Marian Wilhelm Theofil von Smoluchowski
28 May 1872 – 5 September 1917

Marian Wilhelm Theofil von Smoluchowski [*pronounced:* smoloohovski] was born in Vorderbruehl, a small town on the southern outskirts Vienna, 28 May 1872. Although living near Vienna, the family's Polish roots and heritage were cultivated in the Smoluchowski house. Thanks to his father's position as a privy councillor in the Office of the Austrian Emperor, Marian attended the Collegium Theresianum in Vienna, a prestigious secondary school. He graduated in 1890 with distinction.

It is frequently evident that a teacher's excellence inspires and promotes students' excellence. This was apparent in the case of Marian Smoluchowski. His teacher of philosophy, mathematics and physics at the Theresianum was Alois Höfler, who himself was a student of Boltzmann (1844-1906) and Stefan (1835-1893).
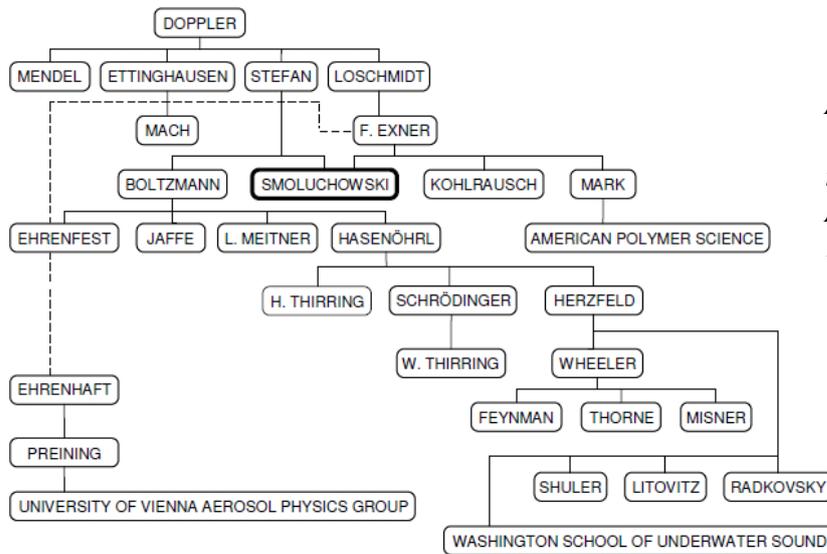

Marian with his older brother Tadeusz (about 1877)

After graduation from the Collegium Theresianum, Smoluchowski then entered in 1890 the University of Vienna, Faculty of Philosophy, to study physics. Among others he was taught by Josef Stefan and Franz Exner (1849-1926). Although it is not well documented, it is likely that

Smoluchowski had personal contacts with Ludwig Boltzmann who became a professor at the Philosophical Faculty in theoretical physics in 1894 filling a vacant position following the death of Josef Stefan.

Smoluchowski was at the University of Vienna in a time when this institution produced a number of leading scientists who had an impact far beyond the borders of the national state borders as can be seen from the "family tree" shown below. Interestingly, it was again Exner whose research assistant Felix Ehrenhaft worked on the Brownian motion of aerosols and then as early as 1909 on the elementary charge using solid aerosol particles. Ehrenhaft can be viewed as the initiator of the aerosol research at the University of Vienna.
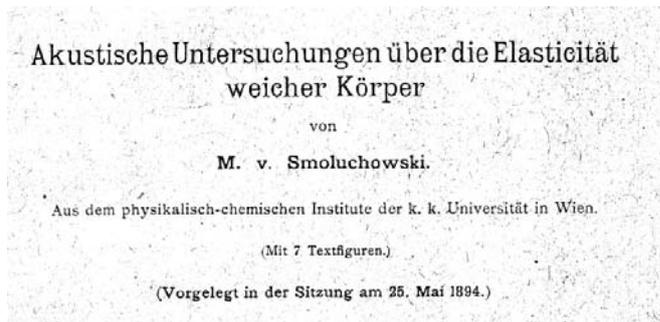
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                          DOPPLER

