AUTARCHICI TEOREMI

Aspects of Italian mathematics
during the Fascist period

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The Founding Fathers

In March 1861, Italy achieved independence and was unified under the Savoy monarchy (except for Venice and Rome, which joined in 1866 and 1870, respectively).

This spurred a resurgence of Italian mathematics, which had been languishing for many years.

Some seminal events:

- Three analysts take a trip: **Betti, Brioschi** and **Casorati** in Paris, Göttingen and Berlin (1858)

- Founding of the *Annali di matematica pura ed applicata* (1858)

- The influence of **Bernhard Riemann**

The Founding Fathers (cont.)

Around the same time, the Italian school of algebraic geometry was founded by **Luigi Cremona** (1830-1903), best known for the introduction of **birational transformations**.

Eugenio Beltrami (1835-1900) made great contributions to differential geometry, non-Euclidean geometry, and mathematical physics.

Ulisse Dini (1845-1918), a student of Betti, is best known for his work in real analysis and Fourier series.

Cremona, Beltrami and Dini, like Betti, all became **senators of the kingdom**.

NOTE: At this time, approximately 75% of all Italians were illiterate and worked in agriculture.

The Golden Age

In the years to follow, Italy quickly became one of the leading countries in many areas of mathematical research, together with Germany, France and Great Britain (Russia and Sweden also played an important role).

In the late 1800's, some of the main figures of Italian mathematics were:

- **Salvatore Pincherle** (1853-1936) [functional analysis, complex analysis]
- **Gregorio Ricci-Curbastro** (1853-1925) [tensor calculus]
- **Luigi Bianchi** (1856-1928) [number theory, algebra, differential geometry]
- **Giuseppe Peano** (1858-1932) [analysis, axiomatics]

The Golden Age (cont.)

- **Vito Volterra** (1860-1940) [analysis, mathematical physics, biomathematics]
- **Corrado Segre** (1863-1924) [algebraic geometry]

All of them created important schools of mathematical research in the universities of Bologna, Padua, Pisa, Turin, and Rome.

An important event of this period was the rise of the **Circolo Matematico di Palermo**, founded in 1884 and directed by **G. B. Guccia** (1855-1914). The **Rendiconti** of the Circolo soon became one of the leading mathematical journals in the world. Many famous mathematicians, including **Poincaré, Picard, Hilbert, Schmidt, Weyl, Dickson, Birkhoff**, etc. were members of the Circle and published in its journal.

Protagonists

The central figures in Italian mathematics in the early 1900's, besides **Segre** and **Volterra**, were the algebraic geometers **Guido Castelnuovo** (1865-1952), **Federigo Enriques** (1871-1946) and **Francesco Severi** (1879-1961), and the renowned mathematical physicist **Tullio Levi-Civita** (1873-1941).

All of them except Severi were Jewish.

The Italian Jewish community was rather different from that of other European countries. It was small, highly integrated, strongly involved in the commerce and professions and in politics, with a high percentage of non-practicing members. Volterra, Castelnuovo, Enriques and Levi-Civita all considered themselves as liberals and "free thinkers" .

Mathematicians vs. philosophers

Federigo Enriques had developed a strong interest in philosophy and psychology, largely as a result of his own research in geometry.

This interest encompassed the foundations of geometry (which he thought of as a part of physics, not unlike **Riemann** and **Klein**), the psychology of mathematical discovery or invention, and the respective roles played by intuition and logic.

Enriques was also deeply interested in the history of science and philosophy, and knew very well the work of the ancient Greek geometers and philosophers. In this, he was the antithesis of the modern specialist.

He became close to **Einstein** and founded the interdisciplinary journal *Scientia*.

Mathematicians vs. philosophers (cont.)

Even during his work on algebraic surfaces, **Enriques'** involvement in the philosophical scene was so deep that he became president of the Italian Philosophical Society (1907-1913) and chaired the International Congress of Philosophy that took place in **Bologna** in 1911.

This was the occasion for a memorable clash with the leading Italian philosopher of the time, **Benedetto Croce** (1866-1952), and his then close ally, **Giovanni Gentile** (1875-1944). The "traditional" (neo-idealistic) philosophers resented what they felt as an intrusion by an invadent *dilettante* (and a realist to boot).

This clash was to have profound consequences on Italian culture, which are still felt today.

Mathematicians vs. philosophers (cont.)

In newspapers interviews and other venues, **Croce** sharply criticized **Enriques'** organization of the congress, especially the choice of speakers (which included several mathematicians and natural scientists) and the way Italian philosophy had been represented.

