MATHEMATICS IN CHILE

SOCIEDAD DE MATEMÁTICA

Contents

Note: The image in the front page of this document was designed by the Spanish-Chilean artist José Balmes (1927-2016) for the Iberoamerican Mathematical Olympiad held at Viña del Mar in 1995. One of the participants (and, actually, a golden medalist) of this olympiad was Artur Avila, the first Latin American Fields medalist.

A brief history of mathematics in Chile until 1990

Chile became an independent country by 1810-1818. During the XIX century, mathematical research was inexistent in Chile. Mathematics was though with emphasis on (civil) engineering by scholars educated abroad, mainly in France.

$$d = \text{diameter of the circle}$$
$$\frac{a}{d} = \varphi$$
$$\frac{u}{v} = \frac{v}{w} = \varphi$$

$$\frac{y}{x} = \varphi$$
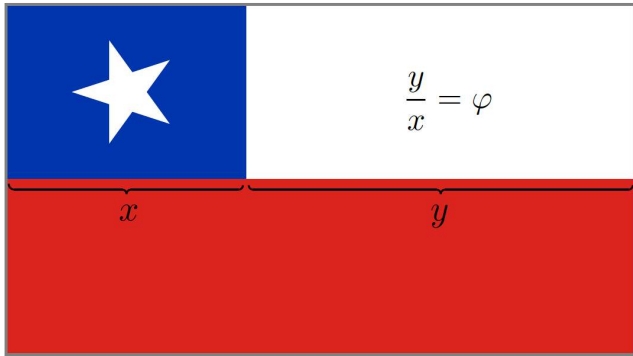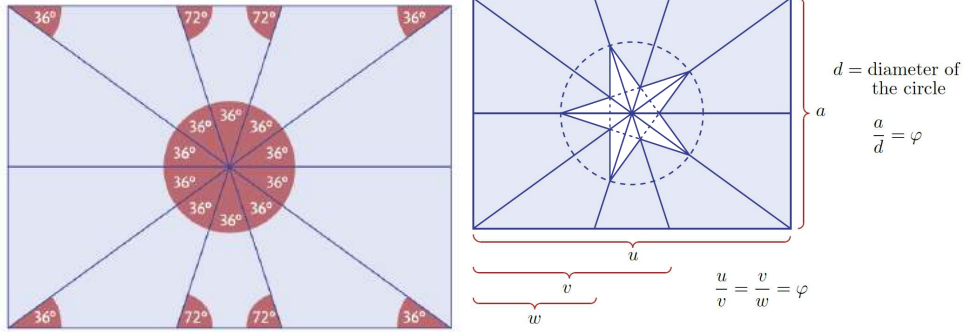
The original Chilean flag was designed according to a geometric configuration leading to golden proportions. Unfortunately, in 1912, this was turned into a simpler model, with no mathematical interest.

The only remarkable exception to this view of mathematics was Ramón Picarte, who can be considered not only the first Chilean mathematician but also the first Chilean scientist. He improved Newton's method for the function 1/x and, using it, produced the best table of divisions of that time, more accurate than the one in official use, which was compiled by the astronomer Joseph Lalande. He presented his work in 1859 to the French Academy of Sciences, with the presence of Charles Hermite in the jury. Picarte's table -which does not contain any single mistake- became the most popular one in Europe, and was widely reproduced until the invention of computers. Unfortunately, in Chile, Picarte's work never received the recognition that it deserved.

Around 1890, two important political decisions were taken by the government of José Balmaceda for the development of science and, specifically, mathematics. First, the foundation of the Instituto Pedagógico for preparing school teachers, and second, the call for scientists from all around the world to collaborate on this task. In this way, people coming mostly from Germany, including Augusto Tafelmacher, Ricardo Poenish, Francisco Proschle and, some decades later, Carlos Grandjot, came to Chile to build the first school of mathematicians. They introduced mathematics as a genuine science and wrote many textbooks (in Spanish) that became popular not only in Chile, but also in Argentina and Brasil.
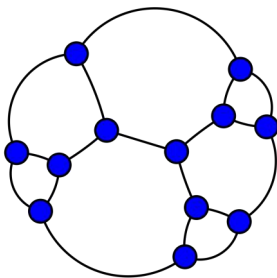
The Frucht's graph is the smallest degree-3 regular graph with no nontrivial symmetry.

The wave of immigrants from Europe due to the Second World War and religious persecution made Roberto Frucht, a mathematician from Berlin specialized on graph theory, come to Chile in 1940. He wrote a textbook with Harold Coxeter, and he is the author of the first mathematical scholarly article produced in a Chilean university (1959, Univ. Técnica Federico Santa María UTFSM).

Frucht was one of the founders of the Chilean Mathematical Society (SOMACHI), which was created in the early seventies. By that time, many universities, as Universidad de Chile, Universidad Técnica del Estado (currently Universidad de Santiago, USACH), Pontificia Universidad Católica de Chile (PUC), Pontificia Universidad Católica de Valparaíso (PUCV), Universidad de Concepción and Universidad Católica del Norte, had undergraduate and graduate programs in mathematics and/or mathematical engineering, some of which were developed with international collaboration. However, the military coup in 1973 stopped most of this cooperation, and produced a diaspora of mathematicians of this generation (several of which never returned to Chile). Fortunately, in this period, the French Cooperation played a crucial role in maintaining the relations of Chilean mathematicians abroad supporting many PhD fellowships to finish graduate studies in France. This allowed to drastically change the research activities, for instance, in the Department of Mathematical Engineering at University of Chile.

The situation became slightly more stable in the 80's. The first CIMPA schools took place in the region, serving as a great support to the development of mathematics in Chile. A fundamental role was played by the Triennium

Fifth (informal) SOMACHI's meeting (held in Concepción in 1974). Roberto Frucht is on the right side of this picture. The second from left to right is Jaime Michelow, the first Chilean mathematician to obtain a PhD (he founded a postgraduate program, LAM, at Universidad Técnica del Estado, which had a great impact in recruiting students that later went abroad to pursue PhD studies). Soon after this the Chilean Society of Statistics was born (SOCHE, 1977), and later the Chilean Society of Educational Mathematics (SOCHIEM, 1991). By now, there is a project for establishing a Chilean Society of Industrial Mathematics.

Award granted by the United Nations Development Program (PNUD), which involved not only mathematics but all sciences. Between 1984 and 1988, the PNUD, administrated by Ricardo Baeza, allowed SOMACHI to fund research fellowships and international mathematicians scholar visits. This had a very big impact, both qualitatively and quantitively, on the local community. Besides this, Fundación Andes, a Chilean private institution, was a permanent collaborator starting from 1984 until its dissolution in 2004.

