Mittag-Leffler, the man, the mathematician and his network
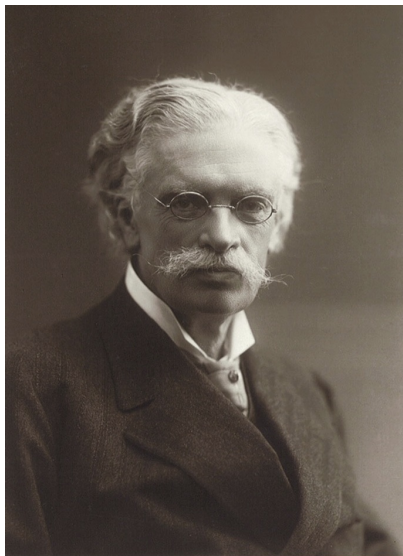
Tom Koornwinder

Korteweg-de Vries Institute, University of Amsterdam
T.H.Koornwinder@uva.nl

Mathematics Colloquium, University of Groningen,
March 11, 2014;

last modfied: August 12, 2015

G. Mittag-Leffler

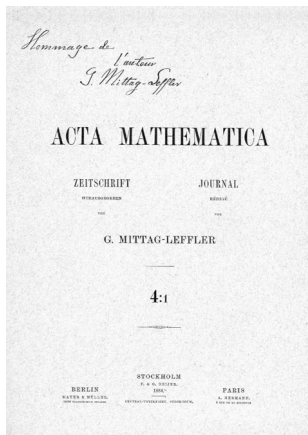## Contact us

Institut Mittag-Leffler

Auravägen 17
SE-182 60 Djursholm
Sweden

Tel. +46 8 622 05 60

info@mittag-leffler.se
http://www.mittag-leffler.se/

Acta Mathematica

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Description

Publishes original research papers of the highest quality in all fields of mathematics. Acta Mathematica is a well established and highly respected international mathematics journal. It is published by the Institut Mittag-Leffler, a research institute of the Royal Swedish Academy of Sciences. Two volumes consisting of two issues each are published annually.

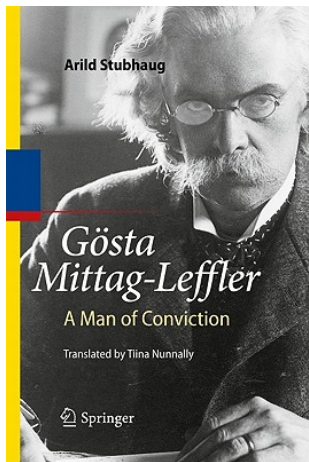**211** Volumes **269** Issues **2,064** Articles available from **1882 - 2013**
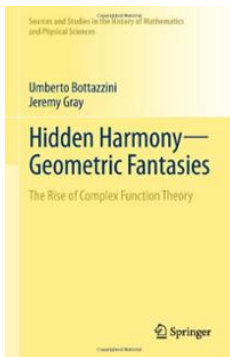
Find your Volume or Issue

Volume   Issue   🔍   Browse Volumes & Issues

Norwegian edition 2007,
English translation 2010

2013

Chronology

1846   born March 16 in Stockholm

1855–61   at elementary school in Stockholm

1861–65   at Gymnasium in Stockholm

1865–72   student in Uppsala up to doctorate in mathematics

1872–73 and 1876–77   docent in Uppsala

1873–76   "postdoc" in Paris, Göttingen and Berlin

1877–81   professor in Helsingfors (Helsinki)

1881–1912 professor at Stockholm College

1881   first volume of Acta Mathematica

1882   marriage with Signe Lindfors (from Helsingfors)

1884   Sonya Kovalevsky becomes docent in Stockholm,
            in 1889 she becomes professor there.

- 1891 moves to new villa in Djursholm; death of Sonya K.
- 1892 death of his sister Anne Charlotte
- 1903 death of his mother
- 1906 final remodeling of his villa with big library room
- 1909 buys summer house in Tällberg (Dalarna)
- 1912 retires from Stockholm College
- 1916 publishes his will, establishes M-L Math Foundation
- 1921 death of his wife Signe
- 1927 dies on July 7

Father and mother
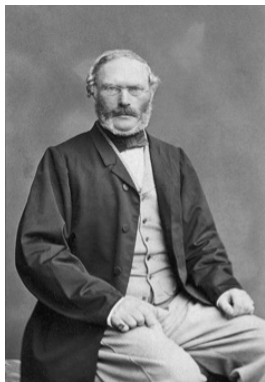
Johan Olof Leffler (1813–1884)

Gustava Mittag (1817–1903)

Both had paternal ancestors originating from Germany.