    MENDEL   ETTINGHAUSEN  STEFAN  LOSCHMIDT

              MACH              F. EXNER

        BOLTZMANN    SMOLUCHOWSKI   KOHLRAUSCH   MARK

 EHRENFEST   JAFFE   L. MEITNER  HASENÖHRL    AMERICAN POLYMER SCIENCE

              H. THIRRING  SCHRÖDINGER   HERZFELD

                           W. THIRRING   WHEELER

 EHRENHAFT                          FEYNMAN  THORNE  MISNER

  PREINING

 UNIVERSITY OF VIENNA AEROSOL PHYSICS GROUP   SHULER  LITOVITZ  RADKOVSKY

              WASHINGTON SCHOOL OF UNDERWATER SOUND
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Adapted from "On the Vienna School of statistical thought" (E. W. Montroll, AIP Conf. Proc. V.109, 1984)
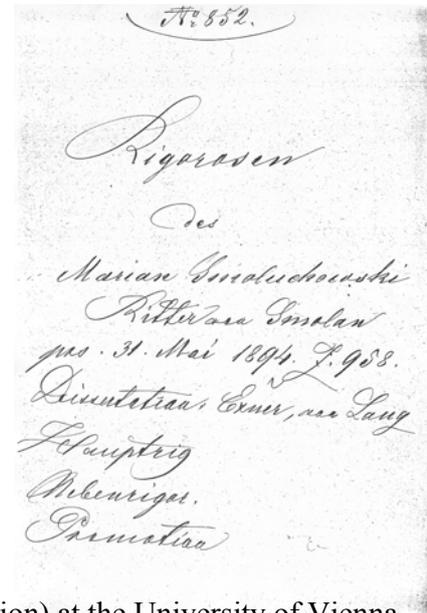
Toward the end of his university education (1894/1895), Smoluchowski spent a year in the Austrian army. Returning to the University, Smoluchowski received his PhD in 1895 for a thesis on "*Acoustical studies of the elasticity of soft materials*" graduating from the University of Vienna with the highest possible distinction of the time ("Promotio sub auspiciis Imperatoris"**)**.

Thanks to his academic achievement as a doctoral student, he received a scholarship from the Imperial Ministry for Culture and Education that allowed him to spend two years following his graduation from the University of Vienna for post-doc studies. First he went to Paris for eight months at the Sorbonne working with Gabriel Lippmann (Nobel Laureate, physics, 1908). In the spring of 1896, he was offered an assistant professor position with Boltzmann but he declined and decided to continue post-doctoral scholar visits. He went to Glasgow to work with William Thomson (Lord Kelvin) in Glasgow, and later to Berlin to work experimentally on thermal conduction of rarified gases with Emil Warburg until August of 1897.

After returning to Vienna in September 1897, he approached theoretically the problem of temperature leap at decreasing gas pressures at the gas-wall boundary. This question cannot be interpreted properly within the frame of classical thermodynamics. It is this very work which Albert Einstein cited first in his obituary for Marian Smoluchowski in the journal "Die Naturwissenschaften" (*Science*, December, 1917.

Akustische Untersuchungen über die Elasticität
weicher Körper

von

M. v. Smoluchowski.

Aus dem physikalisch-chemischen Institute der k. k. Universität in Wien.

(Mit 7 Textfiguren.)

(Vorgelegt in der Sitzung am 25. Mai 1894.)

◄——*First page of*
Smoluchowski's PhD Thesis

Handwritten report regarding the final PhD ——►
Exams (Rigorosum) of M. Smoluchowski
At the University of Vienna on May 31, 1894.
His examinators were Profs. Exner and v. Lang

In 1898 Smoluchowski obtained "venia legendi" (Habilitation) at the University of Vienna. Until recently it was the highest academic qualification scholars could achieve by their own pursuit at the University. Only two years later in 1900, he became at 28 years old the youngest university professor in the Austro-Hungarian Empire taking the chair of theoretical physics at the Lvov University (now in Ukraine). This move from Vienna to Lvov was likely dictated by his patriotic feelings towards Poland. The University of Lvov was founded in 1661 (at that time, in the Kingdom of Poland) by the King Jan Casimir of Poland. Smoluchowski stayed in Lvov until mid-1913 when he accepted the chair of experimental physics, Jagellonian University, Cracow.