With the support above, SOMACHI's meetings started being organized with a certain regularity in the eighties, as well as two other important periodic regional conferences: Jornadas Matemáticas de la Zona Sur (JMZS, since 1986) and Congreso de Matemáticas de la Zona Norte (COMCA, since 1991). These joined the Semana de la Matemática (organized by PUCV since 1974); indeed, during many years, the annual SOMACHI's meeting and the "Semana de la Matemática" runned one after the other as a very massive activity. All these conferences continue being organized every year.
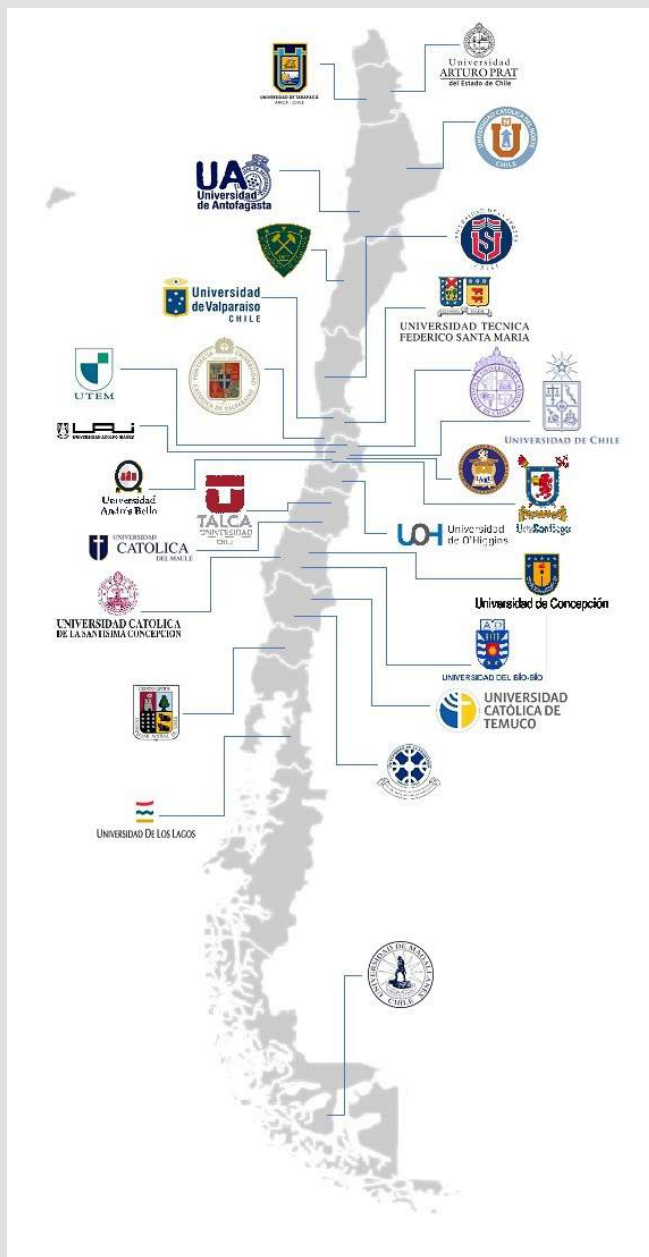
Mathematical research in Chile

Funding

The funding system for science in Chile was centralized at the beginning of the eighties inside the "Comisión Nacional de Investigación Científica y Tecnológica" (CONICYT), based at the Ministry of Education, which had been created at the end of the sixties. At the very beginning, most research projects were individual (FONDECYT). This program continues supporting senior researchers, young researchers and post-docs in separate competitions. During the nineties, special funding for outstanding researchers was granted via the program "Cátedras Presidenciales". These were awarded to Rafael Benguria, Carlos Conca, Eduardo Friedman, Servet Martínez, Rolando Rebolledo and Rubí Rodríguez. By the end of the nineties, research team projects started, being FONDAP (by CONICYT) and later the "Anillos in Science and Technology" (also by CONICYT) and "Millenium Projects" (based at the Ministry of Economy) the most important ones. Finally, since 2005, larger funding has been given to scientific institutes, both from CONICYT and the Millenium program. In what concerns mathematics, the Center of Mathematical Modelling (CMM), based at Universidad de Chile (which is also the first Unité Mixte CNRS outside France), has been (partially) supported this way over the last eighteen years.

In what concerns mathematics, over the last 5 years, FONDECYT has funded about 37 new senior research projects per year, 14 young research projects per year, and 20 postdoctoral projects and fellowships per year. These projects concern an amount of close to $ 25.000 USD per year during (in mean) 3,5 years.

FONDECYT
Fondo Nacional de Desarrollo
Científico y Tecnológico

Institutions and associate members of SOMACHI

There are about 25 universities in Chile where mathematical research is carried out. From these, 22 mathematical departments spread all along the country are associated to SOMACHI or are in process of association. It is worth stressing that four Chilean universities were ranked among the TOP 500 in mathematics in the last ARWU (Shangai) ranking: Universidad de Chile, Universidad de Santiago de Chile, Universidad Técnico Santa María and Pontificia Universidad Católica de Chile. This covers around 25% of the researchers in the country.

There are about 450 researchers in mathematics working in Chile. From these, 341 are associated to SOMACHI, and this number grows every year with the names of researchers just finishing their PhDs, some of which come to Chile via international programs for attracting young talents (as FONDECYT postdoctoral positions). As a matter of comparison, in 1985, the number of people with a PhD in mathematics working in the country was just 45. In 1977, there was no production of mathematical articles in Chile; in 1987, the number of published papers was 73, and this increased to 151 in 1997, to 327 in 1997, and to 736 in 2017 (source: mathscinet).

SOMACHI is the representative of the Chilean mathematics towards IMU. It entered in the group I of the IMU ranking in 1982 (with Rolando Rebolledo as president), and was promoted to group II in 1993 (under the presidency of Rolando Chuaqui). Moreover, between 1995 and 2001, Rolando Rebolledo was the Chairman of the Commission for Development and Exchanges of the IMU. More recently, Alejandro Jofré has been a member of the Committee on Electronic Information and Communication of IMU (2007-2010) and, since its foundation, a member of the IMU-Circle.

Publications

Most areas of mathematics are developed in Chile. Among those with strongest development in the country we can stress Algebraic Geometry, Discrete Geometry, Dynamical Systems and Ergodic Theory, Mathematical Physics, Number Theory, Numerical Analysis, Optimization, Partial Differential Equations, Probability, Spectral Theory, etc. However, there is still a lack of specialists in certain disciplines, as for example Riemannian Geometry, Harmonic Analysis and History of Mathematics.

Over the last 25 years (up to 2017), a number of 8523 publications in mathematics involve the participation of a researcher based at Chile. The growth year by year, illustrated below, has been continuous, with a rapid increment over the last 3 years (it is perhaps the case that some articles published in 2017 have not been processed by mathscinet yet).