Johan Olof studied humanities in Uppsala and became teacher and headmaster in Stockholm.

Gösta's last name Mittag-Leffler already taken at school.

Brothers and sister

left: Artur (b. 1854)
middle: Gösta (b. 1846)
right: Frits (b. 1847)
below: Anne Charlotte (b. 1849)

Frits Läffler became professor of Swedish language in Uppsala, but soon took permanent leave because of health problems.

Anne Charlotte became novelist and playwriter.

Artur became engineer.

- poor health
- mother's child
- likes to play a leading role in organizations
- big spender
- nationalistic with respect to Sweden and Scandinavia, but at the same time very critical about poor Swedish intellectual performance
- always succeeds to get associated with influential people: wealthy people, diplomats, royals, leading European mathematicians
- deals and speculates with stocks; invests in Scandinavian companies, where he is on top of new technologies; sometimes suffers considerable losses because of naïvety and unreliable advisors

First by boat from Stockholm to Uppsala, later by train.

Studies mathematics, physics (prof. Ångström) and astronomy. Some Latin is required, he does not like it.

Very active in the students math association.

Earns some money by tutoring. Notably he was tutor of the son of finance minister Gustaf af Ugglas, and later of the brothers of the king's royal stablemaster Othan Demirgian (Habbib Bey).

Much involved in students' and teachers' opposition against new university legislation.

His thesis is not very remarkable in hindsight. Still he succeeds next to get the very prestigious Byzantine grant for a three years study abroad.

While vistiting the conference for Scandinavian natural scientists, Copenhagen, 1873, he becomes aware of the poor quality of mathematics research and education in Uppsala.

Charles Hermite (1822–1901)

lectures on elliptic
functions

Karl Weierstrass (1815–1897)

lectures on elliptic and
abelian functions

Elliptic functions

Jacobi:

$$x = \sin\phi, \quad u = \int_0^\phi \frac{ds}{\sqrt{1 - k^2 \sin^2 s}} = \int_0^x \frac{dt}{\sqrt{(1 - t^2)(1 - k^2 t^2)}}.$$

inverted as $\phi = \mathrm{am}(u, k)$. Then $x = \mathrm{sn}(u, k) := \sin(\mathrm{am}(u, k))$.

Also $\quad \sqrt{1 - x^2} = \mathrm{cn}(u, k) := \sqrt{1 - \mathrm{sn}^2(u, k)}$

and $\quad \sqrt{1 - k^2 x^2} = \mathrm{dn}(u, k) := \sqrt{1 - k^2 \, \mathrm{sn}^2(u, k)}$.

Weierstrass:

$$z = \int_\infty^w \frac{dt}{\sqrt{4t^3 - g_2 t - g_3}},$$

inverted as $w = \wp(z; g_2, g_3)$.

$\mathrm{sn}, \mathrm{cn}, \mathrm{dn}$ and $\wp$ are elliptic functions, i.e., meromorphic doubly periodic functions.

They can be expressed in terms of quotients of theta functions, which have nice explicit expressions as Fourier series and as infinite products.

Abelian or hyperelliptic functions

Riemann surface $y^2 = p_m(x)$ with p_m polynomial of degree m has genus $g = [\frac{1}{2}(m-1)]$.

Abelian integrals: $z = \int_a^w \frac{t^{j-1}}{\sqrt{p_m(t)}}\, dt \qquad (j = 1, \ldots, g)$.

Abelian functions: $w_i(u_1, \ldots, u_g) \quad (i = 1, \ldots, g)$ obtained by inversion of the system

$$u_j = \sum_{i=1}^{g} \int_{a_i}^{w_i} \frac{t^{j-1}}{\sqrt{p_m(t)}}\, dt \qquad (j = 1, \ldots, g).$$

These are $2g$-periodic meromorphic functions on $\mathbb{C}^g$ and can be written as quotients of (Riemann) theta functions in g variables.

Schottky problem $(g > 1)$: Period matrices depend on $\frac{1}{2}g(g+1)$ parameters, while number of complex conformal moduli of Riemann surface is $3(g-1)$. The difference $\frac{1}{2}(g-2)(g-3) > 0$ if $g > 3$.

