The *Portuguese connection* of José Gallego-Díaz

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Abstract: This essay is dedicated to the life and scientific endeavour of José Gallego-Díaz, a Spanish mathematician and engineer whose career was developed between the early 1930s and 1965 in three different political and social environments: The Spanish Republic and the civil war; then Franco's dictatorial regime from 1939 until 1956; and finally in the Americas. Although a leftist politically involved in the first two stages, regardless of political regimes he was able to produce a body of mathematical ideas and applications which was a breakthrough in the Spanish mathematical panorama, not too prone to applied Mathematics in those times. In the pre-civil war years Gallego-Díaz contributed to Mathematical Biology when this discipline was in its infancy, and after the war he contributed some original studies in the mathematisation of certain fields of economic theory, whose results were published in the Portuguese journals *Revista de Economía,* and *Gazeta de Matemática*, of the Sociedade Portuguesa de Matemática. He was an uncommon teacher who enjoyed problem proposal and elegant solutions, and in addition he often wrote on very different fields, leaving behind him an abundant collection of notes, reviews, recensions, and other materials of non-mathematical nature.

keywords: Applied Mathematics. Economic Theory. Franco regime. Mathematical Biology. Portugal. Problem solving. Spain.
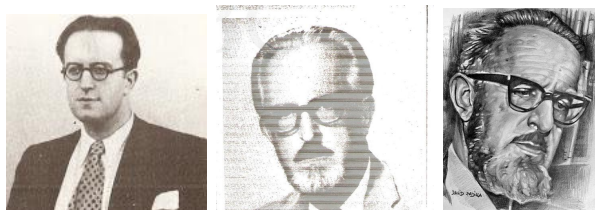
1   Introduction

José Gallego-Díaz Moreno (1913-1965, henceforth, Gallego) was an engineer, mathematician, and economic theorist who enjoyed a rich personal life: he read for –and obtained– three different degrees, published a lot, performed experiments, traveled through Europe and the Americas, made incursions in politics, acted as an uninhibited observer and criticist in the hardest times of the Franco regime, and eventually was recognised in his native Spain

and abroad as someone with an enormous potential that could not be duly developed due to his rather early death.

If it were possible to classify Gallego, he would have been an applied mathematician with broad interests in engineering and in other application-prone mathematical fields, but also an outsider in Spanish Mathematics, where interest in applications was rather small in the mathematical school led by Julio Rey Pastor (1888-1962) before the civil war, and by his succesor Tomás Rodríguez Bachiller (1899-1980) in the 1940s. Although a brilliant mind, Gallego was excluded from the official mainstream of Spanish Mathematics, thus being an example of interior exile until the first 1950s. Mathematically speaking, he was above all a problemist with a tendence to understand life –not only its scientific aspects– as a succesion of problems and attempts to solve them, although he was fond of closed and elegant solutions. There exists a short biographical essay on him (Lorenzo 1987), and another more recent sketch (Guerrero 2001) with no Mathematics in it.

The present study is based on the contrasted hypothesis that there existed a clear continuity across the civil war in Spanish mathematical affairs and their European international connections. This state of things was maintained until the early nineteen-sixties, when the American influence eventually became the rule in most West-european Science (Pacheco 2014). A second point of interest is an analysis of the role of social extraction and formation years of Gallego, and their impact in the post-civil war years and on his personal and professional fate. Primary sources have been his papers and books. As secondary sources, especially for most personal details, in addition to the two just cited biographical items, a review of the leading Spanish newspapers *ABC* and *La Vanguardia* between 1930 and 1970 has been most helpful.

The paper is the structured as follows: to start, a general biographical section followed by a first subsection covering the pre- and civil war years, and a second one devoted to the 1940-1965 period; then an overview on Gallego's Mathematics with three subsections dealing with the various fields to which he contributed, *viz.* Mathematical Biology, economic theory, and books and problems, including some interests in Science Theory. Three basic conclusions are offered to close the article. A detailed catalogation effort of the many items authored by Gallego and spread in minor journals and periodicals is outside the scope of this work.

