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José María Montesinos Amilibia Biographical Sketches

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To José María Montesinos Amilibia
in appreciation for his mathematics, wisdom, and friendship

My interest in the work and life of José María Montesinos Amilibia (JMMA) was first kindled when he asked me whether I could draw the plane unfolding of a polyhedron that *tesselated the Euclidean and* (in a way, v. infra) *the hyperbolic* 3-*space*. Seemingly it had just been discovered in a joint work with Hugh Hilden and María Teresa Lozano Imízcoz (MTLI). At that time I was in the Algebra Department (UCM[1]) and took the exercise in my trip to Barcelona on the coming weekend. The data he gave me were the coordinates of the vertexes and on next Monday I was happy to present him copies of a plane unfolding ready to cut, fold and paste and also a couple of mounted pieces (Figures 1 and 2).

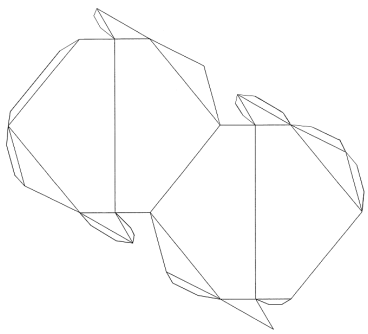

Figure 1: Plane development of the eupolytope.

The result was quite amazing, particularly because the means that then were at my disposal were very rudimentary. If it is true that I had a lot of fun doing it, I do not think that it brought anything to JMMA that he did not already know. Later he told me that he had filled one of the paper models with methacrylate, so that he got a solid transparent model. The vertexes' coordinates can be found in [76], the first paper in which this polyhedron is described and studied in detail. A surprising fact is that *if the dihedral angle at the two longest edges, which is* $120°$*, is decreased to any non-negative value, then the new polyhedron tesselates the hyperbolic space.* Taking into account the meaning of the Greek prefix 'eu',

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[1] For the meaning of acronyms, see the table at the end.

which in scientific coinages connotes 'good, true, genuine' (the etymologies of 'euphony' or 'eulogy' are good examples), I suggested to call it *eupolytope*, or *eupolyhedron*, but I have the impression that for some reason it did not catch, possibly because in his universe all polyhedra would deserve that prefix.

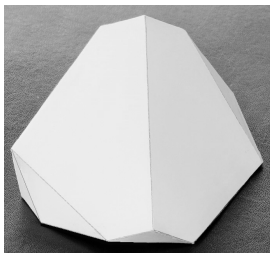
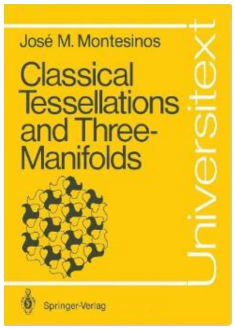


Figure 2: Paper model of the eupolyhedron.

Another precious spark that came a little later was produced in relation to the volume of mathematical contributions in honor of José Javier Etayo Miqueo (UCM, 1994). The paper I wrote, [147], owes a great deal to the questions posed at the start by JMMA (What is the spectrum of a ring? What is it useful for? Is it possible to do without such an abstract concept? . . .) and to the discussions with him all along. In particular I tried hard to show in what ways the spectrum of a ring is naturally connected to the physical notion of spectrum, that is, the set of wavelengths of radiation emitted by (say) atoms. It is not clear to me whether he thought that his questions were answered in that work, but my impression that it was worth while to try still lives in me. Different connections between algebra/analysis and geometry/physics were considered and also the deep analogies between them.

Twenty years later, in the context of the *Árbol de las Matemáticas*, I was involved in the preparation of his profile [151]. Basically it amounts to a mention of a sample of his merits, including a few of his outstanding works, and a sketchy academic biography. It was published in September 2014 and because of that experience, I took as a great honor the invitation that José Manuel Rodríguez Sanjurjo sent me to participate in the homage volume and conference that was beeing planned by the UCM Geometry Department. I could accept because it was clear that MTLI would be in charge of reporting about JMMA main scientific contributions, a job that can be properly done only by a close and sustained collaborator as she is.



Since *by their works ye shall know them*, the first task I thought I had to undertake was to compile a complete list of JMMA's works. The result can be found in the References at the end, which are grouped in four categories: Books ([1]-[5]), Memoirs ([6]-[10]), Papers ([11]-[**?**]) and Articles ([123]-[132]). The section External references ([133]-[152]) contains works not authored by JMMA that are cited in these notes. Most of them are closely related to his work. The entries in each category are ordered by the year of publication.

I also tried to assemble copies of all those references, a task that is practically complete at the time of this writing thanks to the generous help provided by JMMA and MTLI. I regard these materials as the bedrock on which any perspective overview of JMMA scientific profile must be based. My gratitude goes also to Ángel Montesinos Amilibia, for his hospitality in two visits at the home he and José María share in Cebreros (Ávila).

Origins

José María Montesinos Amilibia was born in San Sebastián, the capital of Guipúzcoa (Basque Country, Spain) on 13 November 1944. His father, Lorenzo Montesinos, was a school teacher. In 1938 he was wounded in Teruel, where he fought in the Spanish Civil War enlisted in the "5ª Brigada Navarra". It was a severe bullet injury to one of his legs and for his recovery he chose what he thought was his best option: having made many good friends among the Basque soldiers serving in the brigade, he asked to be carried to a hospital in San Sebastián. There a wise doctor managed, after several delicate operations, to save his leg. He also met Victoria Amilibia, whom he married soon. This union was blessed with five offspring: María Victoria "Mariví", Ángel, José María, Antonio and Coro "Corito". Of them, Ángel and José María were to become mathematicians (although originally Ángel is physicist), while the others pursued different professions.

Á. Montesinos

The basque family name Amilibia has a close linguistic tie to the English family name Cifford. Indeed, if we split both in two parts, 'amil-ibia' and 'clif(f)-ford', the connection is clearly revealed because the meaning of the Basque root 'amil' is close to the English meaning of 'cliff' ('amildegi' in Basque), and similarly with 'ibi' and 'ford'. This was recently told by JMMA when, on launching a symbolic computation program on geometric algebra, the name and the picture of Clifford appeared in the screen.

