

# Mathematics in the Austrian-Hungarian Empire

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Christa Binder

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# THE APPOINTMENT POLICY IN THE AUSTRIAN- -HUNGARIAN EMPIRE

CHRISTA BINDER

**Abstract:** Starting from a very low level in the mid of the 19th century the teaching and research in mathematics reached world wide fame in the Austrian-Hungarian Empire before World War One. How this was accomplished is shown with three examples of careers of famous mathematicians.

## 1 Introduction

This symposium is dedicated to the development of mathematics in the Austro-Hungarian monarchy in the time from 1850 to 1914. At the beginning of this period, in the middle of the 19th century the level of teaching and researching mathematics was very low – with a few exceptions – due to the influence of the jesuits in former centuries, and due to the reclusive period in the first half of the 19th century. But even in this time many efforts were taken to establish a higher education. Following the example set by the French revolution schools, mainly devoted to applications, were founded. The polytechnic institutes in Prague (1806), Graz (1811) and Vienna (1815) established themselves quickly and played a fundamental role in the development of mathematics. The old universities in Prague, Vienna, and Budapest tried to follow, but it took the revolution in 1848 to allow a big step forward.

For the attempt to raise the scientific level of the Empire to the status of the other European countries (France, Germany, Italy, ...) many measures were needed, but some key points were essential for success: One of them was that the universities were opened to foreign students and, at the same time, that domestic students (and professors) were allowed to leave the country and visit foreign universities (provided with generous stipends).

Another one was, of course, the appointment of highly qualified professors, and to allow these professors to teach freely what they want instead of restricting them to the use of approved books. To this end the appointment policy was radically changed. While before professors were chosen by a *Konkurs* – a kind of test of their mathematical abilities – now the procedure was more flexible: The Collegium would express and formulate – usually after long discussions – their preferences in a list of three men. (We need not consider women since, before 1900, women were not allowed to study and – even worse – they could not attend the schools necessary for preparation.) For this list they were no longer restricted by the fact that the best might not want to apply and be tested. Then the ministry – choosing from this list – had the last word and could try to coordinate the wishes of universities throughout the whole empire.

Another fortunate fact was that in the big empire with its many universities (some newly founded included) young men had the possibility that their teaching and researching ability could be tested in smaller institutions before advancing to the main universities.

A typical career (such as the three examples described below) went as follows: studies in Vienna (or Graz, or, ...) then – with the first scientific work – promotion, followed by post-doc (modern term) studies in one of Europe's mathematical centers, usually Berlin, later also Göttingen, or (for geometers) sometimes in Italy. These travels – which allowed

“learning from the masters” and led to useful contacts – were provided with a generous stipend. The next step, after returning home, was to do research and publish some papers to gain habilitation which gave the right to held lectures. After this the university career could begin, first with an appointment to one of the smaller universities (for example in Czernowitz), the next appointment would be to another university (often nearer to Vienna) while the final goal – a position at the University of Vienna – was a goal which, of course, could only be reached by the most successful scientists.

Another important step (for mathematics) was done in 1890 by Gustav von Escherich and Emil Weyr when they founded the *Monatshefte für Mathematik und Physik* because this journal made it much easier for Austrians to publish their results.

## 2 Universities in Austria

Before we take a closer look on the careers of three prominent mathematicians, we briefly sketch the history of university mathematics in Austria and introduce the places which will occur later.

### 2.1 University of Vienna

We first consider the University of Vienna, the most important university of the empire, which was both the starting and the final point for some major careers.

The university was founded in 1365, and in the 15th and 16th centuries mathematics played a big role (Johannes von Gmunden, Georg Peurbach, Regiomontan) before it declined and was neglected for several centuries. Before the period about which we are talking, there were only two mathematicians worth mentioning here: Andreas von Ettingshausen (1796–1878), a professor of mathematics 1821–1835, who introduced the symbol for the binomial coefficients and later was a famous professor of mechanics). And Josef Petzval (1807–1891), professor 1837–1877 who is famous for his contributions to the development of photography; exceptionally, he was allowed to use his own books for his lectures; and he also was the only one allowed to stay after the 1848 revolution.