Left: José Gallego-Díaz Moreno as a young man. Center: In his forties, as portraited in his obituary in *ABC*, February 18th 1965, p21. Right: a recreation by the artist David Padilla (`http://estudiodavidpadilla.blogspot.com.es/2010/07/jose-gallego-diaz-para-presencias.html`)

2 Biographical details

Gallego was born at Úbeda, in the Andalusian province of Jaén, a son of the lawyer, economist, academician, and politician Rafael Gallego-Díaz (1880-1939), a member of a well considered catholic family in a good cultural and social environment with some aristocratic connections. The father was an active person who had participated in many initiatives and negotiations, he had been elected *diputado en Cortes* as a representative of the liberal Party, and also appointed *Gobernador Civil* in two provinces: his native one, and then Zamora. In the meantime he had had time to make a failed attempt to a university chair on Political Economy, to write on historical and economic topics, and to prepare a translation of the thick three-volume History of the French Revolution by Albert Matthiez. He ceased his political activity when the Spanish Republic was proclaimed in 1931, and died shortly after the end of the civil war. His death is recorded in the nobility catalogue (Mayoralgo 2013).

Therefore, Gallego had an education where family connections and the home library played an important role, so no wonder that he became an esteemable writer as observed in his broad production –including some poetry–, and it seems reasonable that this familiar influence had to do with his interest on economic problems from the mid-1940s onwards. A contemporary and friend of Gallego born in the same province, the mathematician Antonio Flores (1913-1992) had studied in Vienna and was the son of the economist Antonio Flores de Lemus (1876-1941), a prominent a very influential person close to the power areas in the 1910s and 1920s. In addition to their common scientific interests, Gallego and Flores embraced republican attitudes in the 1930s, and after the civil war both were forced to live in the outskirts

of the official mathematical Spanish panorama, that otherwise presented a clear scientific continuity with the pre war one.

Agriculture being in those times the most relevant economical activity in his native city and its neighbourhood, it may be taken for sure that it had some weight in the decision to move to Madrid in order to read for a degree in Agronomy, or *Ingeniero Agrónomo*. To enter the Spanish engineering schools, inspired in the French model, an entrance examination demanding a mastery of classical Mathematics and Mechanics was needed, and this his how Gallego contacted the mathematical group of Julio Rey Pastor.

2.1   The pre- and civil war years, and a *Soviet connection*

Gallego's early career is an amazing one. On starting the Agronomy studies, his mathematical inkling was such that at the age of twenty he was already acting as an editor, problem proposer, and solver, in the journal *Matemática Elemental* of the *Sociedad Matemática Española* (SME). Moreover, by 1934-1935 he performed at the engineering school some experiments on the alcoholic fermentation phenomenon, where he tried to adapt contemporary work in mathematical Biology by Vito Volterra (1860-1940) and Vladimir Kostitzin (1883-1963). This piece of research he most esteemed for a long time, for Gallego was still writing on the topic twenty years later in the journal *Agricultura*, published by the Agriculture Ministry under the Franco regime.

For a short time during the civil war he was in charge of some official responsibilities in the Agriculture Ministry of the republican zone headed by the communist Vicente Uribe (1887-1961), a fact that surely helped him and a few other enthusiasts to contribute to the survival of the SME and its flagship journal *Revista Matemática Hispano Americana* (series III) through the war years. Among them were José Barinaga Mata (1890-1965) and Tomás Rodríguez Bachiller, see (González Redondo 2011). Later, Gallego acknowledged Barinaga as a notable influence on him. In the war years he even published a short note summarising his findings on alcoholic fermentation theory in the Soviet journal *Bulletin of Experimental Medicine and Biology*, where he is identified as J. G. Diac, member of a so-called *Institut prykladnyj issledodovaniy* or Institute of Advanced Research –seemingly a tentative joint translation of the names of Spanish funding agencies – (Diac 1937). To our knowledge, this is the only paper published by a Spaniard in that journal in those times. The *Bulletin* is still published with the same name.