On the other hand, the family name Montesinos is connected with Montesinho, the Portuguese version of the Montesino in the Spanish Zamora province, the birthplace of Lorenzo. There is, for instance, a Montesinho National Park just below the northern Portuguese border and not far from Bragança, Zamora's sister city. The fact that JMMA dedicated his landmark work [3] to his parents is a faithful and timely expression of the high esteem and veneration which he felt for them.

Schooling

Through his primary and secondary eduction, JMMA was at the same time a cheerful and lively boy and a mind that took his studies very seriously. He was schooled in the Colegio Sagrado Corazón, in San Sebastián (Mundaiz street, 30). He liked all subjects, except History, and at the same time he engaged in all sorts of playful activities.

The subject he liked best was Chemistry, so much so that he reached a real expert level before entering the university. Then came Mathematics and Physics, but also Grammar, a discipline that he has cultivated all along in different guises, particularly linguistics and etymology. One mark of his cognitive endowment was already apparent in those studies: his unlimited persistence in trying to reach a full understanding, in

Colegio Sagrado Corazón.

his own terms, of the objects and processes that interested him. He had a maturity that was far above the average for his age.

University

The determination of JMMA at the end of the secondary education was to study Chemistry, a subject that, as already indicated, had interested him in high school well above the others and about which he had an extensive knowledge.

At that time, this plan required to enroll in a Science Faculty for a five-year program. These programs were taught in several universities in Spain and consisted of a first general common course whose core was formed by one subject for each of the possible major specialties that could be chosen at the beginning of the second year: Mathematics, Physics, Chemistry, Biology and Geology. The first course had a selective character, in the sense that it was required to have passed its main subjects in order to begin one of the specialties in the second year.

JMMA chose the Science Faculty of the University of Barcelona, where he entered in the Fall of 1962. The experiences of that course had a major impact on his career, for at the end he decided to pursue Mathematics. The first strand for that change arose from a circumstantial contingency. Students were assigned to one of several groups, but for some reason he did not know his group until the end of October. Thus meanwhile he attended the classes of the first group, where Mathematics was in charge of Rafael Mallol Balmaña, a young teacher that had just read his doctoral thesis under the direction of Enrique Linés Escardó. JMMA remembers those lectures as truly enlightening about the nature of Mathematics and its ways, especially because of the crystal clear construction of the basic number systems. Thereafter he *knew* how to approach the study of Mathematics and has been grateful ever since for having learned those basic principles at that moment from an excellent teacher.

The second factor seems to have been that he judged himself, after some minor accident in the Chemistry laboratory, as not having the proper level of manual dexterity. And the third reason was that he eventually was assigned to the group in which Mathematics was being taught by Juan Augé Farreras, a former student of Ricardo San Juan Losá. He found the learning of Mathematics to be rather easy-going and at the end he got the highest mark. The three strands tied him in

a dilemma: to begin a Chemistry career, as initially planned, for which he was well prepared in terms of knowledge but rather insecure about his experimental skills, or to switch to Mathematics, which he now understood and appreciated but for which he did not perceive himself as having any special aptitude even after having been bestowed with the highest qualification. So he approached Professor Augé for advice, who answered with his legendary phlegmatic poise: "Mr. Montesinos, go for Mathematics".

In that year, he was also highly interested in Biology, taught by Professor Enrique Gadea Buisán, and in Geology, taught by Professor José Ramón Bataller Calatayud until his sudden death shortly before Christmas. His Geology studies were eased by his knowledge of Chemistry and he has kept an interest in it ever since, particularly intense in the area of Crystallography, in part because of its deep ties with Geometry and Topology.

Clock tower, UB.

Most of the intense studies of that year were carried out, completely undisturbed, in the clock tower of the historical building of the University of Barcelona. He found his way there and apparently nobody ever noticed. He deemed that the noises emitted by the clock machinery and by the bells on top were agreeable reinforcers of his work schedule. Perhaps it was also an ideal spot from where to play some stealth innocent tricks to the people going about their affairs several stories below.

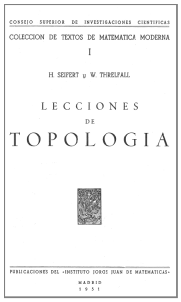
For the four remaining years of Mathematics studies he moved to the UCM. He has good memories of the excellent lectures on Analytic Geometry by Professor Francisco Botella Raduán. Joaquín Arregui Fernández taught him Algebra and Topology. He also organized a seminar on Topological groups, which JMMA attended. He found that the lectures of Germán Ancochea Quevedo on Differential Geometry were great, and also those of Enrique Outerelo Domínguez on General Topology and later in the doctoral courses. He is grateful to José Luis Pinilla for his advice about how to teach problem solving in Geometry, and to Juan Fontanillas Royes and Feliciana Serrano for a similar reason in the case of Topology.

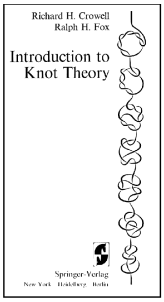
Early research

The first results of JMMA in research were in the period 1969-1971. They had a marked autodidact character and were obtained under rather adverse circumstances.

As most university students of that time, for his military service he chose the "university militias" option, which consisted in two four-months training periods in a military Summer camp, El Robledo (La Granja, Segovia) in his case, followed by a four-months period of service as second lieutenant (alférez) in a military base, which in his case was Cerro Muriano (Córdoba).

When he was called to that service, it was for an immediate incorporation and in a hurry he picked the (Spanish translation of the) treatise [133] and the text [138].