Chilean publications over the last 25 years (source: mathscinet)
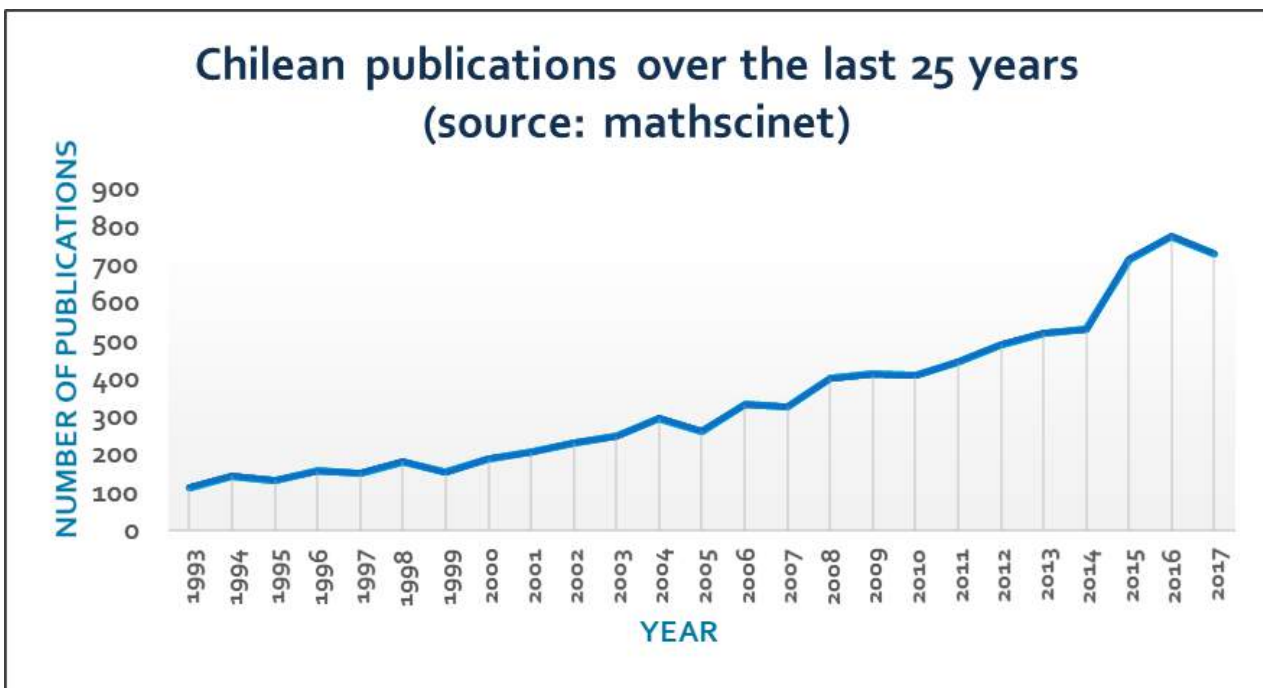
It is worth stressing that Chile is the Latin American country with the highest number of mathematical articles per capita. Indeed, according to mathscinet, 185 papers per one million inhabitants (p/H) have been produced in Chile between 2013 and 2017, an index that is followed by that of Uruguay (107 p/H), Brasil (57 p/H), Argentina (54 p/H), México (42 p/H), Colombia (30 p/H), and other countries (source: mathscinet).

The summary for 2016 including also USA and Canada is illustrated in the graph on the left below. The Chilean position is even more remarkable by the fact that its ratio G(ross)D(omestic)P(roduct)/paper is the smallest in the whole American continent, as illustrated on the right.

Chile in the Americas: Math 2016

Papers/population

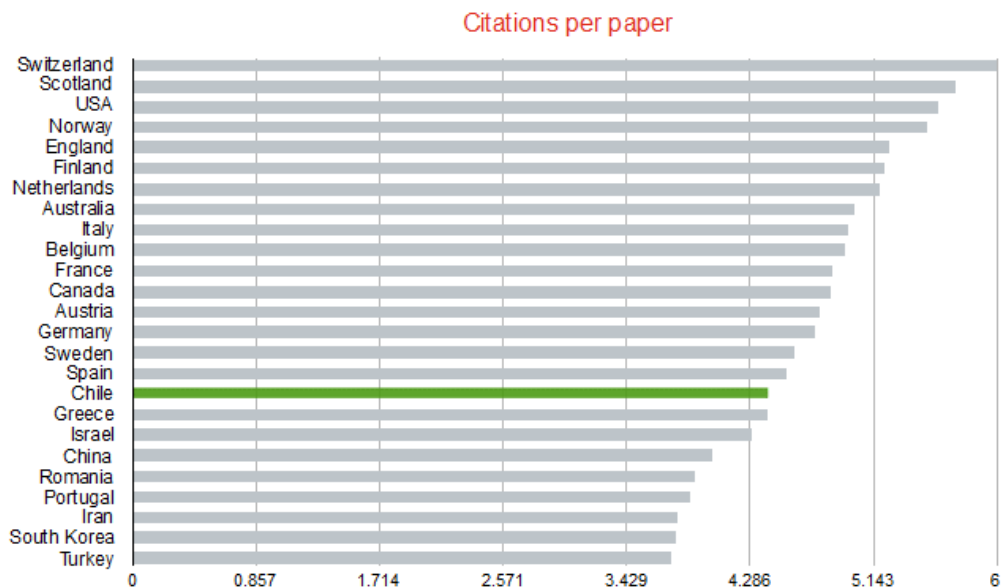| Country	Value
Canada	~430
USA	~270
Chile	~145
Uruguay	~80
Argentina	~50
Brazil	~40
Mexico	~25
Colombia	~18
Venezuela	~12
Cuba	~10

GDP/paper

Country	Value
Chile	~9
Canada	~9
Uruguay	~19
USA	~20
Brazil	~21
Argentina	~25
Colombia	~32
Mexico	~33
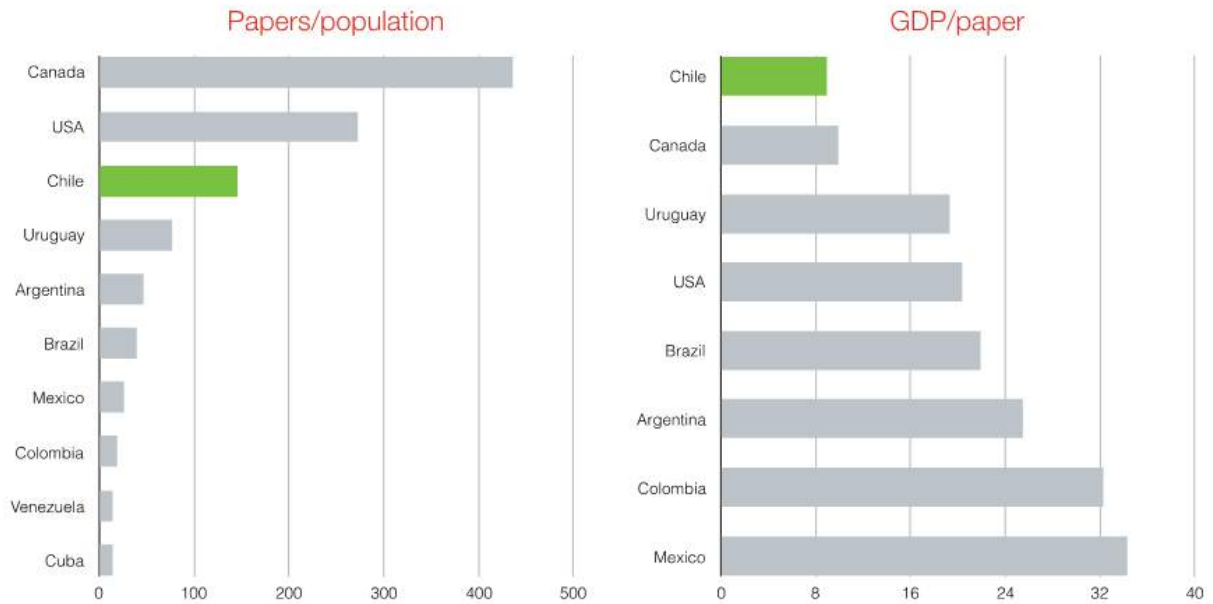
Another point to be stressed is the very high index of citations of the mathematical works produced in Chile, as shown below (source: maths-cinet).