2.2 1941-1965, under the Franco regime

Once the war was over, and after his father's death, Gallego is again in Madrid in 1940-1941 at the learned society *Ateneo de Madrid*, and studying to complete three degrees: Mathematics (known in Spain as *Ciencias Exactas*) and Chemistry, and then his Agronomy studies. Moreover he collaborated from the very beginning in the post-war journal *Euclides*, see below. The political depuration process carried over by the Franco regime does not seem to have been very hard with him, a former member of a republican Ministry headed by a communist. In all probability, his family connections must be credited for this rather indulgent treatment. The conservative newspaper *ABC* published for several consecutive years short condolence notes on the anniversary of Rafael Gallego Díaz' death.

In *Euclides*, Gallego was a fixed contributor for years from 1941 onwards in various topics, mathematical and not. For instance, most of the cultural notes, book recensions, and social chronicle on science talks in Madrid were his in the first issues, as well as many problem proposals and solutions. This periodical was continued until the early 1960s, and in its first years was a tolerated outlet for scientific production of a number of people who in a first instance had not been considered as politically reliable and could not access the *Revista Matemática Hispano Americana* (series IV) from 1940 onwards. On obtaining his degrees, Gallego was hired to teach Probabilities and Geometry between 1943 and 1945 at the Agronomy school, and he was eventually awarded a doctorate in Mathematics in 1945 advised by the mathematician and economist Olegario Fernández-Baños (1886-1946), one of the first members of the Rey Pastor group who had worked for a long time for the Bank of Spain, a post he could not recover after the civil war. Gallego's dissertation had the title *Sobre las hipótesis que sirven de fundamento a la Economía Matemática* –clearly a wink to Riemann's 1854 Habilitationsschrift *Über die Hypothesen, welche der Geometrie zu Grunde liegen*– where he attempted to establish a sort of axiomatisation for economic analyses on a non-euclidean framework. Therefore, by 1946 his academic curriculum was already complete, and in the dark and shabby Spanish mid 1940s, he left the Agronomy school to work at various private academies by coaching students intending to enter engineering studies through the preparation of the Mathematics and Physics examination. Though a demanding job, it was well paid and helped Gallego to buy books and journal subscriptions for the next years. Quite a number of engineers who were his pupils have written reflections and sketches of him in his activity as a mathematical coach. He appears as a prominent figure in one of the stories –*Barojiana*– of a
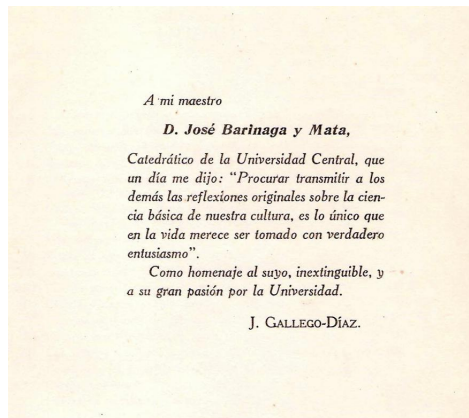
semi-autobiographic recopilatory book by the writer and civil engineer Juan Benet (1927-1993), who was among the coached students and later became a friend of Gallego (Benet 1987).

Between 1945 and 1950 Gallego was a close friend of Cirilo Benítez Ayala (1917-1950), an engineer with whom he shared teaching at various academies as well as an approach to the neomarxist circles of an incipient inner opposition to the Franco regime. Ten years after Benítez' death in a railway accident, Gallego was to remember him in the dedication of a paper on the future of Mathematical Biology published by *El Museo Canario*, a periodical still published at Las Palmas (Canary Islands), the native city of his friend: this paper is the only one dealing with Mathematics ever published in the journal history. He also contributed to this periodical with a few book recensions.

During 1950 and 1956 Gallego traveled privately all over Europe, meeting mathematicians and other scientists, *e.g.* the Soviet mathematician Kolmogorov in Paris, and a number of Americans, and also prepared the access to a chair –in Physics, obtained in 1955– at the Agronomy school. He even had time enough to be a most conspicuous element in some Madrid cultural areas. In addition to the already cited portrait by Benet, a cameo of Gallego appears in min. 12 of the already classical 1955 film *Muerte de un ciclista* [tu.tv/videos/muerte-de-un-ciclista_1] of the renowned Spanish director Juan A. Bardem (1922-2002), a tolerated communist himself.