Croce denied philosophical value to the sciences and asserted the superiority of history and aesthetics as a terrain for philosophical investigation.

Enriques was soundly defeated, and had to retreat for a long time. He was "rediscovered" in the 1970's.

Both **Croce** and **Gentile** were later appointed minister of education. Their victory over **Enriques** in this struggle for egemony had a great influence on Italian culture through **Gentile's** school reform of 1923.

ICM's in Italy (1908, 1928)

The International Congress of Mathematicians of 1908 was held in Rome and was chaired by **Volterra**, who was then at the peak of his fame (and a senator since 1906).

This congress saw the official international recognition of Italy as one of the mathematical superpowers of the time.

The ICM, which is held every four years, returned to Italy (in Bologna) in 1928, in a much different atmosphere. Chaired by **Enriques**, it was the first ICM since WWI to which Germany had been invited, owing to the tireless efforts of **Pincherle** and against strong objections from some quarters.

The German delegation to Bologna was led by the great **David Hilbert**, who received a standing ovation.

ICM's in Italy (cont.)

The effect of WWI on mathematical research had been different on different countries.

France lost a whole generation to the war and was not to recover for several years. In contrast, **Germany** was careful to use her students in support operations rather than combat, and German science recovered quickly.

Italy's mathematics lost a brilliant young mathematician, **E. E. Levi**, who died in combat in 1917, but was otherwise spared.

Some important work was done by **Severi** and by **Levi-Civita** during the war years. For instance, Levi-Civita's important memoir on **parallel displacement** was published in the **Rendiconti** of Palermo in 1917.

ICM's in Italy (cont.)

On the institutional side, the early 1920's saw two important developments in the organization of the Italian scientific community:

- Founding of the **UMI** (*Unione Matematica Italiana*) by **Pincherle**, 1922

- Founding of the **CNR** (*Consiglio Nazionale delle Ricerche*) by **Volterra**, 1923

Years later, both these institutions were to become instrumental in the "Fascistization" of Italian science.

Enters Mussolini (1922)

By this year **Rome** had become the main center of mathematical activity in Italy, and many foreign scholars travelled there for visits. The Russian **Oscar Zariski** and the Dutch **Dirk Struik** studied in Rome under **Castelnuovo** and **Levi-Civita**, respectively.

Besides continuing strengths in algebraic geometry and analysis (**Giuseppe Vitali, Guido Fubini, Leonida Tonelli, Mauro Picone, Giovanni Sansone** and **Francesco Tricomi** were the main names here), there was an emerging activity in abstract algebra around the figure of **Gaetano Scorza** (first in **Catania**, then **Naples** and finally **Rome**).

The work of Scorza's school in the theory of algebras was to have considerable influence on the work of the American mathematicians **Dickson, Albert** and **Lefschetz**.

Enters Mussolini (cont.)

By the mid-1920's, political events began to affect mathematicians. **Volterra** led a valiant battle against Fascism in the senate, and was among the so-called *Aventinians* after the Fascists murdered **Giacomo Matteotti**, a Socialist leader, in 1924. **Severi**, a Socialist at the time, resigned from his post as the rector of the U. of Rome.

In 1923 **Gentile** joined the Fascist party and was promptly appointed Minister of Education. In 1925 Gentile and others issued a *Manifesto degli intellettuali del Fascismo*.

It was answered immediately by a counter-Manifesto written by **Croce** and signed by many of the leading Italian mathematicians including **Volterra, Levi-Civita, Castelnuovo, B. Levi, Tonelli, Padoa** and **Severi**.

Signs of decline

The 1928 ICM has sometimes been described as "the funeral of Italian mathematics," which was then beginning to show the first symptoms of a deep crisis.

In retrospect, it is clear that the leading Italian researchers had by then become to decline and that their replacements, while generally very good, were not quite at the same level as the old masters. Moreover, some important new fields of research were being ignored.

It is interesting that the decline in mathematics coincided with the rise of Italy's brightest scientific star, the physicist **Enrico Fermi** (1901-1954), who had close ties with Castelnuovo, Enriques and Levi-Civita. **Fermi** went on to create an important, but short-lived school of modern physics in **Rome**.

The oath (1931)

In the 1930's the regime's grip on every aspect of Italian life became stronger and stronger.

In 1931 **Gentile** convinced *il Duce* to demand of all university professors an **oath of allegiance** to the King and to the Fascist regime. Until then, unlike other State employees, university professors had never been asked to take any oath.