International Context in Mathematics

Citations per paper

Country	Value
Switzerland	~6.0
Scotland	~5.4
USA	~5.3
Norway	~5.2
England	~4.9
Finland	~4.8
Netherlands	~4.8
Australia	~4.4
Italy	~4.4
Belgium	~4.4
France	~4.3
Canada	~4.3
Austria	~4.2
Germany	~4.1
Sweden	~4.0
Spain	~3.9
Chile	~4.4
Greece	~4.3
Israel	~4.3
China	~4.1
Romania	~3.9
Portugal	~3.9
Iran	~3.9
South Korea	~3.8
Turkey	~3.7

Although impact indices can drastically vary from one area of mathematics to another, a certain sign of quality must be recognized in the data above. In this direction, it is worth stressing that Chilean mathematicians use to publish a good percent of their research in top journals. Actually, the funding system (in particular, FONDECYT) explicitly considers this issue for applications. Below we list the number of publications in the period 2013-2017 in some of these journals.

JOURNAL	
Acta Arithmetica	3
Advances in Mathematics	11
Algebraic and Geometric Topology	2
Algorithmica	8
Analysis and PDE	4
Ann. Acad. Sci. Fenn. Math	6
Ann. I. H. Poincaré An. non Linéaire	11
Ann. I. H. Poincaré. T. & M. Physics	1
Ann. Sci. Éc. Normale Supérieure	1
Annales de l'Institut Fourier	2
Ann. Scuola Norm. Sup. di Piza	5
Annals of Mathematics	1
Appl. Math. and Opt. Int. Journal	1
Archiv. der Mathematik	6
Arch. for Rat. Mechanics & Anal.	4
Bayesian Analysis	9
Bernouilli	3
Biometrics	2
Biometrika	1
Bull. London Math. Society	4
Calc. Variations & Partial Diff. Eq.	19
Combinatorica	2
Communications in Math. Physics	12
Commun. in Partial Diff. Equations	10
Comm. on Pure and Appl. Math.	4
Compositio Mathematica	3

Comp. Meth. in Appl. Mech. & Eng.	29
Discrete & Computat. Geometry	3
Discr. & Cont. Dyn. Systems Ser. A	25
Duke Math. Journal	3
Econometrica	1
Electronic J. of Probability	6
Electronic J. of Statistics	3
Erg. Theory and Dyn. Systems	21
European J. of Combinatorics	2
Experimental Mathematics	1
Geometry and Topology	1
Groups, Geom. & Dynamics	2
IMA J. of Numerical Analysis	13
Information & Computation	3
Int. Math. Research Notices	8
Inventiones Mathematicae	1
Inverse Problems	9
Israel J. of Mathematics	19
J. American Math. Soc.	1
J. Amer. Stat. Association	7
Journal d'Analyse Math.	4
J. de Math. Pures et Appl.	9
J. für die Reine und A. Math.	1
Journal of Algebra	16
J. of Algebraic Geometry	1
J. Combinatorial Th. Ser. A	3
J. Comb Theory Ser. B	1
J. Comput. Graph. Statistics	1
J. Comput. System Sciences	8
J. Differential Equations	43
J. Differential Geometry	2
J. European Math. Soc.	3
J. Functional Analysis	17
J. Geometric Analysis	2
J. Graph Theory	3
J. Group Theory	2
J. London Math. Soc.	11
J. Mathematical Biology	6

J. Modern Dynamics	3	Representation Theory	3
J. Multivariate Analysis	11	Revista Mat. Iberoamericana	3
J. Number Theory	10	Scandinavian J. of Statistics	3
J. Optimization Th. & Appl.	18	Selecta Mathematica	1
J. Pure & Applied Algebra	12	SIAM J. on Appl. Dyn. Systems	3
J. Royal Statistical Society	1	SIAM J. on Appl. Math.	2
Journal of the ACM	4	SIAM J. on Computing	13
Math. Programming	14	SIAM J. on Control and Opt.	14
Math. Reseach Letters	3	SIAM J. on Discrete Math.	11
Math. of Computation	14	SIAM J. on Math. Analysis	8
Math. of Operations Res.	4	SIAM J. on Num. Analysis	14
Math. Annalen	7	SIAM J. on Optimization	29
Math. Zeitschrift	9	SIAM J. on Scient. Computing	7
Moscow Math. J.	3	Statistical Science	3
Multiscale Modelling & Sim.	2	Statistics and Computing	4
Nonlinearity	2	Stoc. Processes and their App.	2
Numerische Mathematik	12	The Annals of Applied Prob.	1
Probability Th. & Rel. Fields	1	The Annals of Applied Stat.	6
Proc. Amer. Math. Society	20	The Annals of Probability	8
Proc. London Math. Society	5	The Annals of Statistics	1
Proc. Royal Soc. of Edinburgh	7	Transactions Amer. Math. Soc.	2

Several Chilean researchers are members of editorial boards of prestigious international journals. Among these we can stress: Advances in Operator Theory (Carlos Lizama), Algebraic and Geometric Topology (Andrés Navas), Annales Henri Poincaré: Math. Physics (Rafael Benguria), Annales Henri Poincaré: Combinatorics, Physics and Interactions (Luc Lapointe), Bernoulli (Alejandro Ramírez), Bull. of the International Assoc. of Mathematical Physics (Rafael Benguria), Computational and Applied Mathematics (Carlos Conca), Computers and Mathematics (Norbert Heuer, managing editor), Discrete and Cont. Dyn. Systems Ser. A (Jairo Bochi, Juan Dávila and Manuel del Pino), Electronic J. of Combinatorics (Maya Stein), Electronic J. of Probability (Alejandro Ramírez), Journal of Mathematical Physics (Rafael Benguria), Journal of Nonlinear Mathematical Physics (Enrique Reyes), Journal of Optimization Theory and Applications (Aris Danillidis and Fabián Flores-Bazán), Journal of Spectral Theory (Rafael Benguria), Mathematics of Operation Research (Roberto Cominetti and Aris Daniliiidis), Networks and Heterogeneous Media (Raimund Bürger), Operations Research and Math. Programming B (José R. Correa), Pacific Journal of Mathematics for Industry (Alejandro Jofré), and SIAM Journal on Numerical Analysis (Norbert Heuer and Gabriel Gatica).

There are three mathematical journals regularly produced in Chile:

Cubo, edited by Univ. de la Frontera (with Rubí Rodríguez as the current managing editor), which has been indexed in mathscinet since 2004;

Proyecciones, edited by Univ. Católica del Norte (with Ricardo L. Soto as the current managing editor), which has been indexed in mathscinet since 1989;

Scientia (*Scientific Series A. Mathematical Sciences*), edited by Univ. Técnica Federico Santa María (with Iván Szántó as the current managing editor), which has been indexed in mathscinet since 1983.

Moreover, the journal *Notas de la Sociedad de Matemática de Chile* was produced between 1985 and 1992, with an extra volume in 2001. There is a project to re-launch it as a journal of panoramic articles on different branches of mathematics.

Last but not least, among the many books (co)authored by a Chilean researcher during the period 2010-2018, we can stress:

Time series analysis. John Wiley & Sons (2016); by Wilfredo Palma.

Convex optimization in normed spaces; Theory, methods and examples. SpringerBriefs in Optimization (2015); by Juan Peypouquet.

Bayesian nonparametric data analysis. Springer Series in Statistics. Springer (2015); by Fernando Quintana and Alejandro Jara (joint with Peter Müller).

Cox rings. Cambridge University Press, Cambridge (2015); by Antonio Laface (joint with Ivan Arzhantsev, Ulrich Derenthal and Jürgen Hausen).

Regularity of difference equations on Banach spaces. Springer, Cham (2014); by Carlos Lizama (joint with Ravi Agarwal and Claudio Cuevas).