According to Benet and other sources, Gallego did never hide his leftist sympathies. See *e.g.* in Hernando 1986: *José Gallego Díaz, imaginativo, extrovertido y un tanto bohemio, Catedrático de Física en los años 50 en la Escuela de Agrónomos, a quien quizá por su bohemia no tomábamos muy en serio su militancia ni sus manifestaciones confidenciales sobre la colonización rusa como salvación de España, fruto quizá de su admiración por los matemáticos soviéticos*; and in *El pintor Díaz Caneja* of Benet 1987: *... a excepción de Gallego Díaz, al que se le perdonaba su filiación* (*i.e.* being a communist) *porque además de matemático era todo él un puro disparate.* In any case, he was immediately suspected of being somehow involved in the 1956 student revolt that triggered a deep political reorganisation in the Spanish regime (Mesa 2006). The episode prompted Gallego to leave Spain, which he did by travelling to the US, but it is unclear how he was allowed into the country, still in the wake of the anti-communist phobia of the McCarthy years. Once there he visited a number of universities: he is found at Madison (Wisconsin), where after a series of talks by the economist Martin Bronfenbrenner (1914-1997) he lectured on his mathematical economic

theories; then, funded by the Ford Foundation he was a participant in the famous Stanford 1957 *Summer Institute on the Applications of Mathematics to the Social Sciences* (June 24th -August 17th). Surprisingly, in a sort of political recognition, the Spanish newspapers informed at length on this tour, writing about *el distinguido y prestigioso matemático español Gallego-Díaz...* He was appointed member of the American Mathematical Society by Vanderbilt University (Nashville, Tennessee) in 1958, and the same year the Universidad de Puerto Rico at Río Piedras hired him, so in 1959 he resigned his chair in Madrid and then moved in 1960 to Venezuela, where he worked in the implementation of Agronomy studies at the Universidad del Zulia in the western province of Maracaibo. Eventually, funded again by the Ford Foundation, he switched in 1963 to the Universidad Central de Venezuela in Caracas with the task of organising there a research and education center in the mathematical sciences. He could not see this program finished, due to his untimely death as a result of an automobile accident at Caracas airport on February 18th, 1965. Long and laudatory necrologies were subsequently published in Spain, and years after he was still well and affectionately remembered by a number of his latin-american disciples, see (Nieto and Peña 2000)

A mi maestro

D. José Barinaga y Mata,

Catedrático de la Universidad Central, que un día me dijo: "Procurar transmitir a los demás las reflexiones originales sobre la ciencia básica de nuestra cultura, es lo único que en la vida merece ser tomado con verdadero entusiasmo".

Como homenaje al suyo, inextinguible, y a su gran pasión por la Universidad.

J. Gallego-Díaz.

Acknowledgement to José Barinaga (1890-1965): dedication of the *Curso de Matemática en Forma de Problemas,* 1955

3 Gallego's Mathematics

Some paragraphs above it was pointed out that Gallego might be considered an applied mathematician who dealt with questions not in the mainstream

of applications practised in Spain in the 1930s and 1940s. The bulk of efforts in this area had been devoted in Spain to applications in aviation and aeronautics since the creation of the *Escuela Superior Aerotécnica* in 1928, which was continued after the civil war under the name of *Escuela Superior Aeronáutica.* The 1928 *Escuela* was a personal endeavour of Emilio Herrera (1879-1967), then a colonel and member of the Rey Pastor organisation, which provided a few mathematicians in that first epoch. After the civil war the already general Herrera exiled himself, but the engineer, politician, entrepreneur and former mathematician Esteban Terradas (1983-1950) managed to reopen those facilities in 1942 with the aim of fostering an aircraft industry during World War II. See the comprehensive book (Martínez-Val *et al.* 2004) and comments in (Pacheco 2014).

