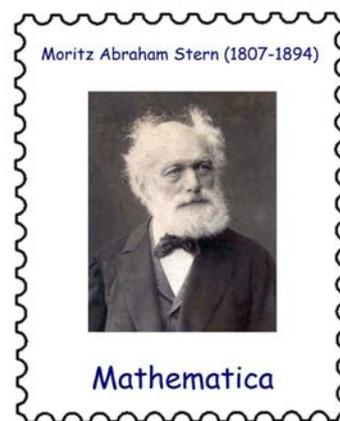## MORITZ ABRAHAM STERN (June 29, 1807 – January 30, 1894)

by HEINZ KLAUS STRICK, Germany

MORITZ ABRAHAM STERN was born in Frankfurt am Main to the wealthy merchant and bookseller, the "protected Jew" ABRAHAM SÜSSKIND STERN (i.e. a Jew with recognised residence rights). Before her marriage, his mother VÖGELE EVA REISS ran a silk shop to support her parents and siblings, because they had lost all their possessions due to a major fire in the Jewish ghetto in Frankfurt. (Incidentally, one of ABRAHAM SÜSSKIND STERN's brothers was a great-great-grandfather of ANNE FRANK.)

MORITZ was taught only by private tutors. The boy showed great interest in mathematics and had a special talent for languages: he mastered Hebrew and Yiddish as well as various ancient languages: Latin and Greek as well as Chaldean (Aramaic) and Syriac.

Incidentally, MORITZ ABRAHAM STERN also learned Russian at the age of 80 in order to be able to read original Russian literature and mathematical writings.

MORITZ began studying mathematics at the University of Heidelberg at the age of 19. His mother hoped in vain that her son would one day become a respected rabbi. On the advice of a friend, he moved to Göttingen after just one semester, where – inspired by CARL FRIEDRICH GAUSS's lectures – he developed a particular interest in number theory. In addition, he also attended lectures in physics and chemistry as well as classical languages.

At the age of 22 he wrote his dissertation on the theory of *continued fractions* (*Observationum in fractiones continuas specimen*) with BERNHARD FRIEDRICH THIBAULT. When THIBAULT fell ill on the day of the oral exam, GAUSS had to step in at short notice. GAUSS later admitted that during this first oral examination of a doctoral student he was probably more excited than the candidate.

After completing his habilitation in 1830, STERN taught at Göttingen University without a salary for eight years before finally being granted an annual salary of 150 thalers – a tenth of the salary of an ordinary professor.

STERN did not listen to the advice of his wealthy family and friends, who considered it pointless that he continued to hope for an academic career, because no Jewish lecturer had ever succeeded in becoming a professor.
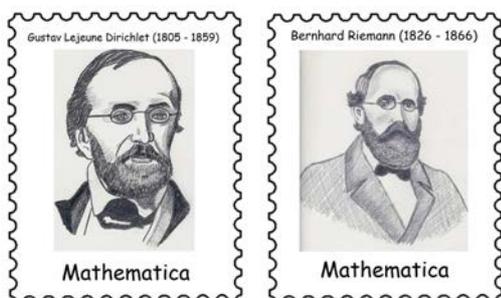
As a consequence of this anti-Semitic behaviour, during this period numerous Jewish scholars were baptised in order to have any chance of a university career. The appointment of a Jewish scientist as a professor at a German university would have been considered a sacrilege in the first half of the 19th century and would have caused a violent wave of protests.

STERN did not count himself as deeply religious, but for reasons of principle and because he felt committed to his family and ancestors he saw no reason to convert to Christianity. He was involved in the *Frankfurt Association of Friends of Reform*, whose aim was to resolve the conflict between the religious statutes of Judaism and the demands of practical life.

In 1841 STERN won a prize from the *Belgian Academy of Sciences* for a treatise on quadratic residues, and in the same year he also won an advertised competition from the *Danish Academy* for his work on solving transcendental equations.

In 1844 STERN married BERTHA SIMON from Frankfurt. However, the wedding could not take place in her home town, because the authority's annual quota of 15 Jewish weddings has already been reached. Their son ALFRED was born first and a second son three three years later. BERTHA STERN died in 1850 when their third child EMMA was born.

After waiting 19 years as a private lecturer, STERN was finally appointed an *extraordinary professor* in Göttingen in 1848. However, this was not linked to an increase in his annual salary.

(drawings © Andreas Strick)

When PETER GUSTAV LEJEUNE DIRICHLET died in 1859 two full professorships in mathematics in Göttingen became vacant. BERNHARD RIEMANN was appointed to one of them and – since no equal applicant was in sight – finally MORITZ ABRAHAM STERN. He was the first full Jewish professor in Germany.

It would not be appropriate to emphasise MORITZ ABRAHAM STERN only because of this significant historical event in the history of Jews in Germany. Naturally in comparison to GAUSS and RIEMANN, his contributions to mathematics were minor.

However, STERN published numerous papers in German, French and Belgian journals: on topics from number theory and the theory of continuous fractions, and also on infinite series and on function theory as well as on properties of the BERNOULLI numbers and the so-called *Eulerian numbers* A(n, k) (number of permutations of the numbers from 1 to n, in which exactly k elements are greater than the previous element).