- Completely analytic. Rare geometry only for illustration. According to ML this was a definite advantage: the Riemann approach failed in discovering properties of higher-order transcendents.

  ML: "Analysis is infinitely more general than geometry."

- No general definitions. No general theorems about functions. A function is a power series and all is deduced from the power series. (Not optimal in ML's view.)

- Utter clarity and precision of proofs. No metaphysics.

- Bad formal presentation. "In France Weierstrass would not have been admitted as a university teacher."

  Probably, therefore few of his students understood him completely.

Application to position in Helsingfors (1876)

ML declined offer by Weierstrass for possible position in Berlin.

Opening in Helsingfors because Lorenz Lindelöf (father of Ernst Lindelöf) became high public servant. He chaired the evaluation of candidates. Applicants had to write a treatise and to present this in a public lecture. ML wrote a treatise about elliptic functions. Hermite, Schering, Kronecker and Weierstrass sent letters of recommendation.

ML travelled in February from Berlin to Helsingfors via St. Petersburg. By accident the yet incomplete draft of his treatise arrived in Stockholm instead of Helsingfors. No chance to pick it up in winter by crossing the Baltic Sea. Only six weeks were left for writing it again from scratch and having it printed.

ML's presentation was very successful. However, much opposition against his candidacy by the movement for Finnish language. The final decision had to be taken in St. Petersburg. The letter of appointment came after one year.

Theorem (Mittag-Leffler, 1876)

For any sequence $\{a_n\}$ of distinct points in $\mathbb{C}$ tending to infinity and for any sequence of non-zero polynomials $\{g_n\}$ vanishing at 0 there exists an analytic function having poles in a_n with Laurent tails $g_n(1/(z - a_n))$ $(n = 1, 2, \ldots)$.

He extended this in 1884 to the case of an isloated sequence $\{a_n\}$ in a domain U of the extended complex plane. So the sequence of poles may have as a limit point an essential singularity of the function to be found.

Mittag-Leffler function (1903): $\quad E_{\alpha,\beta}(z) := \sum_{k=0}^{\infty} \frac{z^k}{\Gamma(\alpha k + \beta)}$.

For $\alpha > 0$ an entire function of order $1/\alpha$.

Mittag-Leffler star (1899–1905): For an analytic function f on the unit disc let $z \in S_f$ iff f has an analytic continuation along the ray from 0 to z. There is a series of polynomials which converges to f on S_f.

Four important women in ML's life

| Signe | Gustava | Anne Charlotte | Sonya |
| 1861–1921 | 1817–1903 | 1849–1892 | 1850–1891 |

Signe Lindfors was 15 years younger than Gösta. Engagement in 1881, marriage in 1882. She was the daughter of wealthy and aristocratic parents in Helsingfors.
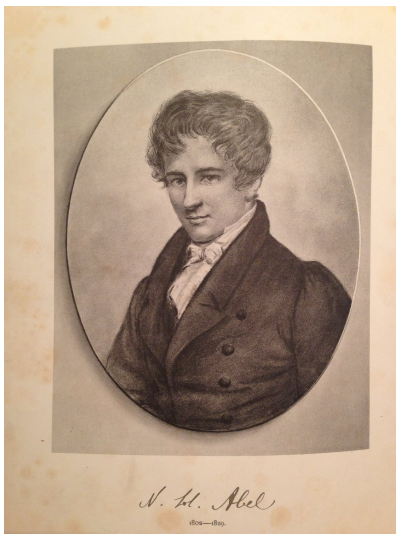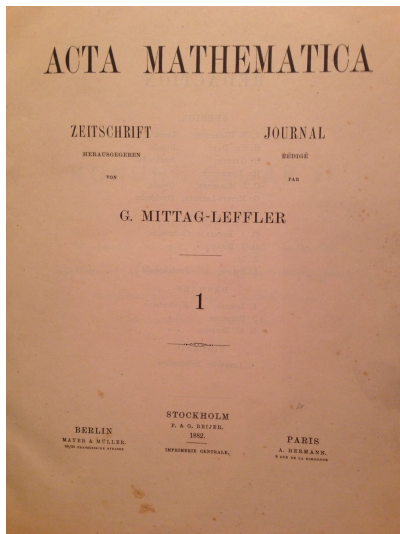
Sonya was hired at Stockholm College in 1884.