The “old University”, now Academy of Sciences



### **The new building of the University on the Ringstraße**

In mathematics, the efforts to change and improve education first led to an attempt to engage Jakob Jacobi, one of the most famous mathematician of the time. However, Jacobi declined the call in 1850.

In spite of this failure a new era developed. The professors who initiated and realized this process were Franz Moth (1802–1879) 1850–1874, Ludwig Boltzmann (1844–1906) 1874–1876, and Leopold Königsberger (1837–1921) 1877–1884 who occupied the first chair, together with Joseph Petzval, Leopold Gegenbauer (1849–1903) 1877–1884 and Gustav von Escherich (1849–1935) 1884–1929 who occupied the second chair.

In addition to these traditional two chairs a third chair was installed in 1875. It was occupied by Emil Weyr (1848–1894) 1875–1894 and Franz Mertens (1840–1927) 1894–1911.

All these professors were well known in the mathematical world, they had good connections to other universities, they wrote scientific articles and useful books, and they had gifted pupils.

## **2.2 Polytechnic of Vienna**

The Polytechnic was founded in 1815 with the purpose to provide – through competent instruction – the experts needed for the fast growing industries, commerce and economy. Here Adam Freiherr von Burg (1797–1882) – professor of higher mathematics 1827–1837 and chair for mechanics 1837–1866 – had a big influence on the development of steam engines, railways, ... He and Leopold Karl Schulz von Straßnitzki (1803–1852) – who worked very actively to improve the situation for teachers – were the most influential mathematicians in the first half of the 19th century. The best known mathematician at the turn of the century was Emanuel Czuber.

In 1872 the Polytechnic became a Technische Hochschule, and the right to promote students granted in 1903.



**The Polytechnic in Vienna (Rudolf von Alt, 1839)**

The complete list of professors in mathematics is as follows:

The Chair for Elementary Mathematics (till 1866, then Chair for Mathematics I) was held by Leopold Karl Schulz von Straßnitzki (1803–1852) 1838–1852, followed by Josef Kolbe (1825–1897) 1852–1896, Moritz Allé (1837–1913) 1896–1906, and Karl Zsigmondy (1867–1925) 1906–1922.

The Chair for Higher Mathematics (till 1866, then Chair for Mathematics II) was held by Josef Salomon (1793–1856) 1838–1856, Friedrich Hartner (1811–1877) 1856–1866, Anton Winckler (1821–1892) 1866–1891, and Emanuel Czuber (1851–1925) 1891–1921.

### 2.3 University of Graz

The university in Graz – one of the oldest universities in the German speaking countries – was founded in 1585. Paul Guldin (1577–1643), a jesuit and well-known geometer taught there. In the 19th century Frischauf, the teacher of Escherich, and Daublebski von Sterneck, a famous number theorist, as well as Viktor Dantscher, an analyst with Weierstraß background, provided a high level of mathematical education.



In more detail, the Chair of Mathematics I was held by Johannes Frischauf (1837–1924) 1867–1906, followed by Daublebski von Sterneck (1872–1928) 1907–1928, and the Chair of Mathematics II (extraordinariat till 1894) was held by Gustav von Escherich 1876–1879, followed by Viktor Dantscher (1847–1921) 1879–1921.

## 2.4 Joanneum (later University of Technology) Graz



The Joanneum was founded in 1811 (four years earlier than the corresponding institution in Vienna, Polytechnic) and became Technische Hochschule Graz in 1874. Among others, in particular, Gustav von Escherich 1881–1884 and Franz Mertens 1884–1894 were teaching at the Joanneum.

## 2.5 University of Innsbruck

The third oldest university in Austria is the University of Innsbruck, founded in 1669. Several of the famous Austrian mathematicians taught there for some years, but, without doubt, the dominating figure was Otto Stolz.

