Mathematicians in Bologna 1861–1960
The old “Aula Magna” of the University of Bologna and the reading room of the University Library. Photograph courtesy of the Historical Archive of the University of Bologna, Alma Mater Studiorum.
Mathematicians in Bologna
1861–1960
The present volume considers the lives and achievements of mathematicians who studied and worked in various roles at the Bologna University in the century following Italian unification. Most contributions to this volume are historical in character; the few which more closely focus on mathematical research do so strictly in relation to a discussion of the mathematicians concerned.

Without claiming to be exhaustive, the volume deals with many of the most representative mathematicians who worked in Bologna in the period 1860-1960, namely with Luigi Cremona (b. 1830), Eugenio Beltrami (b. 1836), Salvatore Pincherle (b. 1853), Pietro Burgatti (1868), Federigo Enriques (b. 1871), Ugo Amaldi (b. 1875), Beppo Levi (b. 1875), Giuseppe Vitali (b. 1875), Enrico Bompiani (b. 1889), Beniamino Segre (b. 1903), Tullio Viola (b. 1904), Dario Graffi (b. 1905), Gianfranco Cimmino (b. 1908) Bruno Pini (b. 1918) and Lamberto Cattabriga (b. 1930). Sometimes the same mathematician is presented from different points of view by different authors. The work of a number of other mathematicians also comes in for perusal, most notably the contributions made by Giulio Vivanti (b. 1859), Ettore Bortolotti (b. 1866) and Filippo Sibirani (b. 1880).

The University of Bologna is one of the oldest universities in the world (indeed, it is traditionally said to have been founded in 1088) and many well-known mathematicians have studied and taught there. We may recall Luca Pacioli, Domenico Maria Novara, Scipione del Ferro, Girolamo Cardano, Ludovico Ferrari, Rafael Bombelli, Bonaventura Cavalieri, Pietro Mengoli, Giandomenico Cassini, Domenico Guglielmini and Gabriele Manfredi, to mention just a few. It is, however, hard to come up with a corresponding list for the first half of the nineteenth century, a dark and difficult period for mathematics in Bologna, although studies of astronomy and hydraulics continued developing along traditional lines.

In order to overcome the local weakness of mathematical research at Bologna, in 1860, soon after Bologna became part of the Kingdom of Sardinia (by the plebiscite of March 1860), the Minister of Education appointed Luigi Cremona as Professor of Higher Geometry and Matteo Fiorini (b. 1827) as Professor of Geodesy. The presence of Luigi Cremona and Eugenio Beltrami (starting from 1862) brought
about a dramatic improvement in the state of mathematical studies and education at the university. Unfortunately, they both left the university a few years after their nomination so that mathematical studies at Bologna went through a new period of difficulty as far as pure mathematics was concerned. Starting from 1880, however, a new generation of mathematicians revitalized the study of mathematics at the university; they attracted colleagues of high quality and the number of students in pure mathematics grew year after year. About forty years later, the founding of the Unione Matematica Italiana (UMI), which has since continued to maintain its headquarters at the University of Bologna, the launching of the *Bollettino dell’ Unione Matematica Italiana* by Salvatore Pincherle and his election as President of the IMU in 1924 were a sign of the new improved standing of mathematics in Bologna, while the holding of the International Congress of Mathematicians in Bologna in 1928 testified to the international recognition that the school had acquired.

Starting from the twenties, however, the effect of the central government policy on the university was already becoming evident. The so-called Gentile reform of education embodied a changed conception of the university’s duties and objectives. Universities became more and more authoritarian; Jewish university professors were sacked as a result of the Race Laws of 1938. At Bologna two professors in the College of Engineering (Facoltà di Ingegneria), Giulio Supino and Emanuele Foà lost their posts. At that time, in 1938, there were four professors of mathematics in the School of Science (Facoltà di Scienze MM.FF.NN) at Bologna University: Pietro Burgatti, Luigi Fantappiè, Beppo Levi, Beniamino Segre. Pietro Burgatti died in May; Segre and Levi were dismissed and Fantappiè was working abroad. For a few months the School of Science had no active professor of Mathematics in Bologna. So, once again, mathematics in Bologna had to face difficult times which profoundly affected the direction and nature of the research that was carried out.

This book is about the protagonists of this arduous and eventful story with all its highs and lows.

What follows are some selected sources for general information about mathematical studies at Bologna (of course, many other interesting papers were written on particular mathematicians). Reference [1] is a beautiful booklet by Ettore Bortolotti, distributed to the participants at the 1928 International Congress of Mathematicians held in Bologna; [2] is a revised and 1947 updated version of [1]. For a short introduction to the history of Mathematics in Bologna, see [3].