Photograph of Marian Smoluchowski
during his years at the University of Lvov.
He put at the bottom of this picture a dedication:
"to my dearest Jadziula – brother Maryan".
(Jadziula was his sister-in-law. Note archaic
spelling of his first name.)

His scientific career and achievements were stopped rapidly at the age of 45 when he died prematurely due to dysentery on 5 September 1917, Cracow, Poland, while preparing for the academic year 1917/1918 as the newly elected Rector of Jagiellonian University.

Marian Smoluchowski (Dean of the Faculty of Philosophy) in front of the Collegium Novum, Jagiellonian University, Cracow, Poland, founded in 1364.

Card written by Marian Smoluchowski to Prof. Stefan Mayer, October, 1915.
In the top left corner is Smoluchowski's postal address in Cracow.

Smoluchowski is probably best known to the aerosol community for equations which now carry his name – the Smoluchowski Equations. Derived within the theory of Brownian motion, they also form the foundations of stochastic processes and modern statistical physics. In 1906 Smoluchowski published his mathematical model of Brownian motion. Scientists today, approaching these issues from a stochastic point-of-view, very frequently apply the methodical legacy of Smoluchowski. The main point in the Smoluchowski theory of Brownian motion is the finding that the proper measure of the motion is not the mean velocity of the particle in the suspension, but the mean square of its shift from an initial position. This quantity was published by Einstein (1905) from general laws of diffusion and statistical mechanics and, on the other hand, by Smoluchowski (1906) by detailed analysis of the mechanism of particle motion. In his work, Smoluchowski acknowledged Einstein's approach, but emphasized that his "method is more direct and hence more convincing than Einstein's".

This was also later stated by Einstein who said that "Smoluchowski delivered particularly beautiful and descriptive theory of Brownian motion", a piece of work of great relevance to aerosol science. Smoluchowski's work on Brownian motion marks indeed the start of the study of stochastic processes. In 1908 he proposed a theory of critical opalescence which explains the

fluctuations in the refractive index of a fluid, liquid or gas. Chandrasekar recognized "Marian Smoluchowski as the Founder of the Physics of Stochastic Phenomena".

Smoluchowski received many honors for scientific achievements during his short life. Passing away at the age of 45 interrupted a very fruitful scientific career. Despite that he was awarded an honorary doctorate by the University of Glasgow, 1901 and the Haitnger's Prize of the Vienna Academy of Sciences for his theoretical explanation of Brownian motion, 1908. He was the Wolfskehl Foundation lecturer at Göttingen, 1913 and 1916. In 1917 Smoluchowski became a corresponding member of the Academy of Sciences in Cracow, soon becoming a full member. He was president of the Copernicus Society of Natural Scientists in Lvov, 1906-08. Besides physics, he published in the fields of physical chemistry, geophysics and geology.

"Lectures about the kinetic theory of matter and about electricity" by Max Planck, Peter Debye, Walther Nernst, Marian Smoluchowski, Arnold Sommerfeld and Hendrik Lorentz, Published by Teubner 1914 (original is at the University of Michigan)

The importance of Smoluchowski's work is emphasized by the fact that two other scientists who collaborated with him in the area of the kinetic theory of matter received Noble Prizes. They were R. Zsigmondy (1925) for his work on "heterogenous nature of colloid solutions" and T. Svedberg for his work on disperse systems (1926). In his Nobel Prize lecture, Zsigmondy said he asked Smoluchowski to "derive an experimentally verifiable formula by which the presence of spheres of attraction could be deduced from the speed of coagulation". He continues, "Smoluchowski agreed to my suggestion and gave, in addition, a complete theory of coagulation on mathematical basis".

In addition, Smoluchowski's research interest covered topics such as application of probability theory to radioactivity, ionization of gas molecules by X-rays, heat conductivity of gases, aerodynamics, and glacier movement.

Acknowledging Smoluchowski's importance to science, the International Astronomical Union decided in 1970 to name one of the Moon's craters 'Marian Smoluchowski'. The Smoluchowski Crater lies in a part of the lunar surface that is sometimes brought into view from the Earth during periods of favorable orbital conditions and illumination from sunlight. It has a diameter of about 83 km and following coordinates: 60.3° N, 96.8° W.