The Chair for Mathematics I was held by Anton Baumgarten (1817–1880) 1852–1878, Leopold Gegenbauer (1849–1903) 1878–1893, Wilhelm Wirtinger (1865–1945) 1895–1903, and Konrad Zindler (1866–1934) 1900–1930.

The Chair for Mathematics II was held by Otto Stolz (1842–1905) 1872–1905, followed by Josef Anton Gmeiner (1862–1927) 1906–1927.



### 3 Some careers

After this overview we are prepared to follow the careers of three mathematicians who – at the turn of the century – were professors at the University of Vienna, and how they got there.

#### 3.1 Leopold Gegenbauer

Leopold Gegenbauer was born on February 2, 1849 in Lower Austria. He went to school in Krems, then he studied at the University of Vienna. After one year of taking courses in history and languages (Sanskrit) he switched to mathematics and physics. In 1869 he passed the teacher's examinations and subsequently taught at various schools in Vienna and Lower Austria. However, he never lost the contact to the University. Thus Gegenbauer became one of the first Austrian mathematicians who gained a stipend to Berlin to further his studies. In Berlin, an important center of mathematics, he had the opportunity to attend courses by Weierstraß, Kronecker, Kummer and Helmholtz. He was most impressed by the analysis as taught by Weierstraß – his carefully prepared scripts of the lectures helped to spread these new ideas – and by Kronecker's contributions to number theory.

Back in Vienna, he declined an offer to be professor at the high school in Wiener Neustadt, because he preferred to accept another offer, namely, to become the first extraordinarius of mathematics at the newly founded University of Czernowitz. This university at the eastern border of the Empire (now Cherniivski, in the western Ukraine) was founded in 1875 as a German speaking university. Though he was well received – later (in 1879) he got a honorary doctor degree from the university – Gegenbauer was not happy there, and he therefore applied several times to be transferred to another university.



**University Czernowitz**

In 1878 – after the retirement of Anton Baumgarten – a vacancy opened in Innsbruck. The faculty made the following proposal for his successor: On first place Eduard Weyr, on second place ex aequo Gustav von Escherich and Leopold Gegenbauer. The final outcome was the following: Weyr went to the Polytechnic in Prague, Escherich was prepared to go to Czernowitz, and Gegenbauer was appointed as extraordinarius. This shows quite well

the influence and the intentions of the ministry which considered the empire as a whole. The first choice of the Innsbruck collegium, Eduard Weyr, was appointed at a place where his specific accomplishments – he spoke Czech – were needed; Gegenbauer wanted to leave Czernowitz, but – in consideration for his colleagues – the ministry avoided to promote Gegenbauer to a full professor, while, in compensation, Escherich got an ordinariat in Czernowitz. Before he took up his new position and started to teach in Innsbruck, Gegenbauer was allowed to spend the winterterm 1878/79 in Italy. In 1881 he was promoted and became ordinarius, and in 1893 he could move to his final position in Vienna where he was appointed professor of mathematics at the University as the successor of Petzval (the chair had been vacant for 16 years).

In Vienna he found a wide field of activities: He initiated a course for actuary mathematics, he was director of the mathematics seminar, he gave excellent courses on various topics. Moreover, his influence spread also into politics where he was involved in the development of curricula of schools and in the organization of old-age pension schemes. His mathematical interests were not restricted to one field. He made significant contributions to number theory, algebra, the theory of integration and complex analysis. However, his most famous contributions are the so called *Gegenbauer polynomials*, a generalization of Bessel functions.

Gegenbauer died on June 3, 1903 in Gießhübl, near Vienna, after a stroke.



