State University has been since Heiskanen's days up to the present day a brilliant international center of geodetic research and education.

A scientist

According to his own words, Veikko Heiskanen had four loves in his life: the first of them was astronomy, the second, in chronological order, his wife Kaarina, the third was geodesy and the fourth the World Geodetic System.

Because of his first love, Heiskanen spent the winter 1920 to 1921 in Potsdam, Germany, for studying astronomy, physics and geophysics under Professor Ludendorff. In Potsdam he wrote his first scientific papers. Among them was also a manuscript published under the title *Über den Einfluss der Gezeiten auf die sekuläre Acceleration des Mondes*, treating the influence of the ocean tides on the orbital motion of the Moon.

The first director of the Finnish Geodetic Institute, professor Bonsdorff, had written his doctoral thesis in the field, which studied the isostatic balance of the Earth's crust, and so perhaps he gave to young Heiskanen the stimulus to start studying isostasy. There were two alternatives in isostasy: either mountains had risen from their substratum like dough, in which case their density would be inversely proportional to their height (Pratt model), or continents floated on top of fluid internal matter like ice floes on the ocean, in which case the higher a mountain was the deeper would be its roots (Airy model). Heiskanen considered Airy's model to be more natural and began to develop it. He would soon demonstrate that if one chose a suitable value for the thickness of the Earth's crust, Airy's theory would be at least as workable as the Pratt's theory. Heiskanen put Airy's model into mathematical form and used the first results as a basis for his doctoral thesis published in 1924 under the title *Untersuchungen über Schwerkraft und Isostasie*. Later he calculated and published maps showing the thickness of the Earth's

crust in different parts of the world. These calculations have decisively been confirmed only much later by deep seismic soundings.

In 1931 Heiskanen became convinced that the shape of the Earth could be pictured in detail, using the gravimetric geoid, computed with the aid of Stokes' formula from available gravimetric material. According to him, the most important scientific mission of geodesy was to determine the dimensions of the reference ellipsoid and to compute the detailed form of the geoid. Therefore he proposed to his research assistant at that time, Reino Hirvonen, that he would write his doctoral thesis on gravimetric methods for determining the geoid. Hirvonen followed the advice of his supervisor, and when the dissertation *The Continental Undulations of the Geoid* became ready in 1934, Heiskanen was satisfied, as the results of the work were both important and promising. Hirvonen was the first to apply Stokes' formula to the calculation of the gravimetric geoid. In spite of the incomplete global coverage of the gravity material used, Hirvonen was able to show that the geoid can deviate from the reference ellipsoid only a little, on the average ±50 metres.

Heiskanen's other assistant, Lauri Tanni, who worked at the Isostatic Institute, continued Hirvonen's studies. In 1948 he published a study that came into widespread use: *On the Continental Undulations of the Geoid as determined from the present gravity material*. The gravity material available to Tanni consisted of some 13 000 pendulum points and thousands of gravimetric points. Most of them were on land. In spite of the deficient global coverage of the gravity material, the main features of the figure of the Earth were clearly visible in Tanni's geoid and in their right places.

At the start of his American career, Heiskanen presented his views and plans for solving the fundamental problems of geodesy in his publication *The World Geodetic System*. To realize this, a worldwide project was set up. This program had many goals: 1) to gather all relevant gravity data in Ohio for computing a global geoid and deflections of the vertical, 2) to check the dimensions of the Earth, 3) to merge the existing geodetic systems to the World Geodetic System with aid of the global gravimetric geoid, and 4) to furnish not yet triangulated areas with astrogeodetic control points for mapping. Material was received from many a country, but due to the Cold War was collected slowly, and gaps remained in the global gravimetric map which would not be filled during Heiskanen's lifetime.

In 1957, Heiskanen completed a Figure of the Earth, based on observations from 59 countries and known as the Columbus Geoid.

Teacher

In addition to hundreds of scientific papers, Heiskanen published numerous books to be used in the universities. Among them there were two course books written only in Finnish, namely *Kenttämittaus ja kartoitus* (The field measurements and mapping) and *Pallotähtitiede* (Spherical astronomy). Internationally best known he is for two textbooks which are *The Earth and its Gravity Field*, written together with F. A. Vening Meinesz and *Physical Geodesy*, written together with Helmut Moritz. Both of them are excellent books for education and have been widely used by geoscientists all around the world.

Devout Christian

In Finland Heiskanen's name is best known for a popular book on astronomy published in two volumes and entitled *Tähtitiede, osat I ja II* (Astronomy, parts I and II), both of them written in Finnish. In this book, which consisted of about 1 000 pages, he gave a comprehensive description of all the discoveries in the astronomy up to that time. The book did not use any higher mathematics: he wrote this book for the general readership, thinking of the people's hunger for knowledge and desire to read. Heiskanen concluded this book with a quotation from the 8th Psalm of the Bible: „When I consider thy heavens, the work of thy fingers, the moon and the stars, which you have ordained; What is man, that thou art mindful of him? and a son of man, that you visitest him? For thou hast made him a little lower than the angels."

Heiskanen had inherited from his pietist parents a simple but strong faith, which was never stifled by the erudition and worldly wisdom he later acquired; on the contrary, it was only strengthened further. Therefore, it is easy to see, how happy he was, when he in 1964 was appointed by the Pope at Vatican to the membership of the Pontificia Academia Scientiarum.

Last five years

Heiskanen returned home from Columbus finally in 1966. He spent his last five years with his wife Kaarina at home in Helsinki mostly in silence. A few times, however, he visited the Finnish Geodetic Institute. In 1972 the American Geophysical Union published a monograph entitled *The use of the artificial satellites for geodesy*. This monograph was dedicated to Yrjö Väisälä, „who made geodesists cast their vision upwards", and to his brother-

in-law, Veikko Heiskanen, „who inspired the dream of a global geoid". This dedication never reached Heiskanen, who passed peacefully away on October 23rd 1971.

References

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