There are now three Awards for outstanding scientific achievements carrying the name of Marian Smoluchowski. The international Smoluchowski Award of the Gesellschaft für

Aerosolforschung (GAeF) has been conferred annually since 1986 for significant research contributions to aerosol science. The Marian Smoluchowski – Emil Warburg Prize of the Polish Physics Society (PTF) and German Physics Society (DPG) conferred biannually since 1997 for outstanding contributions to pure and applied physics to scientists whose center of living and work is in Germany or Poland. The Polish Physics Association confers annually the Marian Smoluchowski Medal for exceptional research in physical sciences and for contributions to promote physics and physics education in Poland. This reward may be conferred to persons of any nationality and scientific background.

Medal of the Smoluchowski - Warburg Prize carries profiles, names and dates of Marian Smoluchowski and Emil Warburg. The recipient's full name and the year of the award are engraved around the rim.

On the brink of the twentieth century, societal influences limited opportunities for women in science. Smoluchowski was likely fortunate to know personally such exceptional women as Lise Meitner, Maria Skłodowska-Curie, Sophie Germain, Zofia Kowalewska and Tatiana Ehrenfest. He recognized the difficulties women encounter on the way to brilliant scientific achievements and presented his view on the matter in a lecture in 1912 in Lvov, where he dealt with the bizarre but then-existing dogma about supposed inferiority in logical thinking and disinterest in science among women. He stated in his lecture "women who decide for the scientific career should be strongly supported; all societal obstacles, all those ridiculous old views which for women ... make difficult the education, scientific work and access to leading university positions should become extinct. In science (and also in other areas) the principle of independent contest should prevail." (*translation from Polish by WWS*)

Marian Smoluchowski was a family man, which originally was probably not something he considered to the highest priority in his life, judging from his remark after he had met his future wife Zofia Baraniecka. Then he wrote: "*I recall now with certainty, what I stated earlier ... that happiness is simply the lack of unhappiness*". On 1 June 1901, he married Zofia Baraniecka. The Smoluchowskis had two children, a daughter Aldona and son Roman. What is less known about Marian Smoluchowski is his passion for music. He was a fine pianist, like his mother, Teofila. His other passions were mountaineering and painting.

The purity of mountain nature and the challenge of climbing influenced Smoluchowski's way in science. He described himself what mountains taught him: "*undertaking difficult tasks, happiness from conquering difficulties and adornment of everyday life with the finest poetry – the poetry of mountains*." Obviously Marian Smoluchowski was an expert climber. His most frequent companion was his brother Tadeusz with whom he climbed such serious mountains as the Breithorn (3782m), Jungfrau (4159m), and Finsteraarhorn (4275m). Later he began what we would call today extreme alpine skiing, mainly in the Tatra Mountains and Carpathians.

Zofia Baraniecka (1900), daughter of a mathematics professor at Jagiellonian University

Wedding picture of Zofia and Marian Smoluchowski (1901)

Marian with companion (in front) climbing in the Tatra Mountains, Poland

Smoluchowski in the mountains of Czernohora, Ukraine

Despite his drive to physically conquer a mountain by climbing to the top and then skiing downhill, Smoluchowski always recognized the monumental beauty of nature, which he often captured in his aquarelle paintings.

Marian Smoluchowski achieved much during his short life. To have such a fulfilled life, one needs more than good fortune. What is also needed are principles, ideals and, personal brilliance. He was an extraordinary and complete personality – an accomplished scientist – a true pioneer of aerosol science - with love for the beauty of nature and arts capable to perpetuate his emotions and at the same time a great humanist cultivating and enjoying the value of a family life.

Aquarelle paintings by M. Smoluchowski: "Za Bramka" (1904) and "Prosner Point" (1908)

Colored drawing by Smoluchowski made during his visit to Cambridge. His note at the bottom of the picture: Cambridge, back of Queens towards King's College, Oct. 1905.

Aquarell of an alpine landscape (Interlaken) from September 1909.

Biography prepared by Wladyslaw W. Szymanski and Harald Posch