Gegenbauer



Escherich

### 3.2 Gustav von Escherich

Gustav von Escherich was born on June 1, 1849, in the Italian fortress Mantua, as son of an officer in the Austrian army. In 1862 his family came to Vienna where he completed school at the renowned academic gymnasium. He had good teachers who recognized his talent and recommended him to study mathematics at the University of Vienna. Later he wrote about this time that he could not attend many lectures (because of sickness), and thus had to study from books and – lacking useful textbooks – from original works. At that time the professors were Josef Petzval and Franz Moth who gave courses on analytical mechanics and analysis. Otto Stolz, just back from Berlin, taught analytical geometry. His



former schoolteacher introduced him to Johannes Frischauf (at the Joanneum in Graz) who offered him an assistantship there. 1873 he promoted at the University of Graz (because then the Joanneum – now the University of Technology – had not yet the right to promote), and in the following year, 1874, he got the right to lecture (Habilitation) with a work on the geometry on surfaces with constant curvature, a memoir which was published by the Austrian Academy of Sciences.

Much to his regret Escherich was not able to travel as many of his colleagues did, neither to Berlin or Göttingen nor to Milano – the latter because Escherich was a geometer, and at that time Milano was the center for geometry. We can only suspect about the reason – perhaps it was due to his continuous sickness (or weakness).

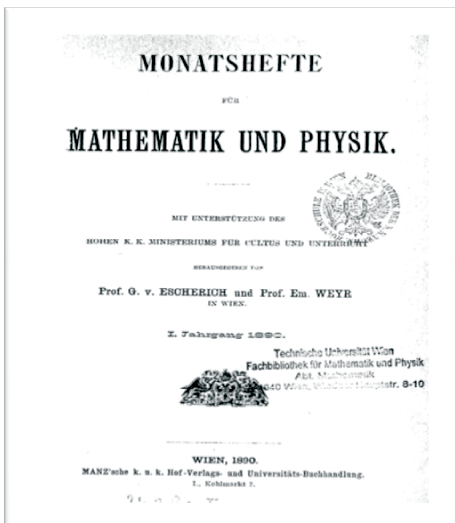
The next years he spent in Graz at the University, 1875 till 1876 as Privatdozent, 1876 till 1879 as extraordinarius. 1879 he got a call as ordinarius to the University of Czernowitz where he replaced Leopold Gegenbauer who went to Innsbruck in 1878. (See above for details.) In Czernowitz Escherich wrote an Introduction to the analytical theory of the space (1881), and he became interested in the rediscovered Ausdehnungslehre. He also wrote some treatises on determinants of higher rank and their application to the theory of invariants and coinvariants.

After three years (1882) he got a call to the Joanneum in Graz, and 1884 he reached his final position as professor of mathematics at the University of Vienna once more following Gegenbauer. His successor in Graz was Franz Mertens who came from Kracow and who ten years later came to Vienna, too. Escherich stayed in Vienna for 36 years until his retirement in 1920.

Escherichs courses on analysis and functional analysis had a big influence and were essential for the development of mathematics in Vienna and the high level that it finally reached. As we shall see, most of the famous mathematicians of the early 20th century learnt analysis in the Weierstraß style from Escherich. Even though he has not had direct contact to Berlin himself, he was well informed through Otto Stolz (who wrote one of the first textbooks) and Leopold Gegenbauer.

Their style – the exact treatment – suited his personality perfectly.

Austrian-Hungarian mathematicians often had difficulties to publish in German journals. To improve on this situation, Escherich and his colleague Emil Weyr founded an own Austrian journal, the *Monatshefte für Mathematik und Physik*, in 1890. This new journal was a big success and immediately gained international recognition.



In 1894, the German society of scientists (*Deutsche Gesellschaft der Naturforscher*) held its yearly meeting in Vienna. On this occasion, Felix Klein proposed a big and ambitious project, the *Enzyklopädie der Mathematik und ihrer Grenzgebiete*, a comprehensive encyclopedia of mathematics, worked out in cooperation of the the academies in the German speaking countries. Escherich became the representant of the Austrian Academy of Sciences, and on his initiative, many articles for this encyclopedia were written by Austrian mathematicians. (Gustav von Escherich was a member of the Austrian academy since 1892.)

As a mathematician Escherich started with geometry. His favorite topic was the construction of a surface of degree three from 19 points. Later he became more interested in analytical topics, mainly in the second variation of some integrals. But he was also interested in the theory of determinants and differential equations.