Anne Charlotte had a "mariage blanc" with Gustaf Edgren starting 1872. In 1888 she met Pasquale del Pezzo in Naples. They fell in love, married and got a son. Soon after she died.

Position at Stockholm College (1881–1912)

- Stockholm College started its educational activities in 1878. Until 1904 it was not allowed to grant degrees.
- ML fiercely opposed that it would become degree granting: If there was no focus on getting degrees, the school could attract the best students by offering advanced lectures.
- Was rector several times, never reelected after one year.
- ML had some very good students: Bendixson, Phragmén, von Koch, Fredholm.
- He had weekly seminars in the evening at his home.
- He invited famous guest lecturers to Stockholm: Painlevé and Volterra.
- For a while he was unhappy in Stockholm and made sondations for getting a position in the USA.
- In later years he often took leave in early spring for health reasons and went to Italy or a Swiss spa, doing under way a lot of business in Paris and Berlin.

ACTA MATHEMATICA

ZEITSCHRIFT JOURNAL

HERAUSGEGEBEN RÉDIGÉ

VON PAR

G. MITTAG-LEFFLER

1

BERLIN
MAYER & MÜLLER

STOCKHOLM
F. & G. BEIJER
1882
IMPRIMERIE CENTRALE

PARIS
A. HERMANN

N. H. Abel
1802—1829.

HANS MAJESTÄT

KONUNG OSCAR II,

genom hvilkens

högsinnade beskydd och kraftiga understöd

utgifvandet af denna tidskrift blifvit möjliggjordt,

hembäres underdånigast Redaktionens

vördnadsfulla tacksamhet.

C'est à la munificence de Sa Majesté le roi OSCAR II que nous devons d'avoir pu fonder le journal dont nous offrons la première livraison aux amis des mathématiques. *L'Association en mémoire de Lars Hierta, la Fondation de Letterstedt* ainsi que les personnes dont les noms suivent ici — C. J. Malmsten, Ch. Hermite, Fr. P:son Beijer, F. Kempe, H. R. Astrup, Ç. Ekman, N. G. Sörensen, O. Wijk, Fr. Piper, O. Dickson, B. Kempe, W. Kempe, S. Axell, L. E. Rubenson, C. O. Rubenson — ont également contribué aux frais de l'oeuvre dont l'auguste souverain a daigné se constituer le protecteur.

L'époque à laquelle nous commençons notre publication est certainement l'une des plus fécondes dans l'histoire des mathématiques, par le grand nombre et l'importance des découvertes qui touchent aux principes les plus essentiels de l'analyse. On sait combien, en divers pays, ce mouvement a été puissamment secondé par des journaux mathématiques, qui contiennent les oeuvres

Der Grossmuth Seiner Majestät des Königs OSCAR II verdanken wir es diese Zeitschrift gründen zu können, deren erste Lieferung wir hiermit den Freunden der Mathematik übergeben. Die Stiftung *Lars Hierta's Andenken* und der *Letterstedt'sche Verein* sowie verschiedene Personen, deren Namen in dankbarer Anerkennung hier genannt werden — C. J. Malmsten, Ch. Hermite, Fr. P:son Beijer, F. Kempe, H. R. Astrup; C. Ekman, N. G. Sörensen, O. Wijk, Fr. Piper, O. Dickson, B. Kempe, W. Kempe, S. Axell, L. E. Rubenson, C. O. Rubenson — haben gleichfalls zur Deckung der Kosten des Unternehmens beigetragen, welches der erhabene Fürst unter seinen besonderen Schutz zu nehmen geruht hat.

Der Zeitpunkt, zu welchem wir die Herausgabe beginnen, ist gewiss einer der fruchtbarsten in der Geschichte der Mathematik, wegen der grossen Anzahl und Wichtigkeit der Entdeckungen auf dem Gebiete der Analysis. Dieses rege Leben ist durch die in verschiedenen

J. E. Barrow-Green, *Gösta Mittag-Leffler and the foundation and administration of Acta Mathematica*, in: *Mathematics unbound: the evolution of an international mathematical research community, 1800–1945*, AMS, 2002.

Acta Mathematica 1 (editorial board and contents)

REDACTION

SVERIGE:

A. V. BÄCKLUND,	Lund.
H. Th. DAUG,	Upsala.
H. GYLDÉN,	Stockholm.
H: HOLMGREN,	"
C. J. MALMSTEN,	Upsala.
G. MITTAG-LEFFLER,	Stockholm.