In all, only 20 professors (out of approximately 1200) refused to take the oath and were forced to resign; among them **Volterra**, who was wealthy and went on a self-imposed exile.

Several other professors, among which **Levi-Civita**, were able to use their connections to reach some type of honorable compromise and retained their post.

The Godfathers: Severi and Picone

By 1930, Italian mathematics was effectively in the hands of two men: **Severi**, who by then had set aside his initial opposition to the Fascist regime, and **Mauro Picone** (1885-1977), who had been a convinced Fascist since the very beginning.

The previous year the venerable but politically unreliable *Accademia dei Lincei* had been disbanded and replaced by the more pliable *Accademia d'Italia*; scientists loyal to the Fascist regime were rewarded with a seat in it, and the huge perks that went with it.

Severi was among the first to attain membership and, with it, the title of *Sua Eccellenza*; **Fermi** was another one.

The Godfathers (cont.)

Severi and **Picone** represented the two souls of Italian mathematics: the "pure" and the "applied" one.

Severi insisted on the intrinsic value of mathematical thought (regardless of its possible applications) and elected himself to the role of defender of the Italian school of algebraic geometry, its methods, and results.

Picone was eager to put mathematics to work at the service of society and to increase the industrial and military strength of the country. His own work was mostly in analysis and applied mathematics.

Picone's interest in effective methods of solution of differential equations originated from his service as an artillery officer in WWI.

In 1927 he created the **INAC** (Istituto Nazionale per le Applicazioni del Calcolo), the first center in the world devoted to numerical analysis.

The Godfathers (cont.)

Picone developed the **INAC** with Mussolini's approval and encouragement. The Institute was concerned with both basic and applied research. Many young mathematicians started their career there, including **Renato Caccioppoli, Lamberto Cesari, Giuseppe Scorza Dragoni, Gianfranco Cimmino, Carlo Miranda** and, after WWII, **Ennio De Giorgi**.

One of **Picone**'s merits is to have understood the importance of the new (abstract) functional analysis, which was being developed in the late 1920's and early 30's, especially in Poland (**Banach**), Germany (**von Neumann**) and USA (**Stone**).

In this he differed from other analysts, like **Volterra** and **Tonelli**, who were suspicious of the new and clinged to the old style of analysis.

The Godfathers (cont.)

The importance of **Picone** lies primarily in his institutional role, his vision, and his school, which was to lead the recovery of Italian mathematics after the war. Because of his openness to new currents of thought, he proved instrumental to the survival of mathematical analysis research in Italy.

The most famous member of **Picone**'s school was **Renato Caccioppoli** (1904-1959), who acted as a bridge between the pre- and post-war generations.

The life of **Caccioppoli** was dramatic enough to make him the subject of a 1992 movie by **Mario Martone** (*Morte di un matematico napoletano*).

The Godfathers (cont.)

Severi yielded even greater power and influence than **Picone**, to whom he was far superior as a mathematician. **Severi's** international fame was such that on a conference tour of Japan in 1937 he was received by the Emperor. At the end of his life, he belonged to 26 scientific academies worldwide.

Severi had direct access to Mussolini. He used his influence to exert complete control on every aspect of mathematical life in Italy: competitions for university positions, editorial boards of major journals, publications and translations of books, conferences, educational policy, etc.

In 1939 **Severi** founded the *Istituto Nazionale di Alta Matematica* (**INDAM**) in Rome.

Lagging behind

In the 1930's Italian mathematics entered a deep crisis. The causes of this decline were both **internal** to the various disciplines and **external**.

In some areas, like analysis and mathematical physics, activity remained at a decent level, but far from the past glories. By and large, modern developments were shunned. The use of modern topological and functional-analytic methods and language were seen by many as a concession to fads from abroad, not to be taken seriously.

Young researchers could jeopardize their career if they tried to keep up with contemporary trends.

Ironically, in better times **Pincherle, Volterra**, and **Arzelà** had been pioneers in functional analysis.

Lagging behind (cont.)

In the same years Italy made no meaningful contributions to mathematical logic, of which **Peano** had been one of the founders. Topology, number theory, Lie theory, and commutative algebra were virtually ignored.

Scorza's attempt to create a school of abstract algebra clashed against the impossibility to establish university chairs in the subject and foundered. Many of his students had to go into more traditional fields in order to find employment.

Rapidly, Italian algebraists became unable to keep up with the imposing development of algebra in **Germany** (up to 1933) and **USA**.