Among all his activities, however, Escherich's influence on the development of mathematics in Austria was, without doubt, most important through his pupils of whom the best known are in chronological order:

In 1887 Wilhelm Wirtinger (1865–1945) promoted,  
 in 1898 Alfred Tauber (1873–1942),  
 in 1898 Josef Plemelj (1873–1967),  
 in 1902 Hans Hahn (1879–1934),  
 in 1903 Heinrich Tietze (1880–1964),  
 in 1910 Johann Radon (1887–1956),  
 and in 1920 Leopold Vietoris (1891–2002).

### 3.3 Franz Mertens

Our third example career is Franz Mertens who is an exception because he was German (from Prussia, a province of Posen), but nevertheless his career was a typical Austrian one.

Franz Mertens was born on March 20, 1840 in Schroda as son of of a surgeon. He first studied mathematics and physics at the University of Berlin with Kronecker, Kummer and Weierstraß (a few years earlier than Gegenbauer) and promoted in 1865. Immediately after his promotion he got a call as extraordinarius to the University of Krakow (the second oldest university of Central Europe), thus entering the Austrian empire.



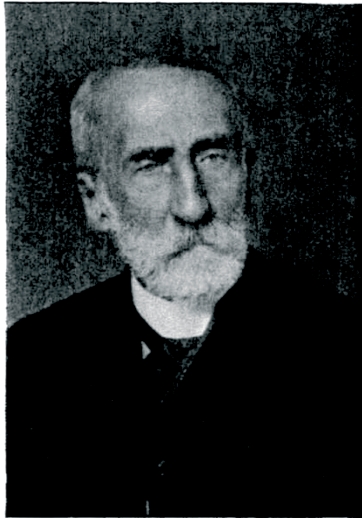
University Krakow

In 1870 he became ordinarius of pure mathematics. The languages spoken at the University of Krakow were German and Polish, and Mertens gave courses in both languages. Mertens stayed in Krakow for 19 years and established his fame as one of the leading mathematicians of his time. He published on potential theory, geometry and determinants. He was elected member of the *Göttinger Gelehrten Gesellschaft*.

In 1884 Mertens got a call to the Joanneum in Graz and finally, in 1894, he reached his goal and became professor at the University of Vienna. There, in Vienna, he was a very successful teacher and researcher till his retirement in 1911. He served in numerous academic offices and received many honours: He was a member of the Austrian Academy of Sciences, he even got a medal, the *Franz-Joseph-Orden*, and he was very popular among his students and colleagues.

His mathematical interests were spread over many fields, but became more and more focussed on the analytical theory of numbers. He simplified many complicated proofs and gave clear introductions to complex theories. Through the *Mertens conjecture* his name found its way into the mathematical language. The *Mertens function* is built as sum over the *Möbius function*, and the conjecture stated that this function were bounded by the square root of  $x$ , what – if true – would imply the validity of the Riemann conjecture. Unfortunately, in 1985 the Mertens conjecture was disproved by Andrew Odlyzko and Herman te Riele.

Franz Mertens died on March 5, 1927 in Vienna, only a short time after his last paper was published.



## 4 Conclusion

While these three careers can be considered – to some extent – as typical for the more prominent mathematicians in Austria (others would be Wilhelm Wirtinger, Emil Weyr), not all of them reached Vienna (for example Josip Plemelj (1873–1967) who stayed in his home country Slovenia), while a few did not travel so often (Otto Stolz stayed in Innsbruck). In any case, it is this type that fits the Austrian-Hungarian monarchy best.

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### Address

Christa Binder  
 Institute for Analysis and Scientific Computing  
 University of Technology Vienna  
 Wiedner Hauptstr. 8–10  
 1040 Vienna  
 Austria  
 e-mail: [christa.binder@tuwien.ac.at](mailto:christa.binder@tuwien.ac.at)



**Christa Binder and Martina Bečvářová**