A simple introduction to the mixed finite element method. Theory and applications. SpringerBrielfs in Mathematics (2014); by Gabriel Gatica.

Quasi-stationary distributions; Markov chains, diffusions and dynamical systems. Probability and its Applications, Springer, Heidelberg (2013); by Servet Martínez and Jaime san Martín (joint with Pierre Collet).

Complex analysis. In the spirit of Lipman Bers. Graduate Texts in Mathematics 245, Springer, New York (2013); by Rubí Rodríguez (joint with Irwin Kra and Jane Gilman).

Distance expanding random mappings, thermodynamical formalism, Gibbs measures and fractal geometry. Lecture Notes in Mathematics 2036, Springer (2011); by Bartlomiej Skorulski (joint with Volker Mayer and Mariusz Urbanski).

Groups of circle diffeomorphisms. U. Chicago Press (2011); by Andrés Navas.

International collaboration

Besides IMU, Chilean mathematics as a whole is represented in several other international organizations. SOMACHI is one of the members of the Unión Matemática de América Latina y El Caribe (UMALCA) and both SOMACHI and CMM are associate members of the Mathematical Council of the Americas (MCA). Moreover, CMM collaborates with the Pacific Rim Mathematical Association (PRIMA).

The funding system includes research projects with foreign countries, as for instance Math-AMSUD (Latin American countries and France) and ECOS (Chile and France). Moreover, both individual Fondecyt projects and team research projects involve a non-negligible percent of resources for international collaboration.

Many international mathematical conferences held every year in Chile. Some of them arise from bilateral or multilateral collaboration. Among these, we can stress those realized in recent years: the UMALCA Congress in Santiago in 2009, the AMS-SOMACHI meeting in Pucón 2010, and the first joint meeting with the Unión Matemática Argentina in Valparaíso in 2016 (the second version of this

meeting will be held in Mendoza, Argentina, in 2019).

Most research groups have conferences of a certain tradition, among which we can mention the "Colloquium on Dynamical Systems", which has held 63 times, the conference "Information and Randomness", which has held 8 times (it runs every two years during December), the "School on Discrete Mathematics", which has held 7 times (it runs every year during January), the meetings on "Numerical Analysis of Partial Differential Equations", which have held 9 times in different cities of the country, the "Chilean Meeting on Number Theory", which has held 5 times in Santiago and Valparaíso, the "Congress on Functional Analysis and Evolution Equations", which has held 12 times in Chile and Brasil, the Congress "ANESTOC: Stochastic Analysis and Mathematical Physics", which has held 6 times since 1996, the "Japanese-Chilean Workshop on Nonlinear Partial Differential Equations", which has held 3 times in Chile and Japan, etc.

Besides, several research groups have succeeded in attracting to the country many international meetings, as the "International Congress of Mathematical Physics" held in Santiago in 2015 (this was the second version of this con-


First Joint Meeting AMS - Somachi
December 15-18th, 2010   Pucón, Chile

gress in Latin America), the "International Conference on Continuous Optimization" (ICCOP) held in Santiago in 2010, the "PASI School on Probability" held in Santiago in 2012, the "Integer Programming and Combinatorial Optimization" (IPCO) conference held in Valparaíso in 2013, the "XIX Latin American Colloquium of Algebra" held in Pucón in 2012, the "VII Conference Global Dynamics Beyond Uniform Hyperbolicity" held in Olmué in 2015, the "VI Latin American Conference on Lie Theory and Geometry" held in Antofagasta in 2016, etc. Moreover, CIMPA and EMALCA schools are periodically organized in different places of the country.

Among other meetings to be soon organized in Chile, we can stress the "School and Workshop Geometry at the Frontier" (Pucón, November 2018), the congress "Random Physical Systems" (Patagonia, December 2018), and the CIMPA Research School entitled "Fourth Latin American School on Algebraic Geometry and its Applications" (Talca, December 2019).
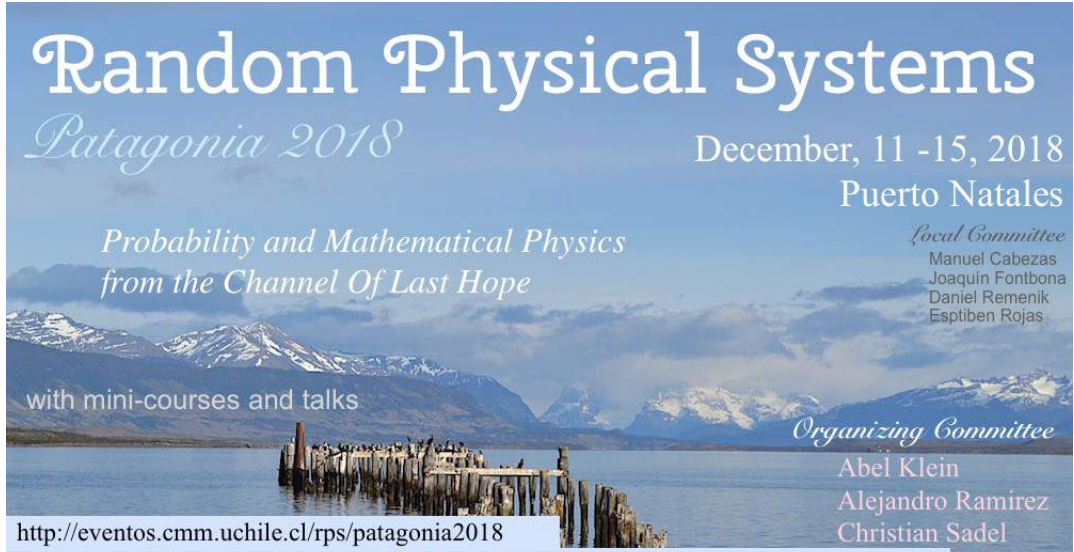
# Chile at the ICM and international recognition

The first Chilean mathematician to deliver a talk at ICM was Gunter Uhlman in 1998 (special session on "Partial Differential Equations"). Uhlman is one of the mathematicians that left Chile by the military coup. He has developed his career at USA, yet he is an associate researcher of CMM.

In 2010, Manuel del Pino, from U. de Chile, was also invited to deliver a talk in the special session on "Partial Differential Equations". Soon after that, in 2013, del Pino was awarded a National Prize of Science, thus revealing how important was this nomination in the local community. For the ICM 2018, three mathematicians from Chile have been invited to give talks in special sessions: Jairo Bochi (PUC) and Andrés Navas (USACH) in the special session on "Dynamical Systems and Ordinary Differential Equations", and Raimund Bürger (U. de Concepción) in the special sessions on "Numerical Analysis and Scientific Computing" and "Mathematics in Science and Technology".

Moreover, the whole Chilean community was invited to the 2014 ICM to show its progress in the context of a special panel for discussing the promotion of mathematics in developing countries. The presentation was made by Rubí Rodríguez and Samuel Navarro in the form of a video, which is freely available at https://www.youtube.com/watch?v=sd6YDSLbu5Y.

In 2010, Manuel del Pino became the first mathematician working in Chile to give an ICM talk.