Nevertheless, in the mid-1930s Gallego's interests looked to other areas like biological problems in view of their industrial applications, where very active research lines in different disciplines had internationally developed a large theoretical and experimental body on population dynamics, modeling, Genetics, traveling waves and related topics. Most of them emerged from the mathematical and biological considerations formulated in the pioneering efforts of Volterra and a considerable number of mathematicians with various backgrounds.
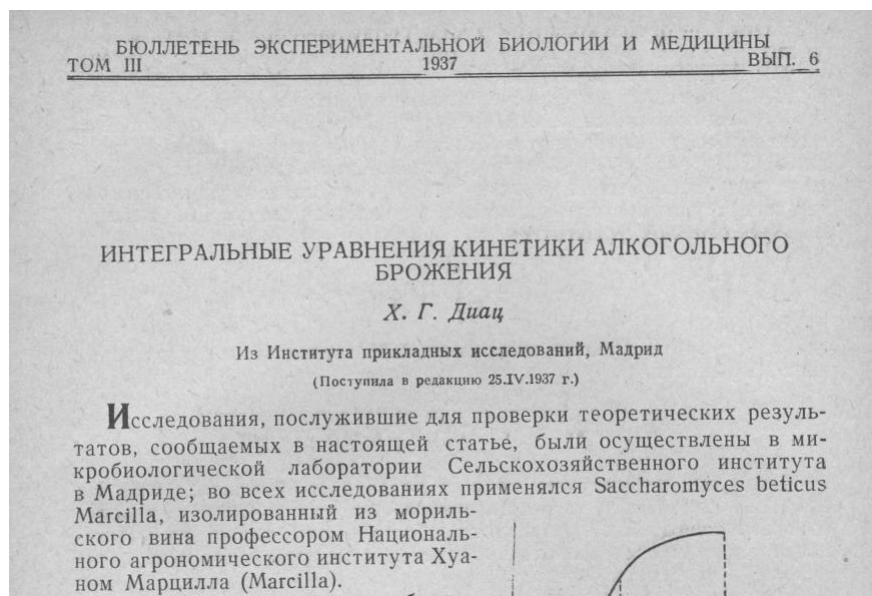
The mathematisation of Economics and the Social Sciences, for years a deep concern of many schools and scholars, was the other field where Gallego contributed. Many attempts had been made to establish the foundations of those sciences in ways similar to or inspired in, classical Mechanics: Vilfredo Pareto (1848-1923) had even written down a table with the analogies needed to formulate an economic theory parallel to classical Mechanics that was not further developed. There was as well a Spanish attempt to mathematisation of the Social Sciences in a similar line by Antonio Portuondo Barceló (1848-1926), the author of the 1912 book *Mecánica Social,* later translated into French in 1926, but no relationship has been found with Gallego (Pacheco 2008).

3.1   Mathematical Biology

Due to its industrial interest, the modelling of fermentation techniques had been an active research field in applied Chemistry for years. The alcoholic fermentation, studied by several scientists under a variety of assumptions, eventually led to consider the role of biological environmental conditions, *i.e.* the yeast population involved in the process, that prior to these studies had been considered only as a sort of catalyst. The British chemist Arthur

Harden (1865-1940) was awarded the 1929 Nobel Prize in Chemistry for research in the topic (see also Harden and Young 1913, Hopkins and Roberts 1935, Slator 1906). On the other hand, the mathematicians Volterra and Kostitzin had developed mathematical tools for integral and integro-differential equations and their applications (Israel and Millán 1993, 2002; Kostitzin 1935).

Gallego made his first research steps under the guidance of the engineer and enologist Juan Marcilla (1886-1950), the discoverer of a particular yeast named *Saccahromyces beticus*. It may be noted here that Gallego did not have any stipend of the funding agency *Junta de Ampliación de Estudios* as his colleague Flores had a little later, but Marcilla had some funding from a newer agency, the *Fundación Nacional de Investigaciones Científicas y Ensayos de Reformas*, created in 1931 in order to bring applied research to the forefront of scientific activity. Gallego contributed to the field by adopting an approach directly inspired on the observation of the yeast population, stressing its role and tracking it in order to optimise the results. His case study was the wine of the producer domain Moriles in Córdoba, close to his native province, and in a presentation to the SME on October 5th, 1935, he claimed good agreement between experimental results and those of his model for the evolution of yeast biomass (Anonymous 1935).