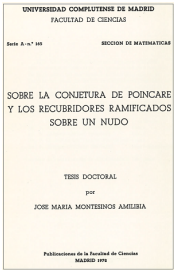


The circumstances in Cerro Muriano, and his cunning ways of dealing with them (the shadow of a holm oak as a regular office instead of attending the military instruction on the tasks that he would be later assigned), allowed him to study those texts in depth, so that he had a deep knowledge and understanding of them when he came back to Madrid at the end of 1969. But in January 1970 he felt sick, with high fevers, and it turned out that he had tuberculosis. It took one year for his full recovery, mostly spent at the Valdelatas Hospital (Madrid). Under these hard circumstances, he managed nevertheless to seize enough time and strength to carry on the research he had begun in Córdoba.

A key move after studying [138] was getting a copy of [134] (it is likely that the intercessor to bring it to Valdelatas was Professor Botella). The book is the proceedings volume of the 1961 meeting on *Topology of* 3*-manifolds and related topics* held a the Mathematical Institute of the University of Georgia under the auspices of the Office of Naval Research and the National Science Foundation. It is a superb and awesome book that "presents summaries and full-length reports of the Institute's five seminars, which covered decompositions and subsets of E^3; n-manifolds; knot theory; the Poincaré conjecture; and periodic maps and isotopies".

R. Fox.

One of the heroes of that meeting was Ralph Hartzler Fox, a Princeton Professor in his late forties. He is the single author of four papers included in [134], three among the six in the knot theory section (that include the survey [135]) and one among the seven in the Poincaré conjecture section, namely the three-page summary [137] about *constructions of simply connected* 3*-manifolds*. There is a fourth paper in collaboration with O. G. Harrold in the knot theory section and he was about to publish the first version of [138], the masterful memoir (actually a more elaborate version of [135]) with which JMMA was already thoroughly familiar at the outset of his illness. The focus of JMMA inquiry was [135], where the mood is that some simply connected branched coverings of S^3 might be counterexamples to the Poincaré conjecture.



With his characteristic persistence, JMMA introduced new techniques that allowed him to solve Fox's problem, that is, to show that all 3-manifolds produced with Fox's approach were homeomorphic to S^3. Loosely speaking, the core of the method relies on modifying the ramification of a branched cover of S^3 (without modifying the covering manifold) by means of what came to be known as *Montesinos' moves*, a procedure that has had many interesting applications ever since (v. [152]). With this, he could complete his doctoral thesis [1] toward the end of the 1970 Summer and read it the following year.

Consolidation

The completion of the thesis marked the beginning of a five-year period that was decisive to consolidate him as a researcher. The value of his work and ideas was soon recognized by first rank experts and as a consequence he gradually got in contact with them. It is enough to check the reviews of the papers published in that period, and who signed them, to realize that he was accepted (and perhaps even feared by some) as a new star in the field of low-dimensional topology.

The first important contact was with R. H. Fox, to whom he sent his doctoral memoir and the two subsequent papers he had published in volume 32 of the RMHA, [12] and [13]. The focus of [13] was the solution of Fox's problem, while [12] included two conjectures (A and B) that implied the Poincaré conjecture and that the Poincaré conjecture implied B. Fox reported about these works in his seminar at Princeton and then published the note [139], which cites the three mentioned works and in part is a summary of the thesis [1]. In addition, Fox proves a theorem that shows that conjecture A is false as stated and after some discussion proposes a modified form A' of A (adding a hypothesis of simple-connectednes) and a conjecture B' that has (at least to the eyes of a non expert) more of a new conjecture than a modified form of B. Jointly, A' and B' are equivalent to the Poincaré conjecture.

The next milestone was the publication of [14] and [15]. Of the latter, for example, the reviewer (H. E. Debrunner) says that it "is a fine piece of geometry, being specified throughout with interesting examples". It is an early recognition of a steady characteristic trait in his research: the balanced dialectical counterpoint between deep conceptual thinking and well chosen examples presented with the delicacy of a jeweler.

The doors were being opened. Laurent Siebenmann invited him to impart a one-month seminar in Paris mainly focussed on the last cited paper. Since then, the knots introduced there are known a *Montesinos' knots*. He also started a collaborative correspondence with Hugh M. Hilden, Joan S. Birman and Francisco J. González-Acuña. The collaboration with Hilden, often involving other coauthors (particularly MTLI), has endured unabated since the first joint paper in 1976 with an average of one paper per year. The collaboration with F. J. González-Acuña produced over half a dozen papers in the period 1978-1993, while Birman coauthored just two titles (in 1976 and 1980, the first also signed by González-Acuña).

L. Siebenmann, H. M. Hilden, J. B. Birman, and F. J. González-Acuña

JMMA had dreamt about working with Fox in Princeton, but sadly Fox died after his sixtieth birthday (1973). Part of the dream, however, came about to be true in other ways. The start was an invitation of Birman to publish a paper in the volume that was being planned in the memory of Fox [140]. The result was [20], which in the volume comes just after John Milnor's contribution. The technique introduced in that paper is known as *Montesinos trick* and it turned out to be very productive. In view of the quality and height of his inquiries, Birman proposed him to visit the Princeton IAS. He was accepted (by Milnor) and during the two-year stay (1976-1978) he met a good many of the geometric topologists, some working in high dimensions (like Milnor, Siebenmann, and R. D. Edwards), others in low dimension (like William Thurston, Yukio Matsumoto, Cameron Gordon, Andrew Casson and Ronald Fintushel), and with occasional visits by Robion Kirby and R. H. Bing. In JMMA's own words, "the solution of the Poincaré conjecture in dimension 4 was cooked there; we all attended Thurston's lectures; I was fortunate enough to absorb all this and by 1978 I was a new man".

J. Milnor, W. Thurston, Y. Matsumoto, C. Gordon, A. Casson, R. Kirby.

Full Professor

Upon returning to Spain, JMMA won a position at the University of Zaragoza, first as an Associate Professor (1979-1981) and then as a Full Professor (1981-1986). Officially, the term 1981-1982 he was a Full Professor at the Universidad Autónoma de Madrid, but actually it was arranged that he could continue in Zaragoza. The full year 1985 he was on leave with a position at the MSRI. Finally, since 1986 he is Full Professor at the UCM, where he holds the chair of Analytic Geometry and Topology.