NORGE:

C. V. BJERKNESS,	Christiania.
O. J. BROCH,	"
S. LIE,	"
S. SYLOW,	Fredrikshald.

DANMARK:

L. LORENZ,	Kjöbenhavn.
J. PETERSEN,	"
H. G. ZEUTHEN,	"

FINLAND:

L. LINDELÖF,	Helsingfors.

FIGURE 1. Editorial Board of *Acta Mathematica*, 1882

INHALT. TABLE DES MATIÈRES.

FIGURE 2. Table of contents of the first volume of *Acta Mathematica*, 1882–1883

CONTRIBUTIONS TO *Acta Mathematica* 1882-1897							
1882-1887: VOLUMES 1-10							
1887-1897: VOLUMES 11-20							
COUNTRY	NUMBER OF AUTHORS		NUMBER OF MEMOIRS/NOTES		NUMBER OF PAGES		NUMBER OF PAGES %	
	82-87	87-97	82-87	87-97	82-87	87-97	82-87	87-97
France	16	12	42.5	25	1594	1234	40	29
Germany	28	29	64.5	47	1220	1027	31	24
Scandinavia	20	19	34	26	932	958	21	22
(Sweden)	(10)	(8)	(19)	(14)	(510)	(419)	(13)	(10)
Italy	4	4	6	7	92	323	2	8
Russia	3	6	4	10	45	554	1	13
Others*	6	8	11	10	192	173	5	4
TOTAL	77	78	162	125	3979	4269	100	

*1882-87: Austria, Belgium, Holland, Switzerland, United States of America
1887-97: Austria, Belgium, England, Holland

ACTA MATHEMATICA VOLUMES 1-20

SUBJECT OF MEMOIR	1882-1887	1887-1897
Biography	0	2
Set Theory	9	0
Algebra	12	14
Number Theory	18	16
Probability	2	2
Series	1	3
Analysis	89	50
Geometry	18	20
Mechanics & Mathematical Physics	11	18
Other	2	0

LANGUAGE OF MEMOIR	1882-1887	1887-1897
French	95	69
German	66	54
English	1	2

Dutch contributions, 1882–1912

6 (1885) and three more:

UN THÉORÈME D'ALGÈBRE.

Extrait d'une lettre adressée à M. Hermite

PAR

T. J. STIELTJES
A LEYDE.

12 (1889):

ÜBER GEWISSE EBENE CONFIGURATIONEN

VON

J. DE VRIES
in KAMPEN (Holland).

21 (1897):

A SPECIAL CASE OF DIRICHLET'S PROBLEM FOR TWO DIMENSIONS

BY

J. C. KLUYVER
of LEYDEN.

27 (1903):

SUR L'INTÉGRATION DES DIFFÉRENTIELLES BINÔMES

PAR

W. KAPTEYN
à UTRECHT.

Acta Mathematica

- truly international journal
- perfect start by Poincaré's Fuchsian papers in Vol. 1 and French translations of 10 papers by Cantor in Vol. 2.
- good balance between German and French contributions
- exclusively Scandinavian editorial board; ML dominating. Later Sonya K. important board member.
- also important work by editorial assistants: Eneström, Phragmén, Marcel Riesz (index volume 1–35 in 1913).
- financed by donations (King Oscar II, etc.), support by the Scandinavian countries, subscriptions from many countries; annual deficit paid by ML.
- every year foreign trips by ML to raise money and attract submissions.
- enemies of the journal (and ML): Kronecker and Schwarz.
- André Weil: *The Acta Mathematica were the product of his genius, while nothing more than talent went into his mathematical contributions.*

Henri Poincaré (1854–1915)

- already at young age seen by ML as a genius (his work on automorphic functions)
- exchanged 259 letters with ML
- informal style of writing
- 25 papers in Acta, notably the ones on rotating fluids and on divergent series

King Oscar II prize competition

- announced in 1885, deadline 1888, prize award in 1889
- choice of 4 topics, including the *n*-body problem
- jury of Hermite, Weierstrass and ML (chair); winning paper to be published in Acta
- Poincaré's submission on $n = 3$ case got the prize
- many clarifications needed, by which the paper grew
- serious error discovered by Phragmén after printing; correction took one year; birth of the idea of chaos

Sonya Kovalevsky (1850–1891)

- Student of Weierstrass. Her thesis was about (i) Abelian integrals, (ii) the rings of Saturn, and (iii):

- **Cauchy-Kovalevsky theorem**
  $u_t = \sum_{j=1}^{n} a_j(t, x_1, \ldots, x_n, u)u_{x_j}$, pde for vector-valued $u(t, x)$ with matrix-valued $a_1, \ldots, a_n$ analytic near $(0, \ldots, 0)$, has for $u(0, x) = 0$ unique local analytic solution $u(t, x)$.