Integral equations of the alcoholic fermentation kinetics (Bull. Exp. Biology and Medicine, III(6), 1937), by J. G. Diac (= José Gallego Díaz)

He started by assuming a logistic growth for the yeast biomass, complemented with a negative growth term accounting for environmental conditions, whose coefficient involved the convolution of the biomass and a memory function $\varphi(t)$, so the basic model equation was

$$X'(t) = \alpha X - \beta X^2 - \gamma X \int_0^t \varphi(\tau) X(t - \tau) d\tau$$

In his already cited 1937 paper in Russian –essentially the 1935 presentation– Gallego claims to have solved this equation with adequate side conditions, writes down the solution in closed form, presents some graphs illustrating its behaviour, and comments on the agreement between his theoretical results and experimental data. In fact, he only worked and solved the particular case with $\varphi(t) = 1$, for which the closed form solution presented by Gallego was present in the 1935 memoir by Kostitzin on integral equations. Nevertheless, he proudly writes: "Kostitzin has recently found the same results..." (Diac 1937, p. 576).

The interest on biological questions was a life-long concern for Gallego, though he did not publish much on them: In addition to the few notes in the journal *Agricultura* during the 1950s, the 1960 paper published in Las Palmas, and a 1964 short note on a model for cellular division inspired on some ideas on biological time (Nouß 1936) have been recorded (Gallego 1960, 1964).

3.2   Economic Theory, and the *Portuguese connection*

In his doctorate, the standpoint adopted by Gallego to address the fields of Choice Theory and Demand Analysis was inspired by a variation on the concept of utility known as "ophelimity", defined by Pareto in 1896 as *the driving force leading people to make decisions regardless of their effective usefulness*. Because of its psychological implications, it is more complex than just utility, and in our time it is usually termed "ordinal utility" or "revealed preference" (see Bruni and Guala 2001, Chipman 1976, Donzelli 1997, Mirowski 1995, Tarascio 1969, Wold and Jureén 1953).

Gallego undertook a mathematical treatment of ophelimity, and he introduced ideas of riemannian Geometry into economic analyses by describing everything –an election inspired on the lorentzian distance of restricted relativity, with an adequate change in a sign– in a $(2n + 1)$-dimensional "economical space-time" where the usual euclidean metric was abandoned in favour of a riemannian metric approach by introducing in the punctured positive orthant of this spatio-temporal continuum a distance concept via

the differential expression

$$ds^2 = \frac{dt^2}{t^2} + \sum_{i=1,...,n} \frac{dx_i dy_i}{x_i y_i}$$

Here n is the number of different goods x_i offered for consumption, the y_i being their respective prices. In the stationary case $dt = 0$, this metric describes invariance under homotheties, *i.e.* the distance between two points is a function of the quotients of their coordinates, which was thought by Gallego more appropriate for dealing with his scale-free vision of economic concepts:

$$dist[(z_{11}, z_{12}, ..., z_{1,2n}), (z_{21}, z_{22}, ..., x_{2,2n})] = f\left(\frac{z_{11}}{z_{21}}, \frac{z_{12}}{z_{22}}, ..., \frac{z_{1,2n}}{z_{2,2n}}\right)$$

where the first n coordinates represent (quantity of) goods and the other n are their prices. An expression satisfying this property is:

$$f\left(\frac{z_{11}}{z_{21}}, \frac{z_{12}}{z_{22}}, ..., \frac{z_{1,2n}}{z_{2,2n}}\right) = \left(\prod_{i=1,...,n} log\left(\frac{z_{1i}}{z_{2i}}\right)\right)^{\frac{1}{2}}$$

The simple case $n = 1$ under stationarity yields the differential expression $ds^2 = \frac{dx}{x}\frac{dy}{y}$, for which geodesics in the first orthant are the curves $y = kx^m$. Then a variational formalism was provided: Should the ophelimity for a certain individual be expressed as $\omega = \omega(x_i, y_i, t)$, then her economic trajectory would be defined as an extremal curve Γ –if it exists one for which a maximum is rattained– for the integral

$$\int_\Gamma \omega ds.$$

It must be remembered that at the end of World War II, the Franco regime experienced a hardening episode –it culminated with the UNO sanctions– and the explicit authorisation of Bachiller was a necessary gesture ensuring the thesis presentation. No wonder, then, that the biographer Javier de Lorenzo complains that Gallego could not publish his work as a whole in Spain and therefore had to split it into several papers published outside Spain (Lorenzo 1987; Gallego 1947, 1949, 1951a, 1951b, 1951c, 1951d).