Lagging behind (cont.)

The most important case, however, is that of algebraic geometry, where **Castelnuovo, Enriques, Severi** and their students had dominated for decades. The birational classification of algebraic surfaces, essentially due to Enriques, remains to this day a major achievement.

By the mid-1920's the synthetic methods of the Italian school had reached their natural limits, and were insufficient to deal with the most pressing problems of the discipline. **Castelnuovo**, who was well aware of that, directed his student **Zariski** towards the use of more refined algebraic methods, a piece of advice that was to lead to profound changes in the foundations of the subject.

Severi, on his part, followed **Picard, Lefschetz** and **Hodge** in teir use of powerful function-theoretic and topological methods in the study if higher-dimensional varieties.

Lagging behind (cont.)

Severi also violently attacked **Enriques**, who was still very active at the time, for the lack of rigor in his work.

It is a fact that **Enriques** privileged the moment of discovery over that of painstaking logical justification. He had little interest in (and even despised) rigorous, detailed proofs, and some of his theorems had been shown to be defective. In most cases the results were true but the proofs were incomplete or even wrong. This attracted a good deal of sarcasm, especially from German and French geometers (**Weil**).

Enriques was a perfect example of the intuitive genius. His geometric investigations were of the experimental, almost "tactile" kind, in agreement with his Platonist views.

Lagging behind (cont.)

Italian algebraic geometry was "classical," i.e., it was developed entirely over the field of complex numbers. Either explicitly or implicitly, many of its results relied on topological properties of the complex plane.

In the late 1920's several mathematicians, including **Zariski, van der Waerden** and **Weil** began to rebuild the entire edifice of algebraic geometry in the new language of commutative algebra. This was needed both to put the whole subject on a firm foundation, and to break the standstill that had been reached.

Eventually, this led to the replacement of the complex field with an arbitrary (abstract) field. Many of the results of the Italian school no longer applied in this more general setting.

Lagging behind (cont.)

Unable to meet the new challenge, **Severi** (by now the sole "owner" of Italian pure mathematics) reacted by clamming up and strenuously defending the classical methods against the new abstract trends, which he saw as largely devoided of geometric meaning.

He repeatedly clashed with "the enemy" (especially with **van der Waerden**) in several occasions, like the 1932 ICM in Zürich which marked the official beginning of the new trends in algebraic geometry. He was to clash again with **Zariski** at the 1950 ICM in Cambridge and with **Weil** as late as 1954 in Amsterdam.

As a result, the contributions of the Italian school of algebraic geometry were virtually forgotten until their "rediscovery" in the 1970's, due mostly to the Soviet mathematician **Shafarevich** and his school.

Lagging behind (cont.)

Among the **external** factors, it should be kept in mind that in the 1930's Italy became increasingly isolated (economically, politically and culturally) as a result of the colonial campaign in Africa.

Travel, visitors, conferences, journal subscriptions became more and more problematic. The so-called *Autarchia* was enforced.

The rigid hierarchical organization of society (including university studies) did not encourage innovative work on the part of the new generations being formed.

A sterile rivendication of Italy's "leadership" in mathematics (by now a fading memory) replaced honest confrontation with the stimuli coming from other, more advanced nations.

Day of infamy (1938)

In the Fall of 1938, under pressure from Hitler, Mussolini's regime passed a set of anti-Semitic laws.

The ground had been prepared by extensive anti-Jewish propaganda on the political front, and by the infamous *Manifesto della Razza* on the ideological front.

This document had been issued by a group of medical researchers, zoologists, anthropologists and other self-styled scientists. Two prominent academics, **Nicola Pende** (1880-1970) and **Sabato Visco** (1888-1971), were among the authors.

The *Manifesto* was endorsed by the powerful Propaganda Ministry (MINCULPOP).

Day of infamy (cont.)

The *Manifesto* stated the existence of a **pure Italic race** (belonging to the Aryan family) and the need to defend its purity from contamination by "extra-European races."

One of the immediate effects was the dismissal of nearly all professors, teachers, and students of Jewish heritage from all schools, at all levels.

Castelnuovo, Enriques, Levi-Civita, Fubini, B. Levi, G. Ascoli, G. Fano, A. Terracini and **B. Segre** were ousted from their positions and from the editorial boards of journals.

Castelnuovo helped organize and direct the clandestine "Jewish university." He and Enriques spent the war years in Rome, hidden by friends. Other emigrated to the USA, the UK, Switzerland, Argentina, etc.

Day of infamy (cont.)