STERN wrote two popular books on astronomy, translated SIMÉON POISSON's textbook on mechanics and published a textbook on algebraic analysis in 1860. His commemorative speech on CARL FRIEDRICH GAUSS was famous, and his encyclopaedia contributions on the scholars JOHANNES VON GEMUNDEN and REGIOMONTANUS were noteworthy.

One of his papers dealt with a conjecture made by CHRISTIAN GOLDBACH in 1752:

- *Every odd natural number can be represented in the form $p + 2a^2$, where p is a prime number and a is an integer.*

Examples: $9 = 7 + 2 \cdot 1^2$, $11 = 3 + 2 \cdot 2^2$, $15 = 7 + 2 \cdot 2^2$, $21 = 3 + 2 \cdot 3^2$, $49 = 17 + 2 \cdot 4^2$.

STERN found that the numbers 5777 and 5993 do not meet GOLDBACH's condition (these are so-called *STERN numbers*).

He also proved that the only prime numbers p that cannot be represented in the form $p'+2a^2$ (with $p' < p$ and $a > 0$) are the numbers 17, 137, 227, 977, 1187 and 1493 (the so-called *STERN primes*). The prime numbers 2 and 3 are also counted among the exceptions today, since the number 1 is no longer counted as a prime number, as was still common in STERN's time.

MORITZ STERN became famous for his contribution *Über eine zahlentheoretische Funktion* (On a number-theoretical function), which he submitted to *Crelles Journal* in 1858, in which he basically described the countability of positive rational numbers with the help of a tree diagram.

Independently of STERN, the brilliant French watchmaker ACHILLE BROCOT discovered the same tree structure two years later when he was looking for an algorithm that could be used to find approximate series for rational numbers:

- *Which gears with the smallest possible number of teeth can approximately achieve a given gear ratio?*

$\frac{0}{1}$								$\frac{1}{1}$								$\frac{1}{0}$
$\frac{0}{1}$				$\frac{1}{2}$				$\frac{1}{1}$				$\frac{2}{1}$				$\frac{1}{0}$
$\frac{0}{1}$		$\frac{1}{3}$		$\frac{1}{2}$		$\frac{2}{3}$		$\frac{1}{1}$		$\frac{3}{2}$		$\frac{2}{1}$		$\frac{3}{1}$		$\frac{1}{0}$
$\frac{0}{1}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{2}{5}$	$\frac{1}{2}$	$\frac{3}{5}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{1}{1}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{2}{1}$	$\frac{5}{2}$	$\frac{3}{1}$	$\frac{4}{1}$	$\frac{1}{0}$

The basic idea of the STERN-BROCOT Tree was the formation of so-called *medians* (introduced by NICOLAS CHUQUET at the end of the 15th century).

The median of $m_1 = \frac{a}{b}$ and $m_2 = \frac{c}{d}$ is defined as $\overline{m}(\frac{a}{b};\frac{c}{d}) = \frac{a+c}{b+d}$ (for example: $\overline{m}(\frac{3}{5};\frac{3}{4}) = \frac{6}{9} = \frac{2}{3}$).

When STERN's daughter EMMA died in 1884 – she had cared for her widowed father for many years – STERN ended his 25-year post as full professor at Göttingen University and moved to Switzerland. There he lived in the house of his son ALFRED, who held a chair in history first in Bern and later in Zurich.

MORITZ ABRAHAM STERN died in his home at the age of 86 – without ever being seriously ill.

Here an important hint for philatelists who also like individual (not officially issued) stamps. Enquiries at europablocks@web.de with the note: "Mathstamps".

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$a \equiv b \mod m$
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$\pi(x) = |\{p \in \mathbb{P} \mid p \leq x\}|$
1792: $\pi(x) \sim \dfrac{x}{\ln x}$
$x \to \infty$
1849: $\pi(x) \sim \displaystyle\int_{2}^{x} \dfrac{1}{\ln u}\, du$
1896: Hadamard de La Vallée Poussin
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Fundamentalsatz der Algebra
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$f(x) = x^n + a_1 x^{n-1} + a_2 x^{n-2} + \ldots + a_n$
$= (x-\alpha)(x-\beta)\ldots(x^2+rx+s)(x^2+ux+v)\ldots$
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über
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R. DEDEKIND.
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Peter G. L. Dirichlet (1805 – 1859)
$a, d \in \mathbb{N};\ d \geq 2;$
$ggT(a,d) = 1$
$\Downarrow$
$a, a+d, a+2d, a+3d, \ldots$
unendlich viele Primzahlen
Primzahlsatz von Dirichlet
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Bernhard Riemann (1826 – 1866)
„Denen, die Gott lieben, muessen alle Dinge zum Besten dienen."
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BERNHARD RIEMANN
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$\zeta(s) = \displaystyle\sum_{n=1}^{\infty} \dfrac{1}{n^s}$
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Christian Goldbach (1690 – 1764)
Brief an L. Euler 7. Juni 1742
$\displaystyle\bigwedge_{n=2\cdot v>2} \ \bigvee_{p_1, p_2} \ n = p_1 + p_2$
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