The 1947 paper appeared in a French journal, but the 1949 and the 1951d ones in *Gazeta de Matemática* –its first number, 1940– of the Sociedade Portuguesa de Matemática (SPM), while 1951a, 1951b, and 1951c

were published by the *Revista de Economía* (Lisboa), edited and owned by Eurico Colares Viera (1920-£?) between 1948-1960 and 1962-1964, initially inspired by the mathematician and economist Bento de Jesús Caraça (1901-1948).

Gallego never published anything in the official Spanish journal, the *Revista Matemática Hispano Americana* (series IV), to whose survival through the civil war he had contributed, but quality had little or nothing to do with that implicit prohibition, as a study of the *Mathematical Reviews* of those years easily shows. Some of his papers were reprinted in Spain when the Education minister Joaquín Ruiz-Giménez (1913-2009) fostered a certain relaxation in cultural matters, among them the 1952 authorisation of the philosophical and scientific journal *Theoria*, where the 1949 paper was recovered as an exponent of non-official post-war mathematical production (Gallego 1954).

Although he did not publish in *Portugaliae Mathematica*, the journal of the SPM founded by António Aniceto Monteiro (1907-1980) in 1939, as early as 1942 contributions by Gallego had alredy appeared in *Gazeta de Matemática*, co-founded by Monteiro, Caraça, and Maria Ribeiro (1911-2011), among others. Nevertheless, only four Spaniards are recorded in *Portugaliae Mathematica* between 1940 and 1950: Ancochea (1942 and 1944), Balanzat (1942), San Juan (1941, twice) and Santaló (1946 onwards). Balanzat, on his way into exile, mediated with Rey Pastor in the hiring of Monteiro in Argentina when this one had to leave Portugal.

3.3   Problems, books, and other interests

Gallego's book production was inspired on his idea that Mathematics could be taught –and learnt– via an adequate choice of exercises and problems in addition to the usual theoretical expositions. In the pre-war years *Matemática Elemental* had seen a number of his contributions, and after the war he was an asiduous contributor to *Euclides* and later to the *American Mathematical Monthly* and the *Mathematical Magazine*: Over thirty items on problem solving have been recorded in the usual mathematical databases. Some of his proposals are clockwork pieces where the technique may be found by close inspection of the formulas or texts, but others need more insight on apparently simple questions, like in Gallego *et al.* 1964, on how to obtain a characterisation of the parabola. He was also well aware of the importance of having at hand good bibliographical resources, and in the Universidad del Zulia at Maracaibo he compiled an annotated list of bo-

oks and journals needed for the Physics and Mathematics courses he had planned for that university (Gallego 1963b).

By blending problems, books, and the economic situation in the early post war, his first incursion in book writing was the 1942 *Curso de Matemática en forma de problemas,* with a foreword by Antonio Flores de Lemus, father of his colleague Antonio Flores, who later in the 1950s added the "de Lemus" family name to his own. This text had two companion books: *Formulario de Matemáticas generales* (Gallego 1942b), and *Nociones de cálculo vectorial y complementos de Matemáticas* (Gallego 1943a). A revised printing of the *Curso* appeared in 1944, and it deserved a second and enlarged edition in 1955 with a supplementary presentation by Rey Pastor and a dedication to Barinaga. In 1948 *Problemas de cálculo de probabilidades* was presented, and in the early 1950s two editions of the joint book with Rey Pastor *Norte de problemas,* were given to print (Gallego and Rey Pastor 1950). Exemplars of these early books are found in Portuguese university libraries.

As a translator he prepared three editions of the classic 1879 book by the Dane Julius Petersen (1839-1910), an almost compulsory reading for engineering entrance examinations, where geometrical constructions were a must. The third one includes a very readable theoretical appendix and footnotes by Gallego himself, but no notice is given on the non-Spanish version used for the translation, though for sure it was one of the many available French ones (Petersen 1955). By the time he died he was busy with the preparation of *Nuevos problemas de Matemáticas*, which was posthumously published. In his Maracaibo years he prepared a more ordinary type of textbook, *Curso general de Matemáticas* I, a thick volume with more than 500 pages including items like quaternions and their applications, but the book was reviewed in an unfavourable way by *Mathematical Reviews* in 1965 (MR173608) stressing the sketchy character of the text. Death of the author made it impossible to prepare a revised edition, and a supposed and expected part II never appeared.