MTLI

He arrived at Zaragoza just when MTLI had returned from a two-term stay as an Honorary Fellow at the University or Wisconsin-Madison. She had read her doctoral thesis in 1974, published a number of papers in K-theory, and raised a family with her husband Julio Abad, a theoretical physicist. Those two academic terms were somehow a slightly delayed postdoc that had the effect, basically due to the courses she took from Peter Scott, Paul Melvin and Jim Cannon, of getting her involved in low dimensional topology, and it was there and in this connection that she heard about JMMA

for the first time. The net effect was (cf. [152] about details of how neatly it worked out) that the mathematicians in Zaragoza welcomed warmly and enthusiastically the arrival of JMMA. In the first place, MTLI herself, who was ready to appreciate his thinking and contribute at the highest level with her own, but also Antonio Plans, José Luis Viviente, Elena Martín, Álvaro Rodés and Andrés Reyes.

JMMA taking possession of his first professorship.

JMMA was happy with the atmosphere he found and reciprocated by giving everything he could to the group and to each individual member. In addition to his own lectures, he invited many prominent researchers to Zaragoza, often several times, sometimes on sabbatical leave (like Hugh Hilden, Francisco González-Acuña, Louis Kauffman, Lee Rudolf, Hugh Morton, Kunio Murasugi, Jozef Przytycki, Claude Weber, ...), and this was a major contribution to the international recognition of the department. In Kauffman's book [144], for example, we read in the introduction:

> These notes on the theory of knots comprise an expanded version of a seminar held in the Departamento de Geometría y Topología at the University of Zaragoza, Zaragoza, Spain during the winter of 1984. Due to the *supernatural enthusiasm and persistence* of the members of the seminar, the author was given the energy to record a (we believe!) careful set of notes, and to relish the process.

This wonderful book is dedicated to the memory of Andrés Reyes, who died in an unfortunate car accident in 1984 in his early thirties. Incidentally, JMMA had been a mentor of Andrés and his book [3] is dedicated to his parents, as said before, but also to the memory of "mi amigo Andrés".

In all those years (1979 to today), the research interests of JMMA have diversified and become ever wider: manifolds of dimension 4, existence of universal knots and groups, arithmetic groups (the last two in collaboration with MTLI and H. M. Hilden), or open manifolds and wild knots. At present he is also dealing with questions concerning the degeneration of geometries (in collaboration with MTLI) and the automorphism group of quadratic forms.

Very often his works get excellent reviews and have good citation records. Already in 1985, at the end of his period in Zaragoza, with two thirds of his production still in the future, the treatise [142] cites a dozen works for wich he is a single author and seven more for which he is a coauthor (one with Birman, three with González-Acuña and three with Hilden), only below Fox (29 citations) and Murasugi (30 citations).

One important aspect of JMMA's academic life has been advising students for their doctoral research. The following list summarizes the information about those he has advised: the year in which it was read, the name of the student, the title of the thesis and the university in which it was ascribed.

1979

- Lucía Contreras Caballero: *Esferas homológicas* (UCM)
- José Manuel Rodríguez Sanjurjo: *Teoría de la forma* (UCM)

1984

- Valerio Chumillas Checa: *Cubiertas dihédricas* (UCM)
- Antonio Félix Costa González: *Representación de 3-variedades mediante cubiertas* (UCM)
- Carmen Safont: *Sobre cubiertas ramificadas* (UZ)
- Leopoldo Villarreal Sáez de Urabain: *Recubridores localmente cíclicos* (UCM)

1990

- Milagros Izquierdo Barrios: *Estudio de subgrupos de grupos de caleidoscopios no euclídeos que son grupos de superficies* (UZ, codirigida por MTLI)

1994

- Alberto Borobia Vizmanos: *Matrices no negativas* (UNED)

1998

- Eva Suárez Peiró: *Poliedros de Dirichlet de* 3*-variedades cónicas y sus deformaciones* (UCM)

2006

- Rubén Vigara Benito: *Representación de* 3*-variedades por esferas de Dehn rellenantes* (UNED)

Collected works

Looking at JMMA's work so far, we first notice that he is the single author of more than half of the publications bearing his name. As we can see in the references, this includes four books (among five), the five memoirs, the ten articles, and over fifty papers. If we take into account the extension, this represents well over sixty percent of a total of nearly 3300 pages. In fact, if we imagine all the materials arranged in volumes, we could easily arrive at six quite large books of which two would be devoted to the publications with at least one coauthor.

The creative power required for these accomplishments is apparent through all his career. It can be seen in a most pure state in his doctoral thesis, which looks as if it blossomed out of a few lines from [137] (our emphasis):

> In 1920, Alexander showed [Note on Riemann spaces, BAMS 26, 370-372] that any orientable n-manifold Σ is a branched covering of S^n, and that, furthermore, when $n = 3$, the branching may be assumed to take place over a tame link L in S^3 and to have branching index ≤ 2 everywhere on Σ. Alexander makes this last statement without proof, but if follows from results obtained last century by **Clifford** [On the canonical form and dissection of a Riemann's surface, PLMS 8 (1877), 292-304]. Alexander's theorem, therefore, makes it reasonable to search among the branched coverings of S^3 for simply connected 3-manifolds. It turns out that one can find bushel baskets of them this way. *No doubt most of them, and* ***possibly all****, are actually* S^3*, but I have never had the patience to verify this except for the one simple example of the* 3*-fold irregular branched covering of the trefoil.*

Further witnesses for this view, and also for the originality and independence of his thinking, are the reviews of his early papers (like [15], already commented before, [17], or [20]) and by the fact that they count among the best cited in the field. We may include on this count the book [3]. As declared by the referee (R. Fenn, but my emphasis):

> Incidentally, for the benefit of Hispanophiles, this book produces photographic evidence ***once and for all*** *that all 17 plane symmetry patterns appear in the Alhambra.*

But JMMA has carried out (and carries) collaborative work with a number of researchers. From the well over two thousand pages of the 111 papers in the references, about 55 percent belong to works with at least one coauthor. Among the coauthors, there are two that stand out far above all others: MTLI and Hugh Hilden. They appear as coauthors of about 36 and 30 percent of those pages, respectively (counting papers, the order is the other way around: 34 and 40, respectively). Actually, the coalition HLM (Hilden, Lozano, and Montesinos) has signed 28 papers that in pages add up to 28 percent (see 40-42, 47, 48, 55, 60, 66-69, 71 75-79, 81, 83-85, 92, 94, 98, 100, 106, 108, 114]). Since these are being considered in [152], here we will just note two comments on the significance of a few of them, and in particular [56] (one of the two papers of JMMA bearing Whitten's signature, the other being [52]).

