

## PROFESSOR JOSÉ PINTO PEIXOTO

by

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Significant references have already been made [1-17] to Professor José Pinto Peixoto, but his extraordinary nature is an endless source for meditation, testimonial and inspiration, as well as an example one should attempt to follow.

We had the benefit to collaborate with him within his activities of the Academy of Sciences of Lisbon, and the privilege to private with him as one of his so numerous friends. With the approach of the celebrations on his memory on the occasion of the date of his birthday, we consider we ought to present this modest contribution which aims to testify his noble personality, admirable character, encyclopaedic knowledge and indefatigable activity, as we have recognized in a personal way. This is also a manner to express our gratitude for what we have learned from this Friend, an "older Brother", who was continuously enriching the human, cultural and scientific dimensions of all those who were fortunated to be close to him.

### Personality

Professor Pinto Peixoto was an exceptional symbiosis of an outstanding intellectual talent with a prodigious human dimension.

He was a man devoted to the "two cultures", a cultivator of Arts and Humanities with a remarkable memory and knowledge namely on classical culture, Latin language (in which he was fluent) and religion (*e.g.* he cited often Ecclesiastes and St. Francis of Assisi), as well as a prominent scientist of his century, an worldwidely recognized authority on atmospheric sciences, theories of climate and the global hydrological cycle, fields in which he obtained striking pioneering achievements and developments.

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His scientific activity appears to have followed the obligation expressed in *Ecclesiastes* that he cited *e.g.* when recognising the need “to pursue towards an increasing level of understanding and of greater sensibility in the use of science and technology to the profit of mankind” [18]:

*“I have applied my soul to an attentive study and to the wise observation of all the things that are observed under the Heavens, since this ungrateful duty has been imposed to man by God” (1:12).*

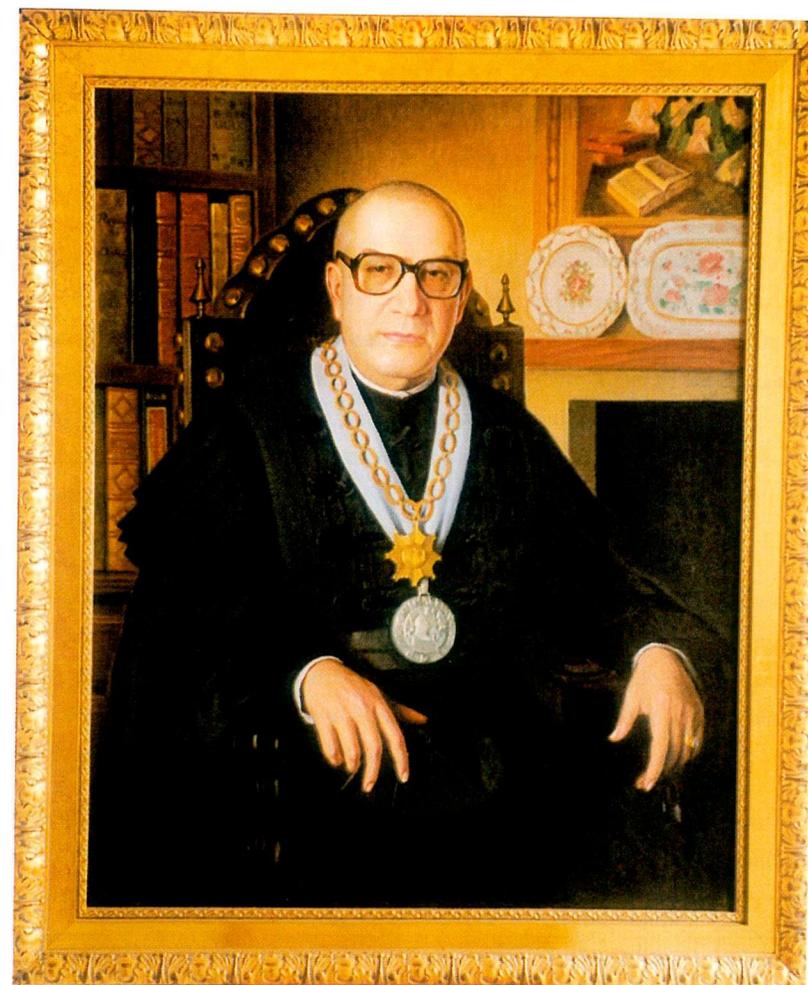
His life was an example of noble human behaviour, with an impeccable moral, a magnanimous character and a solid personality although without detriment to a natural affection to people and places.

In spite of the high professional and cultural positions he held along his life, the political power did not attract him and he always declined invitations for such a type of charges.