The response of the official body of Italian mathematicians, the UMI, came on 10 December 1938. This was the darkest day in the society's entire history.

The UMI issued a statement according to which the "departure" of mathematicians of Jewish race had a minimal impact on the status and health of Italian mathematics.

Moreover, the document expressed concern that the university chairs that had just become vacant could be redirected to other disciplines, something to be avoided at all costs.

For the next few years, several members of the UMI will devote themselves to rewriting the history of Italian mathematics in a way that minimized (and indeed, erased) the contributions of Jewish mathematicians.

Day of infamy (cont.)

Some mathematicians saw the opportunity to settle the score against their colleagues. **Severi** took full advantage of the situation to harass **Enriques**, his ancient teacher and collaborator, with whom he had clashed for personal and scientific reasons in the previous years.

He forbade him from entering the Mathematical Institute at the University of Rome, of which he was now director.

He also obtained the withdrawal of the geometry textbook by **Enriques** and **Amaldi**, adopted in all Italian high schools, and its replacement with his own textbook, a very lucrative move!

Day of infamy (cont.)

The impact of anti-Semitic law was even worse on Italian Physics. Of **Fermi**'s collaborators, only **Amaldi** decided to stay.

By 1939 **Fermi** (whose wife was Jewish), **Segrè, Rasetti, Rossi, E. Fubini, U. Fano, Racah, L. Pincherle, De Benedetti** and **B. Pontecorvo** had left Italy. **Fermi, Segrè** and **Rossi** worked at **Los Alamos** on the atom bomb.

Among biologists, Italy lost two future Nobel prizes: **Salvatore Luria** and **Rita Levi Montalcini**, both students of **Giuseppe Levi** (the father of the writer **Natalia Ginzburg**) in Turin in 1938.

Fascist rhetoric in mathematics

Like every other aspect of Italian life, mathematics was not immune from the changes in language that resulted from the Fascistization of the country.

Of course, mathematical exposition does not lend itself to the bombastic; to see this change one has to look into the prefaces to research monographs, the accounts of mathematical meetings in the *Bollettino dell'UMI*, book reviews, reports, letters, etc.

Strongly nationalistic tones, with many references to the "Italic genius" and the "race," became virtually mandatory during the 1930's.

Some historians, like **Ettore Bortolotti** (1886-1947), undertook the task of exhalting Italys' contributions to matematics; many became obsessed with priority claims.

Other countries

It is natural to compare the situation in Italy with that of other nations, especially **Germany**. During the Weimar years, Germany had achieved a position of absolute excellence in mathematics and physics, particularly in the universities of Göttingen, Münich and Berlin.

All this came to an abrupt end in 1933, with the advent of Hitler. However a few scientists, like **Einstein** and **von Neumann**, had moved to the US as early as 1930.

The Nazi virtually destroyed German science. Nearly all the leading mathematicians and physicists were forced or decided to leave. The vast majority emigrated to the US, enormously benefitting American science, which was already on the rise on its own.

Other countries (cont.)

The Nazi dismissed such major achievements as the theory of relativity and quantum mechanics as "Jewish science." They even created two journals, *Deutsche Mathematik* and *Deutsche Physik*, devoted to the exposition of "Aryan science."

This was supposed to be **synthetic** and **intuitive**, whereas Jewish science was **analytic** and **abstract** (!).

Some German scientists enthusiastically embraced Nazism and anti-Semitic views, often with a personal agenda. The prominent mathematicians **L. Bieberbach, W. Blaschke**, and **O. Teichmüller** were among them.

It is fair to say that German mathematics suffered more than Italian mathematics during this period.

Other countries (cont.)

Another country of interest is **Poland**. This country, which had been outside the mainstream of scientific thought until the early 1900's, enjoyed an amazing flourishing of mathematics in the period between the two world wars.

The main centers were **Lwów** and **Warsaw**. Polish researchers, not burdened by schools or traditions, wisely chose to concentrate on the emerging fields of mathematical logic, set theory, measure theory, probability, general topology and functional analysis.

Poland contributed immensely to modern mathematics, especially through the work of **Steinhaus**, **Banach**, **Sierpinski**, **Kuratowski**, **Borsuk, Schauder, Mazur, Ulam, Kac, Tarski, Lukasiewicz, Zygmund, Bochner, Orlicz** and others.

Other countries (cont.)

The 1930's saw the enormous development of mathematics (and physics) in **USA** and in **USSR**, which was to continue at a much faster pace after WWII.