In the historical notes to the last chapter of [146], a chapter devoted to geometric orbifolds (in Spanish, JMMA calls them *orbificies* when seen as topological objects and *caleidoscopios* when they have geometric structure), the papers [66] and [67] are cited, together with papers by Weber-Seifert (1934), Meyerhoff (1985), and Adams (1992), "for some interesting examples". And then we find the following paragraph:

> It is an interesting fact due to Thurston that every closed orientable 3-manifold has a hyperbolic orbifold structure. In fact, every closed orientable 3-manifold is an orbifold covering space of the hyperbolic orbifold in Example 5 [based on a regular hyperbolic dodecahedron, as explained on page 703]

and as a reference the author gives [56]. This paper was reviewed by V. G. Turaev, giving a clear picture of that example, and stating that "this theorem offers *a new approach to the Poincaré conjecture*" (my emphasis), which perhaps may still be

perceived as an opportunity for those that are not completely blinded by Grigory Perelman's great success early in the current century.

Similarly, in [145], and again in relation to orbifolds, we find that (my emphasis)

> A classification of simply-connected orientable three-dimensional compact orbifolds admitting geometric structures other than hyperbolic can be found in Dunbar [1988]. In this connection, the following *quite amazing result* of Hilden, Lozano, Montesinos and Whitten [1987] should be mentioned: there are discrete groups Γ of motions of the space $\mathbb{H}^3$ (called universal) such that any orientable three-dimensional compact manifold is homeomorphic to $\mathbb{H}^3/\Delta$, where Δ is an appropriate subgroup of finite index in Γ (whose action is not necessarily free).

The 1987 cited paper is again [56].

Going down our (quantitative) collaboration scale, we find Francisco González-Acuña (alias Fico), on one hand, and Débora María Tejada and Margarita María Toro Villegas (TT), on the other. Fico coauthored seven papers in the period 1978-1993 (77 pages): [27, 35, 36, 39, 70] as a sole coauthor (52 pages), and [23] and [54] (25 pages), that are also signed by Birman and Boileau, respectively. The paper [27], published in AM, exhibits 2-knots that have infinitely many ends and so it answers affirmatively the last question posed by Fox in [136] (Problem 40). In paper [39], a quasiaspherical n-knot K in S^{n+2} is constructed having infinitely many ends, thus disproving a conjecture of J. G. Ratcliffe. Paper [70] is outstanding for its technical virtuosity in providing an 'elementary' deduction of the equations defining the character variety of group representations in $SL(2,\mathbb{C})$. JMMA's esteem for Fico can be appreciated at length in [127], and also in the dedication of [117] ("Dedicado con agradecimiento y afecto a Fico González Acuña en su septuagésimo cumpleaños").

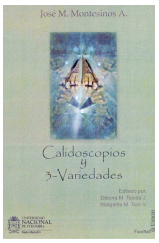
D. Tejada and M. Toro.

The researchers TT appear as coauthors in the period 2004-2012: they sign the six papers [95, 96, 99, 101, 110, 111] (124 pages), jointly with Hilden, and the two papers [104, 105] (39 pages), which are also signed by G. Brumfiel, MTLI, Ramírez-Losada, and H. Short. These works offer interesting results on a number of topics, but appear as somewhat technical to the non expert. An interesting exception may be [110], for we read in its summary:

> It is well known that there are 17 crystallographic groups that determine the possible tesselations of the Euclidean plane. We approach them from an unusual point of view. Corresponding to each crystallographic group there is an orbifold. We show how to think of the orbifolds as artifacts that serve to create tessellations.

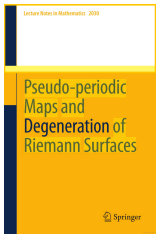
The collaboration of TT with JMMA began with the visits that he made to Medellín (Colombia) in 1995 and 1997. The invitations came from the "Grupo de

Investigación en Matemáticas" that TT had started. One early and important fruit of the lectures and courses that he taught there was the book [4], which roughly speaking is an introduction to the theory of orbifolds, a notion introduced by THURSTON in his Princeton lectures (1976-1977).



In the preface of the book, after explaining the importance of the concept of orbifold, JMMA says: "... and so, when I was invited to give a course of lectures in Medellín, I went with the idea of popularizing it". He found an enthusiastic group of participants, including TT, who took up the job of writing and polishing the text using JMMA's notes, and the students, that drew the figures with great care (there are dozens of them in numbered series and a great many that appear interspersed with the text with no numbering).

It is a pity that this book is not yet translated into English and that thus it is perhaps not as known as it deserves.



Of the remaining coauthors, YUKIO MATSUMOTO deserves a special consideration. He is the coauthor of papers [63, 74] and of the book [5]. Paper [63] provides a detailed proof of a statement on orbifolds phrased by THURSTON in his Princeton lectures that is closely related to his geometrization conjecture (although now settled by PERELMAN, it still makes a lot of sense to look at THURNSTON's classic [148]). On the other hand, the writing of the book [5] was essentially "completed in December 1991, and some remaining additional parts in January, 1992" (2009 addenda to the Preface). The main reason for the nearly twenty years delay in its publishing was "the author's inability to use Tex" (*ibid.*). Because of this, the paper [74] now appears as a harbinger of the book. On the whole, the main points are the classification of the topological types of degenerate central fibers of holomorphic families of closed Riemann surfaces of genus $g \geq 2$ over the unit disc and the extension of NIELSEN's invariants to a complete set of conjugacy invariants for the pseudo-periodic homeomorphisms of negative twist.