Prof. Pinto Peixoto was born on November 9<sup>th</sup>, 1922, in Miuzela (close to Almeida in the district of Guarda, Portugal), a place that he left when he was a 7-years old child, already orphan of Father, to come alone to study in Lisbon. Here, since his Parents were Professors at the Primary School, he was accepted to live at the Institute of the Primary Professorate (the so-called “Palheiro”, *i.e.* “The Hayrick”) during his primary and secondary school period.

He then became a self-made man but always remained so much attached to his origins that he succeeded in publishing [3] an interesting book on Miuzela (entitled “Miuzela, a Terra e as Gentes”, *i.e.* “Miuzela, the Land and the People”), comprising its history (*e.g.* the important role in the defence of the country during the Castela and Napoleonic invasions), ethnology, ethnography and lexicography. In this book, the introductory “memories of childhood”, dedicated to his own family in such a tender and affective manner, typically reflect his warm and noble feelings.

The affection for his Family was evident in his everyday life but a particular occasion when he expressed it with emotion is noteworthy to mention. This happened when he received the “Grand Cross of the Military Order of Santiago de Espada”, in 1993, at the Academy of Sciences of Lisbon. He acknowledged the award stating that, although as a first reaction he considered that he would not deserve it, later on he agreed with the award on account of his Grand-Parents, Parents and Uncles who have spread culture along generations (they were Professors at primary schools) to whom this was the way he could show his gratitude.



*Professor José Pinto Peixoto (1922 – 1996)*

He was a rather modest person who, with all his simplicity, transposed to “climate” (and he was an authority on Climatology) the attitude of Saint Augustine in his “Confessions” towards “time”:

*“Quid est Clima?*

*Si nemo a me quaerat, scio!*

*Si quaerenti explicare velim, nescio!”*

or, in other words: “What is the Climate? If nobody asks me, I know! If one asks what it is and I wish to explain, I do not know!”.

Prof. Pinto Peixoto was always in good mood, cheerful, with an enormous capacity of communication with people and very approachable. He had an unpretentious sense of humor and was a convivial companion, entertaining friends who much enjoyed talking and listening to him. He was always interested on the welfare, social and professional life of those whom he got acquainted with, and he was able in leaving to them the pleasant feeling of being taken by him into proper consideration, esteem and recognized importance. He was a happy God-Father of a great number of his friends’ children. He was a celibatarian with a very large and fortunate “family” of friends. Naturally, he enjoyed also good food and good wine in their company.

He appreciated all forms of art (namely religious) and was a visitor of antique shops and of the well known Lisbon fair “Feira da Ladra”. He was a collector of paintings (he had, *e.g.*, a Picasso’s sketch), sculptures (he was, for instance, a great admirer of José Franco, the emblematic great sculptor of popular art, in Sobreiro, close to Mafra, whom he introduced to us), ecclesiastic ornaments, old tea and coffee cups from over the world, coins, walking-sticks, etc.

Still at his full intellectual capacity, he prematurely and unexpectedly passed away on December 6<sup>th</sup>, 1996 (just two weeks after filling with joyfulness my Daughter’s birthday celebration), during an unsuccessful operation to extract a tumor from his kidney, immediately after he completed a work (“The Total Climatic System and its Components”) for the EXPO 98 exhibition.

#### **Professional and scientific activities**

Prof. Peixoto’s remarkable propensity for both Sciences and Letters led him, after completing the Secondary School studies, to undertake the admission exams for the Faculties of

Sciences, Engineering and Letters, and it was only after some hesitation that he decided to choose the Faculty of Sciences.

He graduated in Mathematics (1944) at this Faculty of the University of Lisbon, then became more interested on earth sciences and graduated in Geophysics (1952), post-graduated at the MIT (Massachusetts Institute of Technology, Department of Meteorology, 1954-56) and got his Ph.D. in Geophysics (1959) at the former University.

He became Professor of Physics at this University and later on also at the University of Beira Interior, President of the Academy of Sciences of Lisbon, Director of the Geophysical Institute Infant D. Luís of the University of Lisbon (since 1970, after being Director of the research division in the National Meteorological Service, 1960-69), Vice-Rector of the University of Lisbon (1969-74), Member of the Installation Commission of the New University of Lisbon (1972-75), President of the Portuguese Section of the International Unions on Astronomy, Geodesy and Geophysics (IUGG), Consultant at the Atmospheric Environmental Research (AER), Member of the Commission for Hydrology of the World Meteorological Organization (WMO-RA VI), Member of the National Commission MAB (UNESCO), Member of the Scientific Committee of the European Centre for Medium Range Weather Forecasting (ECMWF), Member of the OCDE Committee on Science Policy, President of the United Nations Conference on Desertification of the Mediterranean Region, Member of the Executive Committee of the European Science Foundation (1980-86), Vice-President of the National Commission on External Space, etc. He was a consultant to various governmental institutions or Ministries and to UNESCO, and advisor to various universities on environmental matters, science and education.