Many prizes by international organizations of mathematics and science have been awarded by Chilean mathematicians: the TWAS Prize (Servet Martínez in 1999 and Patricio Felmer in 2011), the Umalca Prize (Alejandro Maass in 2009 and Andrés Navas in 2016), the MCA Prize (Andrés Navas in 2013 and Héctor Pastén in 2017), and the Solomon Lefschetz Medal (Gunter Uhlman in 2017). Moreover, among the many recognitions from scientific associations obtained by Chilean mathematicians, we can stress that Rolando Rebolledo was a member of the International Committee of the Bernouilli Society between 1986 and 1992, Rafael Benguria got a Guggenheim fellowship in 1998, Ricardo Baeza and Rodolfo Rodríguez are fellows of the American Mathematical Society, José Correa and Roberto Cominetti received the TLS Best Paper Award in 2002, Eduardo Cerpa got the SIAM Group on Control Theory Prize 2015, Mario Ponce and Patricio Santibáñez got a prize from the Mathematical Association of America (the MAA Prize) in 2015, and Manuel del Pino has recently been appointed a Royal Society Research Fellowship.
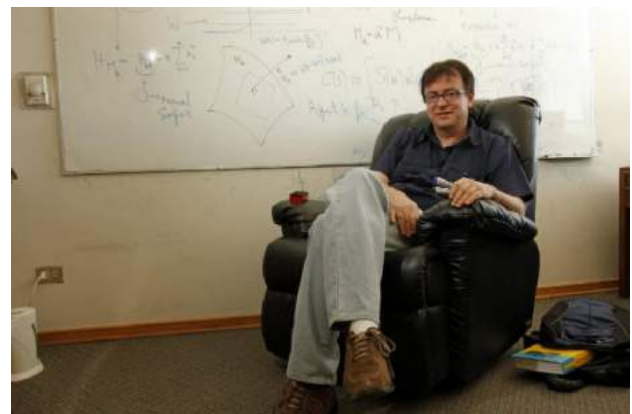
Gunther Uhlman appears on the right-hand side of this picture, receiving the Solomon Lefschetz medal of the MCA (Montréal, 2017). The fifth from left to right is Héctor Pastén, who received the MCA Prize for young researchers.

# Graduate and postgraduate studies

Most of the traditional universities have undergraduate programs in mathematics (on pure mathematics and/or mathematical engineering). Besides, there are 13 Master programs and 12 PhD programs. Last year in Chile, a number of 118 students earned an undergraduate diploma on mathematics, 13 got a Master degree and 12 a PhD. Besides, there is a national system of fellowships (administered by CONICYT) called Becas Chile that, over the last 8 years, has awarded 91 Master and 289 PhD fellowships in national and international programs. It is worth stressing that a good percent of PhD fellowships are granted for co-advised thesis abroad, notably in France.

The progression of the number of PhD fellowships over the last eight years.
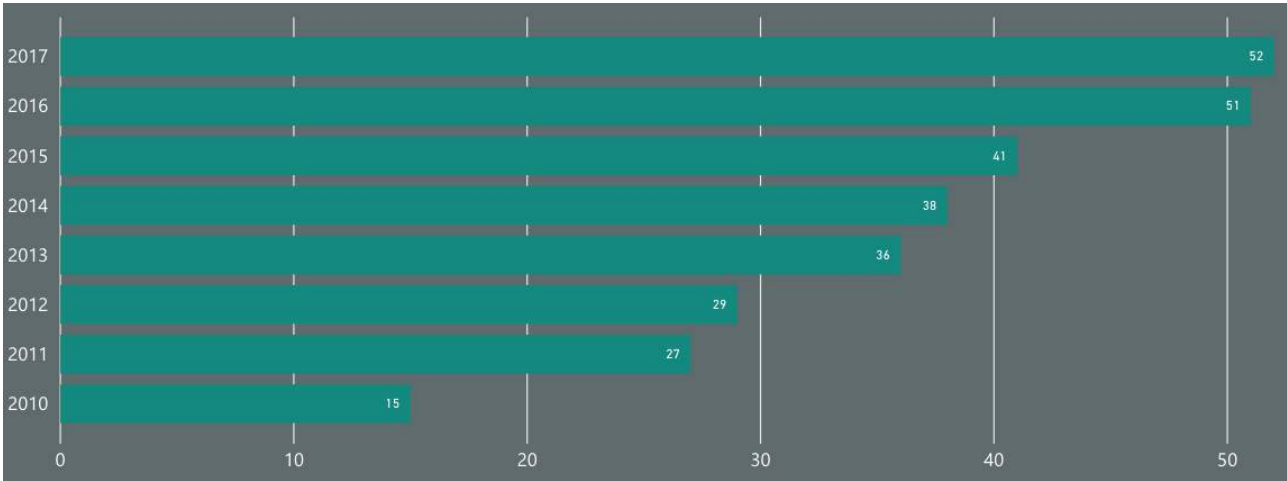
Mathematical education
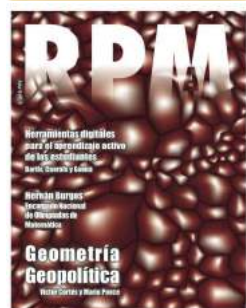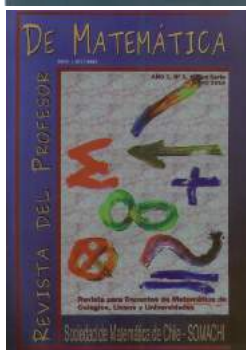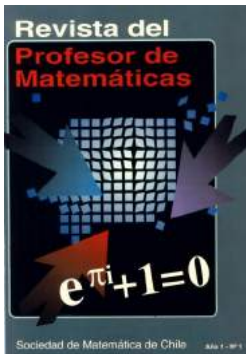
The Chilean mathematical community has always considered that contributing to middle and high school mathematical education is one of its responsibilities. Throughout the years it has organized teacher-training workshops and collaborated with the local educational authorities, ministry and agencies, to plan and execute the curriculum and try to set higher standards for teachers.

For decades, SOMACHI has generated several spaces to promote the teaching of mathematics through dialogue and cooperation between teachers of mathematics, mathematicians, and mathematics educators. In this regard, in each of the three regional congresses sponsored by SOMACHI (annual meeting, COMCA and JMZS), a section with lectures and courses with researches on the teaching of mathematics is assigned. At present, many other congresses on the area both national and international are sponsored by SOMACHI, as for example the "VI Sixth Symposium of Mathematical Work"

(https://www.etm6.pucv.cl) and the "First PME Regional Conference" (https://www.uoh.cl/pme-regional/).

Another contribution of the mathematics community is the Revista del Profesor de Matemáticas, a periodical SOMA-

CHI's publication since 1994. The objective of the Revista is to contribute to the training of teachers, allowing them to maintain a constant study of mathematics and to motivate the transmission of knowledge with challenging problems to their students. Some numbers can be reviewed on the webpage https://rpmat.cl. A similar initiative but addressed mostly to graduate students is the Revista Joven Matemático, pursued by Rafael Benguria and partially funded by the Millenium Nucleus "Mathematical Physics"; see https://issuu.com/joven_matematico.

Chile has around 50 researchers with doctorate degrees in mathematics education (didactics in mathematics) and mathematics who carry out research on micro and macro phenomena of mathematics teaching and learning for different school levels. Chile has an initial (and continuous) training of teachers, a responsibility shared by mathematicians, mathematics educators and education professionals. In recent years, adjustments and modifications to the national curriculum have been made under expert commissions, in which SOMACHI has been present. These dialogues and instances of participation are highly valued in the scientific community, in a country where

public policies have been implemented and efforts have been made to contribute to the training of teachers.