Many short notes published by Gallego in *Euclides* appear without author or just with a couple of initials, and even pseudonyms, but the range of their contents is surprisingly broad: From quotations of known authors in many fields to the agricultural applications of radioactivity to social questions to science-theoretical considerations. Book reviews were written between 1946 and 1952 for the literary periodical *Insula*, where many poets and writers have presented their work since 1946 –it is still published in our days. Among them, a recension of the 1945 high-school book *Aritmética racional*

by António Monteiro and José Silva Paulo. The polemic 1934 *The poetry of Mathematics and other essays* by the historian of Mathematics David Eugene Smith (1860-1944) was also reviewed, and Gallego was remembered in two obituaries published in *Insula* (Cordón 1966; Núñez 1966).

An interest on questions in Science Theory led Gallego to undertake the 1954 translation of John L. Synge's *Science: Sense and Nonsense* of 1951 under the name *Sentido y contrasentido de la Ciencia* (Synge 1954), as well as the 1964-65 translation of a famous symposium based on radio programs of the BBC, *Quanta and Reality*, with texts by David Bohm, Stephen Toulmin, Mary Hesse and others. The Spanish edition was named *Física cuántica y realidad* (Bohm 1965). In the same line, shortly before his death Gallego had contributed three appendices and compiled an updated bibliography for the Spanish translation of Gilbert Cahen's 1953 book *Les conquêtes de la pensée scientifique* prepared by his co-translator José Mł Gimeno and two other people (Cahen 1966). On the occasion of Einstein's death, the journal *Physicalia* –the bulletin of the *Asociación nacional de físicos españoles*– published a monographic issue, where Gallego contributed with a biographical essay (Gallego 1955b). Years after that, he published in the newspaper *ABC* a short note *Einstein tenía razón*, in a polite polemic with the anti-einsteinian Spanish physicist Julio Palacios (1891-1970) (Gallego 1963c). The paper on the future of Mathematical Biology (Gallego 1960) was also an incursion in Science Theory, where he presented a plea emphasising the ever growing role of Mathematics in the development of Life Sciences, but he did not live enough to see the interdisciplinary approaches of today's leading viewpoints on this field.

4   Conclusions

In addition to a rough classification of Gallego as an applied mathematician, a most accurate description of his life and work would be conveyed through a single word: He was a *possibilist* or, in longer wording, a crude example of *survival of the fittest*, to use a very appropriate darwinian expression to describe his trajectory across political regimes, mathematical fashions, and cultural ambients. Several conclusions may be drawn from the above paragraphs, organised in two groups, the first one on the influence of the social environment on Gallego, and the second one on his mathematical contributions.

It may be first concluded that, doubtless, Gallego's familiar extraction played an important role in his life, including both his republican commit-

ment as a young man, as well as the non-official support he was offered in the early postwar and helped him to obtain his academic degrees, to survive in the early francoism, and to make a living on Mathematics. But he was never allowed into the hard core of regime mathematicians controlling the few fundings, publications, and tenures, and this is why most of his purely scientific production was published in Portugal. Although a declared leftist who was in touch with intellectual circles of the inner opposition to the Francoist regime, he was in good terms with the catholic estabishment (Pasquau 1965). Nevertheless, traveling through Europe in the early 1950s made him aware of the narrow horizons awaiting him in Spain, and eventually led him to migrate to the Americas.

Second, the originality of Gallego's Mathematics lies in his entering the mathematical arena via problem solving and experimental work in engineering questions, which he translated into writing by preparing a number of books with that particular leitmotiv: learning and teaching Mathematics through problem solving. His main mathematical contributions are the juvenile studies on Mathematical Biology where he employed the then new techniques in the analysis of alcoholic fermentation. In addition, a much longer involvement, well documented through the articles in *Revista de Economía*, with the intricacies of economic thought and its relationship with the Social Sciences, discovering other mathematical fields of application, and contributing to the expansion and divulgation of applied Mathematics in his last life years.

5   Acknowledgements

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