Taking possession of his numerary seat at the RAC (1990). Left: with his father, Lorenzo. Right: reading his discourse.

A substantial part of the scientific and academic life of JMMA has revolved around the RAC. After taking the position as a Full Professor at the UCM, he was invited to give a lecture at the RAC. He chose the topic *Orbifolds in la Alhambra* (Caleidoscopios en la Alhambra) and subsequently he published it as the RAC memoir [8]. It is the year in which the book *Classical Tesselations and Three-Manifolds* [3] and the Inventiones paper *On universal groups and three-manifolds* [56] were published. The memoir is remarkable in many ways. In the epilog, he refers to the results in [56] and indicates what we have already commented before, namely,

that they provide a new (geometric) tool to attack the Poincaré conjecture. Appendix A is devoted to describe in detail a set of color pictures of mosaics in la Alhambra, thereby showing that all 17 plane crystallographic groups were known to the Nazari artists. Interesting details about who and how the different forms were discoverd, with due regard to the last one to be found (the elusive $D\bar{3}\bar{3}\bar{3}$) is provided in appendix B.

Although JMMA had been nominated as a RAC corresponding member in 1986, his next memoir published by the RAC is [9], which contains the discourse he read on the occasion (1990) of his accepting the nomination as a numerary member and a semblance piece (Discurso de Contestación) by José Javier Etayo Miqueo. As remarked by Etayo, it was the first time that Topology as such was incorporated in the RAC compass. In that solemn moment, JMMA summarized his intentions as follows (*ibid.*, page 9; emphasis in the original):

> The common thread will be the *Low-dimensional Topology*, a science that studies knots and manifolds of dimensions below five. The use of this name, Low-dimensional topology, began in the late seventies, but as a field it started long before. It was cultivated by figures as important as **Euler**, **Gauß**, **Riemann**, **Klein** and **Poincaré**, and by many others in the current century. But it was not until the year 1976 when this new science experimented an exceptional development, if not a complete revolution. A North-American mathematician with training in differential geometry, **W. Thurston**, began to use geometric methods that supplied a new impulse to the field. It is my intention here today to talk about these new methods and ideas.

In the academic term 1996-1997, JMMA was invited by the RAC to deliver the inaugural address. It was read on the 16th of October, 1996, and published as the RAC memoir [10]. The occasion was challenging, for it was expected that the speech should be accessible to a wide audience. The solution he adopted (to talk about the Poincaré problem) was to use a humorous cartoon-like verbal encoding just after testifying that

> it is a good lesson, that every scientist must learn, of how to communicate his knowledge in plain and understandable language for all.

As pointed at by the title, this memoir is an interesting essay on (some aspects of) the unity of mathematics, on the counterpoint between the finite and the infinite, between the discrete and the continuous. I am glad to say that Jaume Aguadé managed to capture faithfully the memoir style and content in his translation into Catalan that was published in 1997.

There are three more works published in the context of activities organized by the RAC aimed at more or less general publics. Two are about the history of geometry ([65] and [73]) and one about geometric crystallography [86]. They are included in the papers section because, as is the rule with JMMA, the reader will always find new poits of view, new ideas, new questions and often also new results.

Finally there are three recent papers published in RACSAM that seem to signal a new trend in his endeavor to contribute to the RAC mission: [103], [119] (joint with MTLI), and [120]. These papers are also special because they are focussed on new and promissing research lines.

Concluding sketches

The memoir [6] won the Prize of the RAC, but is was never published, apparently because it was too long (125 pages). Retrospectively, it seems clear that it was a pity. Taking as a starting point [137], the paper that had inspired his doctoral thesis, in the preface we read (our emphasis) that it:

> soon originated important researches on the topology of coverings that are branched along a link in S^3, and the aim of this memoir is to present *the part of these researches that is purely geometrical and in which we have obtained results or set forth some conjectures.* As a method for the description of results we adopt the different representations of the closed orientable three-dimensional manifolds, namely Heegaard's representation, the Dehn–Lickorish representation by means of surgery, and Alexander's representation using branched coverings. In our view we thus follow a geometrically logical sequence, which does not coincide with the historical unfolding. We omit proofs that involve an excessive algebraic machinery, and which otherwise can be found in the references at the end of the memoir. Instead, *some of the results are presented in a completely new fashion.* Finally, we illustrate the proofs, which are constructive for the most part, with *examples that are published for the first time.*


MOUVEMENTS JAMBES DE NOEUDS, (1)
ESPACES FIBRÉS DE SEIFERT ET MOUVEMENTS DE NOEUDS

par

José Maria MONTESINOS

Notes pour une suite de conférences données à ORSAY au printemps 1976, rédigées avec le concours de plusieurs membres de l'auditoire.

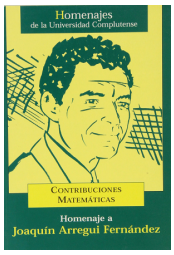
Il s'agit d'une version préliminaire d'un texte à paraître dans un futur numéro d'Astérisques, consacré aux dimensions 3 et 4.

The memoir [7] was written by participants in the Spring 1976 Siebenmann's seminar at Orsay. JMMA was the speaker and the main focus of his lectures was, by the invitation agreement, the paper [15]. The papers [23] and [26] were also important. Michèle Audin and Francis Bohahon wrote a first version of the notes under the supervision of JMMA and in the year 1978 Siebenmann supervised a second version prepared by Michel Boileau and Yves Lemaire. Anyway, at the foot of the cover page we are told that it is a preliminary version of a text to be included in a future issue, devoted to dimensions 3 and 4, of the Astérisque collection (launched in 1973) of the French Mathematical Society. Regrettably, this publication did no happen and so this work has been, for all practical purposes, out of circulation ever since. It is the birth of Montesinos' links, a class that has remarkable ties with the Seifert fibrations, and, as indicated on page 31 (a note added by Siebenmann), "the main theorem [in the first chapter] has given rise to many other theorems that we omit for lack of time, and several among them have been discovered after these lectures".