The proceedings of the international conference held on the occasion of the IX centennial of the University of Bologna are published in [4]: the volume contains more than thirty contributions inspired by research carried out in Bologna. Reference [5] deals with teaching of mathematics at Bologna from 1860 to 1940.

For a more in-depth study of the period 1860–1960, later on we list volumes of collected works by mathematicians who worked in Bologna during those years.
LIST OF VOLUMES OF SELECTED WORKS OF MATHEMATICIANS WHO HAVE WORKED IN BOLOGNA IN THE FIRST CENTURY AFTER THE ESTABLISHMENT OF THE KINGDOM ITALY.


Beltrami, E. 1902-1920. *Opere matematiche di Eugenio Beltrami*, edited by University of Rome Science Faculty, Tomo primo (1902), VII + 437; Tomo secondo (1904) 465; Tomo terzo (1911), 488; Tomo quarto (1920), 554. Milano: Ulrico Hoepli


Burgatti, M. 1951. *Opere scelte* (published under the auspices of the universities of Bologna and Ferrara, the Accademia delle Scienze di Bologna and the Unione Matematica Italiana), VI+354. Bologna: Zanichelli


Cremona, L. 1914–1917. *Opere matematiche di Luigi Cremona*, published under the auspices of the R. Accademia dei Lincei, Tomo primo (1914), con note dei revisori, VII+492, Tomo secondo (1915), con note dei revisori, 459, Tomo terzo (1917), con note dei revisori, con notizie della opere e della vita dell’ autore e con indice analitico per materie, 520. Milano: Ulrico Hoepli


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### References


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Contents

A Short Overview on Mathematicians in Bologna in the First Century after the Establishment of Italy ...................................... v
Salvatore Coen

Beltrami’s Models of Non-Euclidean Geometry .............................. 1
Nicola Arcozzi

Giuseppe Vitali: Real and Complex Analysis and Differential Geometry ...................................................... 31
Maria Teresa Borgato

Pincherle’s Early Contributions to Complex Analysis ................. 57
Umberto Bottazzini

Luigi Cremona’s Years in Bologna: From Research to Social Commitment ................................................................. 73
Aldo Brigaglia and Simonetta Di Sieno

Federigo Enriques: The First Years in Bologna ......................... 105
Ciro Ciliberto and Paola Gario

Enrico Bompiani: The Years in Bologna .................................. 143
Ciro Ciliberto and Emma Sallent Del Colombo

Dario Graffi in a Complex Historical Period .............................. 179
Mauro Fabrizio

Pietro Burgatti and His Studies on Mechanics .............................. 197
Paolo Freguglia and Sandro Graffi

Federigo Enriques (1871–1946) and the Training of Mathematics Teachers in Italy .................................................. 209
Livia Giacardi

Beppo Levi and Quantum Mechanics ....................................... 277
Sandro Graffi
Contents

Leonida Tonelli: A Biography .................................................. 289
Angelo Guerraggio and Pietro Nastasi

Bruno Pini and the Parabolic Harnack Inequality: The
Dawning of Parabolic Potential Theory ................................. 317
Ermanno Lanconelli

Federigo Enriques as a Philosopher of Science ............................ 333
Gabriele Lolli

The Enciclopedia delle Matematiche elementari and the
Contributions of Bolognese Mathematicians .............................. 343
Erika Luciano

The Role of Salvatore Pincherle in the Development
of Fractional Calculus ............................................................ 373
Francesco Mainardi and Gianni Pagnini

Tullio Viola and his Maestri in Bologna: Giuseppe Vitali,
Leonida Tonelli and Beppo Levi ................................................ 383
Clara Silvia Roero and Michel Guillemot

Development of the Theory of Lie Groups
in Bologna (1884–1900) ............................................................ 415
Enrico Rogora

Difference Equations in Spaces of Regular Functions: a tribute
to Salvatore Pincherle ............................................................ 427
Irene Sabadini and Daniele C. Struppa

The Work of Beniamino Segre on Curves and Their Moduli .......... 439
Edoardo Sernesi

Lamberto Cattabriga and the Theory of Linear Constant
Coefficients Partial Differential Equations ............................... 451
Daniele C. Struppa

New Perspectives on Beltrami’s Life and Work –
Considerations Based on his Correspondence ............................ 465
Rossana Tazzioli

On Cimmino Integrals as Residues of Zeta Functions ................. 519
Sergio Venturini

Index of Names and Locations .................................................. 539