- $u_t = u_{xx}, \quad u(0, x) = (1-x)^{-1}$,

$$u(t, x) = \sum_{k=0}^{\infty} \frac{(2k)!}{k!} \frac{t^k}{(1-x)^{2k+1}} \text{ (not convergent)}$$

- **Kovalevsky top**: general integrable case of rotation of solid body, using hyperelliptic functions in two variables. Awarded by Prix Bordin (1888).
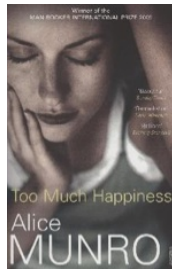
Anne Charlotte and Sonya   Maxim Kovalevsky   Noble Prize 2013

Sonya wrote novels *Russian childhood* and *Nihilist girl*.
She wrote plays together with Anne Charlotte.
From an initially white marriage with Vladimir Kovalevsky a daughter is later born.
During her last years a troublesome love affair with distant cousin Maxim Kovalevsky.
Too much happiness about Sonya is the title story in Alice Munro's book.
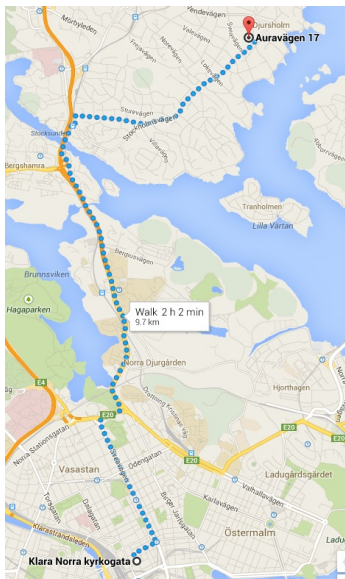
Djursholm, new town for well-to-do middle class. ML bought largest lot; he had his own train stop..

view on the archipelago from the library room

the "gula hus" of Frits Läffler

"Talet är tänkandets början och slut. Med tanken föddes talet. Utöfver talet når tanken icke."

"**Number** (speech) is the beginning and the end of thought. With thought, **number** (speech) is born. Without **number** (speech), thought goes nowhere."

In 1916 there were about 40.000 volumes in the library.

Mittag-Leffler in business

- Starting 1882 for several decades board member and actuary of the Victoria Life Insurance Company.
- From about 1890 increasing involvement in business transactions, investments in new companies using new technologies, in the north of Sweden, Norway and Finland.
- For a while he owned a carbide (CaC_2) factory in Alby. $CaO + 3C \longrightarrow CaC_2 + CO$ (at 2000 °C in an electric arc furnace, invented 1888). Next acetylene (C_2H_2) by $CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$.
- Sometimes desperate that no time was left for math.
- All efforts aimed at collecting enough money for establishing an Institute Mittag-Leffler.

Mittag-Leffler in politics

- Social feelings (insurance company, influence by Anne Charlotte and Sonya) later diminished. He became a conservative and opposed the liberal party.
- Involved with reform of Swedish voting system
- Supported the case for Finnish independence from Russia.
- Regretted the dissolution of the Swedish-Norwegian union in 1905. To maintain Scandinavian ties he orgainized in 1909 the first Scandinavian math congress in Stockholm.
- In 1914 he supported the farmers who demonstrated at the royal palace against the soft Swedish attitude in strengthening the army. He accused the liberal prime minister to give Russian spies access to Sweden.
- Had sympathy for the Germans during World War I. After the war he opposed the boycott of German scientists in international organisations.
- Supported after World War I the independence movement in Åland.

- Could participate in the final votes as a member of the Academy of Science.
- Started sometimes intensive lobbies for a candidate for the physics prize.
- He succeeded with Marie Curie (twice) and Lorentz, but lost the case for Poincaré. He was sceptic about Einstein and Planck.
- Every year in December, after the official Nobel festivities, a grand party for the laureates and many others in his villa in Djursholm.