At an international level, Chile is a member of the International Commission on Mathematical Instruction (ICMI) since 1992. In the recent ICMI study 24, the overarching question is to explore what school mathematics curriculum reforms have been made or are taking place, especially at a meta, macro or system level; and to learn about the many different aspects of mathematics curriculum reforms from past experiences, to specify the current status and issues in reforms world-wide, and to identify possible directions for the future of school mathematics. For example, one of the five themes selected in this study is the globalization and internationalization, and their impacts on mathematics curriculum reforms. In this regard, Chilean researchers contribute through the GEC-PUCV Lesson Study Group, Problem Solving, STEM Group and STEAM-Valparaíso, inserted in 3 PhD programs and the almost 10 master's degree in education mathematics in the country.

In a similar direction, another initiative to be stressed is the program Suma y Sigue, directed by Salomé Martínez, which has been consolidating key initiatives focused on professional development of teachers and pre-service teacher education, strengthening collaborations with the Ministry of Education, regional universities and local educational institutions. This program received the UNESCO-Hamdan bin Rashid Al-Maktoum Prize 2017-2018 for outstanding practice and performance in enhancing the effectiveness of teachers. It has been used in 5 universities during 2017 and, by the end of 2018, it will be implemented in 7 additional universities.

Elizabeth Montoya (on the right-hand side), from the Pont. Univ. Cat. de Valparaíso (PhD in Didactics of Mathematics, Univ. Paris VII), is the new representative of Chile at ICMI (2018-2019). Between 2014-2017, the representative was Rubí Rodríguez (on the left-hand side).

Popularization of Mathematics

Mathematical olympiads

Chilean Mathematical Olympiads (see www.olipmpiadadematemaca.cl) have been organized by SOMACHI every year since 1989. The participants in the last version were close to 15000 students. The winners of these competitions participate in the International Mathematical Olympiads (IMO, since 1994), Iberoamerican Mathematical Olympiads (since 1990) and the Mathematical Olympiad Cono Sur (SouthAmerica, since 1990). Next year 2019, Chile has been invited to compete in the European Girls' Mathematical Olympiad (EGMO). The preparation of the team is being funded by the Anillo Project "New Trends in Ergodic Theory".

Among those who have participated in these Olympiads, around forty gifted students have been detected and later incorporated as professional mathematicians, and today they work on indus-

On the right: the final competition of the last Chilean Olympiads. On the left: the preparation of the girls team for the next EGMO 2019.

tries and universities in Chile and abroad.

In recent years, many other competitions of slightly different nature have been organized. Among them we mention: "Campeonato Escolar de Matemáticas", a competition between school teams organized by Rafael Labarca (since 2003), "Campeonato de Matemática UFRO", a similar competition located at the Araucanía Region organized by Hernán Burgos (since 2004), "Premio al Talento Matemático", an individual competition about a single higher-level problem and funded by the "Colegio de Ingenieros de Chile" (since 2008), and the "International Competition on Mathematical Modelling" organized by CMM (since 2018). All of this has motivated hundred of schools to develop similar competitions, either internal or with the participation of children from other schools.

Mathematical academies and related

Inspired by the mathematical olympiads and other competitions, several mathematical academies have been created inside schools. Moreover, in Santiago, there is a major activity of this kind organized at PUC, namely the "Taller de Razonamiento Matemático", that convenes almost 800 students from the whole of the city.

SOMACHI organized its first one-week mathematical camp (CAMAT) in 1999 and, with the support of the Anillo Project "Center of Dynamical Systems and Ergodic Theory", it was relaunched in 2016. Each of these had a participation of about 100 students. The organization of a third CAMAT is in progress. Similar (but shorter) activities are periodically organized in relation to the "Campeonato Escolar de Matemáticas", some of which have been funded by the Millennium Nucleus "Information and Coordination in Networks".

The ARPA program ("Activando la Resolución de Problemas en el Aula") is another program of this kind, mostly addressed to school teachers. It promotes the teaching of mathematics building on concrete problems, thus avoiding the classical structure of most textbooks.

Other actions have been developed by CONICYT grants like the Anillo Project

"Geometry at the Frontier" and the local educational center CAMVIT, which organizes courses, conferences and communications lectures of mathematics to school teachers every year at the Universidad de la Frontera (UFRO).

Mathematical festivals

There are two cultural festivals (widely open to all people via streaming) that include mathematics in their programs: "Puerto de Ideas" and "Congreso Futuro". One of the speakers in the most recent version of the last one was Terence Tao (this was his first visit to a Latin American country).

Without any doubt, the major event for promoting mathematics towards public is the Mathematical Festival. To the best of our knowledge, this is the unique itinerant mathematical festival in the world. It was created by SOMACHI in

2016, and has been organized in Valparaíso (December 2016), Vicuña (July 2017), San Antonio (September 2017), Talca (November 2017) and Valdivia (April 2018). In October 2018 there will be a new version in Chiloé, the biggest island of Chile.

Each festival occurs in a public space, and the activities are free and accessible to all people. It consists of about 25 interactive stands, all of them designed by professional mathematicians and implemented by students. In there, people can play, discover, and talk about mathematics, thus changing their most common view of it ("a boring science just

involving computations and formulas"). Several other activities occur simultaneously, as for instance mathematical talks for a general audience. Up to now, there have been talks by Alejandro Kocsard (UFF), Anita Rojas (U. de Chile), Amalia Pizarro (U. Valparaíso), Mauricio Godoy (U. de la Frontera), Mariela Carvacho (UTFSM), Andrea Jiménez (U. Valparaíso), Mario Ponce (PUC), Aníbal Aguilera (PUCV), Ricardo Baeza (U. de Talca), Carolina Domínguez (U. Austral), Héctor Pastén (Harvard Univ.) and Claudio Gutiérrez (U. de Chile); see https://www.youtube.com/channel/UC1ZQqTfGlwj8EbZOlD-3Ejw/featured.

Besides talks, spectacles as juggling presentations and street theatre occur in each festival. Actually, theatre plays have developed independently of the festival, with presentations in different cities of the country. Among the most successful presentations we can stress "4-2-1-4", "Primos entre sí" and "¿Quién mató al 8?". These have been founded by different sources, including the Anillo Project "Analysis on Control Problems and Applications" and the Millenium Nucleus "Analysis of PDE". A major event involving theatre and mathematics, EXACTA, runs every year in Santiago.

Women in mathematics

There are several activities organized in Chile for promoting mathematics among girls and establishing a culture of gender equality inside the mathematical academia. In the first direction, a very concrete example is provided by the mathematical camp MATEA, organized every year since 2017. The camp gives new perspectives to girls at secondary studies and their teachers via non-competitive activities spread along three days allowing them to share and enjoy mathematics.

The exhibition in pictures (© GAM).

In the second direction, the most visible activities have been those carried out by the "Colectivo de Mujeres Matemáticas de Chile", a group created in 2014 by women doing research in mathematics from all along the country. Recently (2018), it has attracted to Chile the exhibition Women in Mathematics throughout Europe: A gallery of portraits (http://womeninmath.net), originally created by Sylvie Paycha and Noel Matoff, which has been modified in order to include women researchers from Chile and other Latin American countries. The exhibition has been held at Centro Cultural Gabriela Mistral, the biggest cultural pole in Santiago.