As many others in his generation, JMMA's very early works were written in Spanish: The thesis [1], the papers [11]-[16], and the memoir [6] considered a moment ago. Then, starting with [17], he followed the trend of switching to English for the greatest part of his publications, particularly in the case of papers (96 out of 111), but with a number of important exceptions that can be tallid as follows: the books [2] and [4], which were born from visits to Mexico and Colombia, respectively; the memoirs other then [7] (this one in French, for the reasons already explained), which were produced in the context of RAC activities; the articles, whose general aim is to popularize some aspect of geometrical topology and its applications (but note that [123] appeared as a

translation into Catalan and that [127] is a personal appreciation of Fico); the paper [33], included in the proceedings of the VII Spanish-Portuguese Mathematics Meeting; the Lecce (Italy) lecture [61]; the papers [65], [72] and [73], that are contributions to RAC projects ("History of mathematics in the XIX century", for the first two, and "Cultural horizons: the frontiers of science", for the third); and three more papers that we consider in next paragraph.

When the occasion has arisen to honor a teacher or a colleague, which usually happens in connection with some special birthday, as a rule JMMA has contributed with what he thinks is the only appropriate answer: a research paper. According to the references, the first two such occasions were the seventieth birthday of Luis Vigil Vázquez (1914-2003) and Francisco Botella Raduán (1915-1987), celebrated in 1984 and 1985, respectively. For the Vigil fest, he proposed a revision of the methods used to "'recognize S^3 from a Heegaard diagram" and an analysis of why they fail "for manifolds different from S^3". This paper was translated to English and published as [57]. In the case of Botella, he presented a different proof of a result of Sakuma. This paper can also be read in the original Spanish (included in a volume edited by E. Outerelo) and in English [53]. Next came the paper [62], this time in Spanish, dedicated to Antonio Plans Sanz de Bremond (1919-1997). It is a summary of a lecture JMMA imparted in 1986 at the UCM whose aim was to discuss the state of the art about conjectures relating the Heegaard genus of a 3-fold and different notions of rank. This was in part based on his paper [51].



The next three in this group are dedicated to three of his former teachers at the UCM and Faculty colleagues since 1986: [72], to José Javier Etayo Miqueo (1926-2012), in Spanish; [82], to Joaquín Arregui Fernández (1930-2012), in English; and [93], to Enrique Outerelo Domínguez (b. 1934), in Spanish. In the case of Etayo, he presented "the visual model of hyperbolic geometry", one of the aspects of his inquiries into that geometry, clearly related to activities in the RAC at that time, like [73]. The summary of the Arregui paper, reproduced by the MR, is a very clear description of his contributions (our emphasis): "Let M be a closed orientable 3-manifold. A *Dehn sphere* S is a 2-sphere immersed in M with only double curve and triple point singularities. S *fills* M if S defines a cell decomposition of M. *It is proven that every closed orientable* 3-*manifold has a filling Dehn sphere. Examples are given, and Johansson diagrams are proposed as a method for representing all closed orientable 3-manifolds*". The Outerelo paper got an excellet review (by D. Matei), but the English summary is perhaps the shortest description of its contents (our emphasis): "The fundaments of Fox's branched covering theory are *freshly exposed using inverse limits. Sufficient conditions for a branched covering to be onto, or open, or discrete are given. An example of a branched covering over* S^3 *with a nondiscrete fiber is constructed*". In the final part of his review, Matei adds: "A few intriguing open problems end the article: Are there non-surjective or non-open ramified coverings? Is there a ramified

covering with a fiber homeomorphic to the Cantor set?".

More recently, in this honoring trend, it is the turn of colleagues of similar age or younger. The first in this series has been [112], dedicated to Juan Tarrés, and it will certainly continue with other names. H. M. Hilden published a nice review of the Tarrés paper, but again the summary is concise and to the point (our emphasis): "Under the framework of Fox spreads and its completions, a theory that generalizes coverings (*folding covering theory*) and a theory that generalizes branched coverings (*branched folding theory*) is defined and some properties are proved. *Two applications to* 3*-manifolds theory are given. A problem is stated*".

In addition to all the dedications we have mentioned, there are a number of other papers, sometimes joint papers, that are dedicated to a distinguished mathematician, again usually on the occasion around a special birthday. It is to note that this did not happen until JMMA had well established his international reputation in his specialty. The first was [44], dedicated "To Professor Arthur Stone" (Stone celebrated his seventieth birthday in 1986). Among the score of others, we mention here those professors that seem to occupy a more prominent place in JMMA's constellation: Deane Montgomery [52]; Joan S. Birman [58]; Tatsuo Homma, in his fifth Jupiterian year [63]; Yukio Matsumoto on his 60th birthday [88]; Laurent Siebenmann [90]; María Teresa Lozano Imízcoz, after 27 years of fruitful collaboration [102]; José Manuel Rodríguez Sanjurjo, in his 60th birthday [113]; Jozef Przytycki, in his 60th birthday [122]. There is also one that has a more personal meaning: "en recuerdo de mi padre, Lorenzo Montesinos" [87].

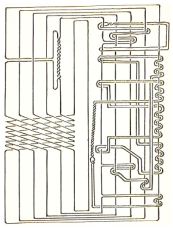
We have seen that a fraction of JMMA's works have been published in Spanish, even after switching to English as the main disseminating language. As it should be clear by what we have said so far, this has more of a personal option than of a constraint, for such works would no doubt have been accepted by good English journals. A similar comment can be advanced about the journals where his papers were sent. In fact, it is again easy to perceive in his production a laudable determination to support a variety of journals by sending them papers that would have no problem in being published in main stream English journals. Here are the main examples concerning journals published in Spain, Mexico and Colombia: BSMM [15, 94, 97, 104, 117, 118]; RACSAM [103, 119, 120]; RMHA [12, 13, 14]; RMUCM [87, 88, 90]; *Revista Colombiana de Matemáticas* [99, 102, 111]; *Collectanea Mathematica* [16, 40] and *Revista Academia Colombiana Ciencias* [96].