ANDRIES MAC LEOD
Foto av I Hedenius

He studied mathematics in Gent, Belgium. While on holidays in Sweden in summer 1914 he stayed there during the war and became librarian of Mittag-Leffler. He had a very cordial relationship with ML. He married ML's secretary Gunhild Sahlén. He returned to Belgium, but came again to Sweden in the thirties. He published philosophical works.

G. & S. MITTAG-LEFFLER
TESTAMENT 16/3 1916.

Auszug aus dem Testament, errichtet und unterschrieben von

G. MITTAG-LEFFLER und SIGNE MITTAG-LEFFLER, geb. AF LINDFORS
den 16. März 1916.

Hiermit erklären wir, unter Änderung des zwischen uns am 6. Januar 1883 errichteten Testamentes, dass unser letzter Wille ist, dass nach unserer beider Tod all unser zurückgelassenes Eigentum einer Stiftung zufällt, die den Namen tragen soll:

Mathematische Stiftung der Ehegatten Mittag-Leffler.

Die Aufgabe der Stiftung soll sein, innerhalb der vier nordischen Länder Schweden, Dänemark, Finnland und Norwegen und besonders in Schweden für die Zukunft die Stellung aufrecht zu erhalten und weiter auszubauen, die die *reine* Mathematik in diesen Ländern jetzt einnimmt und dadurch zugleich dem Beitrag dieser Länder zum höchsten Gedankenleben Achtung und gerechte Einschätzung ausserhalb der Grenzen des Nordens zu erwerben.

Extrait du testament dressé et signé le 16 mars 1916 par

G. MITTAG-LEFFLER et SIGNE MITTAG-LEFFLER, née AF LINDFORS.

Nous soussignés, modifiant le testament mutuel dressé entre nous le 6 janvier 1883, déclarons ici notre dernière volonté, qui est de léguer tous nos biens, pour lui revenir après notre mort à tous deux, à une fondation qui prendra le nom de:

Institut mathématique des époux Mittag-Leffler.

Cet institut aura pour tâche de conserver aux mathématiques *pures* et de développer encore, dans les quatre pays scandinaves, Suède, Danemark, Finlande et Norvège, mais tout particulièrement en Suède, la position qu'elles y occupent aujourd'hui, comme aussi de faire connaître et estimer à sa juste valeur, en dehors de leurs frontières, l'apport de ces pays dans la sphère la plus haute de la vie de l'esprit.

There should be a foundation and a scientific director with tasks:

- to maintain the house and the library, and keep the library up-to-date;
- to give grants to young promising Scandinavian mathematicians;
- to give prizes for really outstanding new results in mathematics;
- to subsidize further research positions at the institute.

Some institute directors

Niels Erik Nørlund   Torsten Carleman   Lennart Carleson

Carleman was director during ca. 1930–1949.
Carleson started with special years: harmonic analysis,
1969–1970; noncommutative harmonic analysis, 1970–1971.
Such thematic years or periods have continued until now.

Some of the above illustrations are taken from the book

[Stu2010] Arild Stubhaug, *Gösta Mittag-Leffler. A man of conviction*, Springer-Verlag, 2010.

These illustrations are listed on the next page, together with the corresponding page numbers in the book.

As acknowledged on pp. ix, x of the book, most of the pictures are from the Institut Mittag-Leffler (IML) in Djursholm (see the table on next page for some further details).

Herewith I acknowledge to the Institut Mittag-Leffler, to Arild Stubhaug and to Springer-Verlag for having reproduced the pictures on my slides.

Illustrations, cntd.

on slides	in [Stu2010]	original source
p.2	p.ii	
p.3, left	p.305, top	photo by Jonas Förare of drawing at IML
p.3, right	p.305, bottom	photo by Xavier Viennot
p.8, left	p.171, bottom left	
p.8, right	p.171, bottom right	
p.9	p.172, bottom left	
p.12, left	p.175, bottom left	
p.12, right	p.175, bottom right	
p.18, Signe	p.173, bottom right	
p.18, Gustava	p.307	photo by Jonas Förare of watercolor at IML
p.28, left	p.174	
p.31, left	p.308, top	photo by Jonas Förare
p.31, right	p.626, top	