Another important activity has been the conference "II Encuentro de Mujeres Matemáticas de América Latina", held this year between January 22-26 in Valdivia (Centro de Estudios Científicos CECS and Universidad Austral de Chile UACH). The number of participants of this meeting was 89 (with 86 women among them); they came from Chile, Argentina, Perú, Bolivia, Uruguay, Brasil,

Ecuador, Colombia, Cuba, Nicaragua and México. There were talks about mathematics and concerning gender, science and feminism. Activities as a round table, a workshop about negotiation skills and a poster session were also organized. Among other institutions, this conference was supported by the Committee for Women in Mathematics (CWM).

6 | **Actualidad**

DIARIO AUSTRAL | Miércoles 24 de enero de 2018

JUVENAL ALUN GÓMEZ

Buscan ampliar la participación femenina en las matemáticas

EN VALDIVIA. *Encuentro reúne hasta el viernes a 90 mujeres latinoamericanas. Participan en charlas y talleres.*

María Alejandra Pino C.
mariaalejandra.pino@australvaldivia.cl

BRECHA
Andrea Vera, académica de la

EN LA CARPA DE LA CIENCIA DEL CECS Y EN LA UACH SE REALIZAN LAS ACTIVIDADES DEL ENCUENTRO DE MUJERES MATEMÁTICAS.

The second meeting of women in mathematics from Latin America in the media.

Dissemination books and maths in the media

There is a certain tradition of production of dissemination books of mathematics in Chile. The first of these, Matemática y poesía (by Arturo Aldunate Phillips, Chilean prize of literature 1976), was published in 1940. Since then, about 15 books have been produced, two during the last (chronological) year: Un viaje a las ideas (by Andrés Navas) and La conspiración de Babel (by Eric Goles). Both books have become best-sellers in the bookstores, thus showing how attractive is mathematics for the general audience. By now, two new books are in
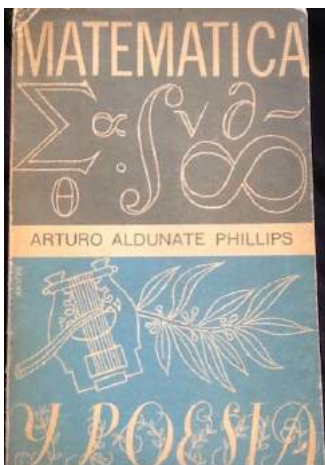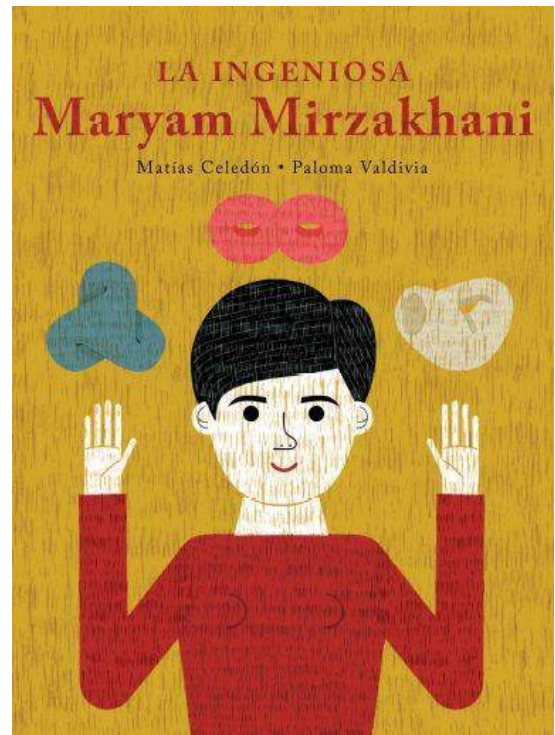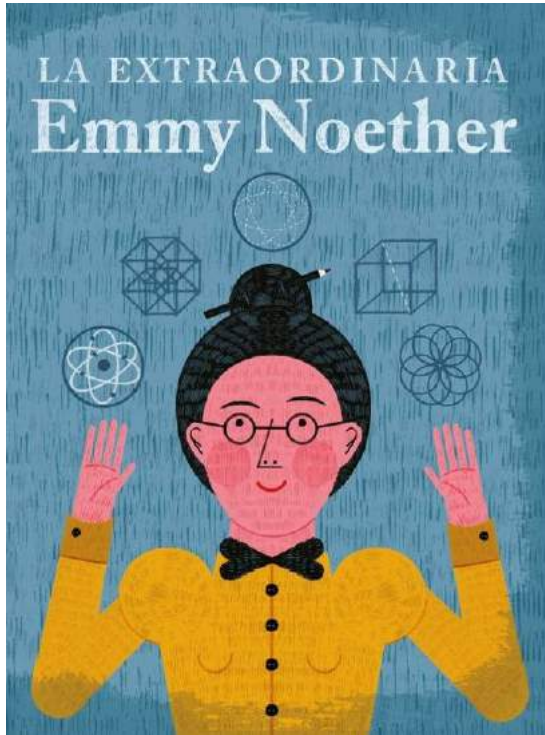
press: Lecciones de Matemática para el Recreo (by Andrés Navas) and Confesiones de un Matemático Rebelde (by Nicolás Libedinsky).

Two other recent books, mostly addres-

sed to children, treat on the life and work of Emmy Noether and Maryam Mirzakhani. These are non-commercial quite beautiful graphical books whose elaboration was funded by the Millenium Nucleus "Stochastic Models of Complex and Disordered Systems".

Matemáticos de la U. de Chile resuelven ecuación que estuvo casi 40 años sin respuesta

Autor: Cristina Espinoza

Solución es un avance clave en área que explica fenómenos como las olas en el mar o las ondas de la luz.

TV Maulinos
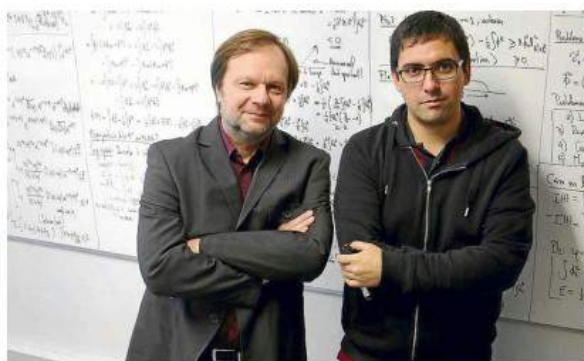
Todo listo para el Primer Festival de Matemáticas de Talca

2 noviembre, 2017

En la instancia se entrega la medalla Fields

Cultura

Tres matemáticos de universidades chilenas expondrán en el congreso más importante de la Matemática mundial

por EL MOSTRADOR, CULTURA+CIUDAD | 19 junio, 2017

Mathematics has also become a topic in the media. This includes a permanent blog by the SOMACHI's president in the most popular electronic newspaper in Chile (http://www.elmostrador.cl/autor/anavas/), as well as many other appearances of mathematics and mathematicians in press-media, radio and television. In this regard, it is nice to stress that one of the trending topics this year was the invitation to three mathematicians from Chile to give talks at the next ICM 2018.

Last but not least, Chile strongly supports the proposal of declaring March 3rd as the International Day of Mathematics (although dates in Spanish are spelled in the reverse order to that of English). In fact, there are many dissemination activities that are organized this day every year.

Día de Pi
Marzo 14, 2018

Conferencistas
Jaime Mena (IMA PUCV)
Edray Goins (Purdue University)
Francisco Valenzuela (IMA PUCV)

Organizadores
Luis Lomelí
Gabriele Ranieri

Con la colaboración de:
Bárbara Núñez
Gabriel Pinochet
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