France returned to the forefront with a *nouvelle vague* of mathematicians that followed the generation that had been "lost" to WWI. As the great **Hadamard, Fréchet, Borel, Lebesgue, P. Lévy, E. Cartan, Picard** etc. reached retirement age, they were replaced by **Weil, Dieudonné, Chevalley, H. Cartan, Ehresmann** and **L. Schwartz**, collectively known as the first members of the famous **Bourbaki** circle.

This new generation looked at Germany for inspiration, especially to **Emmy Noether** (1882-1935) and her school, who were revolutionizing the field of algebra.

Other countries (cont.)

Bourbakism has had a strong influence on modern mathematics, although this influence was felt most strongly in the 1950's and 1960's.

With the conspicuous exception of **André Weil** (1906-1998), who settled in the US, few French mathematicians were permanently lost to the Nazi invasion and French mathematics flourished after WWII.

To this day, **France** remains one of the leading countries in mathematics.

World War II

After the fateful date of 8 September 1943 a number of mathematicians, including some who had been active in Fascist politics, joined the *Resistenza* and fought against the Nazi-Fascists oppressors. **Tonelli** was among them.

The logician **L. Geymonat** (1908-1991) was commander of a *Brigata Garibaldi* in the North of Italy. Another partisan, the mathematical physicist **A. Pignedoli** (1918-1989), was elected to the *Assemblea Costituente* in 1946.

A few others, like **Fabio Conforto** (1909-1954), remained loyal to Mussolini and fought against the Allied forces after their landing in Sicily.

Giovanni Gentile was executed by partisans in Florence in 1944.

The aftermath: amnesty or amnesia?

Shortly after the war, the new (democratic) government, with the support of the powerful Communist leader **Palmiro Togliatti**, passed a sweeping amnesty that pardoned virtually all of the people who had been compromised through their association with the Fascist regime.

This pardon led to a swift reinstatement of many academics in the posts they held before and during the war. This is true even of **N. Pende** and **S. Visco**, the principal authors of the *Manifesto della razza*.

Severi, who narrowly escaped lynching at the hand of his fellow citizens of Arezzo in 1944, returned to his university chair in Rome and to the direction of the **INDAM**, which was named for him after his death in 1961. Likewise, the **INAC** was named after **Picone** on the occasion of his 90th birthday in 1975.

Slow recovery

After WWII and the difficult period of reconstruction of the country, mathematical activity in Italy slowly resumed. The most important centers were Rome (including the **INAC**, by now called **IAC**) and Pisa.

Most of the leading figures in this recovery process were analysts: **G. Stampacchia, G. Fichera, E. Magenes** and **E. De Giorgi**, among others.

However, Italian mathematics was virtually absent from the first post-WWII ICM held in Cambridge, MA, in 1950 (cf. **Zariski**'s address.).

In 1974 **Enrico Bombieri** (b. 1940) of Pisa was awarded the Fields Medal for his work in number theory, algebraic geometry, and partial differential equations.

Slow recovery (cont.)

In 1999 the International Mathematical Union promoted Italy to Group V of nations (also including USA, Russia, France, Germany, Great Britain, Canada, China, Israel and Japan).

Today, Italy's areas of strength in mathematics are, once again, analysis (especially partial differential equations and the calculus of variations), algebraic geometry, and mathematical physics. There is also an important school of numerical analysis in Pavia.

Italy remains weak in other areas of modern mathematics, such as topology.

Selected bibliography

[1] AA. VV., *La matematica italiana dopo l'unità. Gli anni tra le due guerre mondiali*, Marcos y Marcos, Milano, 1998.

[2] AA. VV., *La matematica italiana tra le due guerre mondiali. Atti del Convegno, Milano e Gargnano del Garda, 8–11 Ottobre 1986*, Pitagora, Bologna, 1987.

[3] U. Bottazzini, *Va' Pensiero. Immagini della matematica nell'Italia dell'Ottocento*, Il Mulino, Bologna, 1994.

[4] A. Guerraggio e P. Nastasi, *Gentile e i matematici italiani. Lettere 1907-1943*, Universale Bollati Boringhieri, Torino, 1993.

[5] G. Israel e P. Nastasi, *Scienza e razza nell'Italia fascista*, Il Mulino, Bologna, 1998.

The *MacTutor History of Mathematics Archive* web site:

`http://www-groups.dcs.st-and.ac.uk/history/index.html`

maintained by the U. of St. Andrews in Scotland contains biographies of hundreds of mathematicians (many with pictures).