The ties of JMMA with Mexico and Colombia, not unlike those of many other country fellows for these and other Latinamerican nations, involve a deep emotional realization that he has expressed in words as follows ([4], Preface):

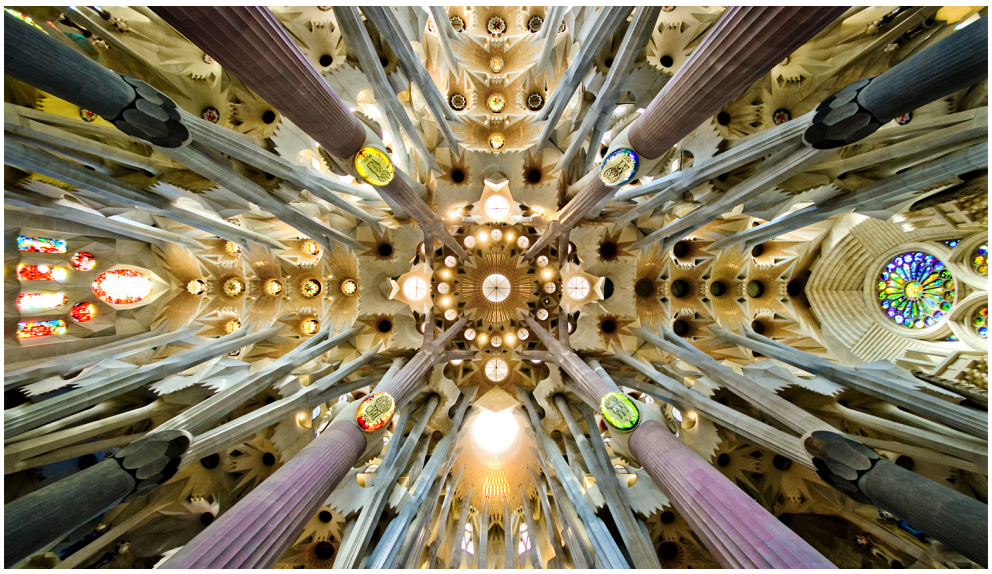
> The outcome and the development of the lectures were literally terrific: I was left open-mouthed on realizing the enthusiasm of the participants. There is in these dear people from Colombia and Iberoamerica something that we no longer have in the Old World and that is renewed each time one travels there. This 'something', very hard to explain, is a living reflection of its transparent skies and of the beautiful colors of the hummingbirds and flowers; of wonderful fruits.

> The friendship, endearing and warm; the faith, simple and strong, engine of hopes and forgiveness; the illusion for new worlds. It is enough to read their poets, if one is not there, or to converse with the people if you are lucky to be among them.

The papers and books of JMMA include many hundreds of pictures, usually drawn by his own hand. We have seen this in the case of the books [4], but we could take any other work, as for example the book [3], which has more than two hundred illustrations (counting numbered figures and graphics in tables). This profusion of graphics seems to be true, but perhaps to a lesser degree, for all low-dimensional topologists. In any case, such pictures form an integral part of how JMMA unfolds his thoughts and arguments. The drawings, and the mathematics behind them (particularly the subtle relations between the knots and the corresponding manifolds), point to an remarkably developed visualizing ability, an inner (mathematical, topological, geometrical) eye that seems utterly impossible to imagine by those lacking it.



On looking at such drawings, like the 'universal knot' in the image (Figure 23 in [48]), JMMA, and in general the low-dimensional topologists, somehow remind me of Antoni Gaudí. He was also endowed with a powerful visionary inner eye and his Sagrada Familia is to a large extent a geometrical monument. Thus there is some mathematical kindship with La Alhambra, the monument to which JMMA has devoted beautiful pages [3, 8, 124, 125, 128].



When people were expressing their astonishment at Gaudí's creativity, materialized in a panoply of forms and designs not yet organized in a whole, he always advised

them to be patient, and then stated that "there will come folks from around the world to see them". Works such as those of JMMA, past, present and future, also require patience from the rest of us, but I am sure that there will come a time when mathematicians will feel the need, as this writer does, to learn more about it.

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In the works authored by JMMA, a pointer to the MR is included whenever the corresponding review exists and is signed. With more that 110 reviews, their printout (including references) has over 75 pages.

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Acronyms

AM	Annals of Mathematics
AMS	American Mathematical Society
BAMS	Bulletin of the American Mathematical Society
BLMS	Bulletin of the London Mathematical Society
BSMM	Boletín de la Sociedad Matemática Mexicana
CJM	Canadian Journal of Mathematics
ELAM	Escuela Latinoamericana de Matemáticas
GTM	Graduate Texts in Mathematics
IAS	Institute for Advances Study
JKT	Journal of Knot Theory and its Ramifications
JLMS	Journal of the London Mathematical Society
JMMA	José María Montesinos Amilibia
LMS	London Mathematical Society
LNiM	Lecture Notes in Mathematics
MPCPhS	Mathematical Proceedings of the Cambridge Philosophical Society
MSRI	Mathematical Sciences Research Institute
MTLI	María Teresa Lozano Imízcoz
PAMS	Proceedings of the American Mathematical Society
PJM	Pacific Journal of Mathematics
PLMS	Proceedings of the London Mathematical Society
RAC	Real Academia de Ciencias Exactas, Físicas y Naturales de Madrid
RACSAM	Revista de la RAC, Serie A, Matematicas
QJM	Quarterly Journal of Mathematics
RMHA	Revista Matemática Hispano-Americana
RMUCM	Revista Matemática Complutense
TAMS	Transactions of the American Mathematical Society
UAM	Universidad Autónoma de Madrid
UB	Universitat de Barcelona
UCM	Universidad Complutense de Madrid
UNED	Universidad Nacional de Educación a Distancia
UZ	Universidad de Zaragoza