Among the *prizes* we was awarded, we can mention the “Grand Cross of the Military Order of Santiago de Espada” (awarded by the President of Republic, 1993), the “Boa Esperança (Good Hope) Prize of Science and Technology” (twice, in 1993 for the book “Physics and Climate” in collaboration with Dr. Abraham Oort, and in 1989 for the book “Systems, Entropy and Cohesion” in collaboration with Prof. F. Carvalho Rodrigues *et al.*), and the Artur Malheiros Prize (awarded by the Academy of Sciences of Lisbon, in 1961, before he was a member of this institution, for his “Study of the Enthalpy Fields in the Atmosphere”). He was also awarded the Victor P. Starr memorial lectureship at MIT (1993). Moreover, he was one of the very few Portuguese personalities, together with the Noble Prize winner Prof. Egas Moniz, selected to be mentioned by his national pavilion at the universal exhibition held in Seville, Spain, in 1992.

Several other homages have been paid to him, by colleagues and friends, in particular a national debate on his work (held at the National Institute of Meteorology and Geophysics, Lisbon, 1987), an international congress on “J. Pinto Peixoto’s contribution to the advancement of Geophysics” (held at hotel Altis, Lisbon, 1988) and other meetings organized by the Association of former students of the Institute of the Primary Professorate. His name was given to a library at the Meteorology Institute (1994), an institution he helped to create.

He was a most dedicated Professor with the ability and the talent to make easily understood and apparently simple even the most complex subjects, expressing himself with high clarity and elegance, adding popular adages and everyday life analogies to help their understanding. His students also admired his sapience, “lived” his lessons with enthusiasm and learned how to like and love Science. Moreover, he collaborated actively in the creation and development of some of the new Universities in Portugal.

His main *teaching* subjects included Meteorological Physics, General Thermodynamics and Theoretical Physics, but he delivered also various other courses on both national and foreign Universities (*e.g.* at the MIT and at the Princeton University, as Visiting Professor), namely on the Hydrological Cycle and the General Circulation, Spectral Analysis in General Circulation of the Atmosphere, Energetics of the General Circulation, Climate as a Dynamical System, Climate and Physics, On the Entropy in Meteorology, etc. Many of those subjects and some of the courses were introduced by him into his Universities.

His *research* interests fell within the general fields of Sciences of Atmosphere, Theories of Climate, Hydrology and Thermodynamics (axiomatic and relation with the information theory), and were developed mainly at the Geophysical Institute Infant D. Luis of the University of Lisbon, the Department of Meteorology (at MIT), the Atmospheric Environmental Research (AER in Cambridge, Massachusetts) and the Geophysical Fluid Dynamics Laboratory (GEDL, Princeton University).

In those fields he became one of the world leading scientists, conceivably the greatest specialist on the global hydrological cycle, and, as stated by Professors Abraham H. Oort (at Princeton) and Barry Saltzman (at Yale University) [6], “his pioneering work at MIT with Victor P. Starr during the 1950s and 1960s ... was adequate to represent the large-scale horizontal and vertical structure of water vapor and temperature as well as their temporal variability and transports

... and enabled him to present fairly complete pictures of the atmospheric branch of the hydrological cycle and of the atmospheric energetics that are still valid today...".

Moreover, "his work with Starr and their collaborators at MIT, ERT, AER and GFDL during the last 4 decades forms the observational foundation for many of the general circulation modelling experiments performed since the 1960s and also for many field experiments, such as the recent global energy and water cycle experiment (GEWEX)" [6].

He supervised and inspired various D.Phil. theses in both Portuguese and foreign Universities, and some of his former research students have prominent professional positions.

He was invited to deliver lectures on his own research at many international organizations (WMO, UNESCO, NATO, ICSU, UGGI, etc.), Universities, Academies, congresses, NATO Advanced Study Institutes (ASIs), etc. He organized in Ofir (1973) an ASI on "Marine Systems Modelling".

He published various books based on his research, namely the abovementioned "Physics of Climate" (in collaboration with A. Oort, published by the American Institute of Physics, 1992) which includes much of his work on the atmosphere and oceans and became a worldwide recognized landmark and reference on the field, "Systems, Entropy, Cohesion" (in collaboration with F. Carvalho Rodrigues, published by Discórdia, 1991), as well as "Atmospheric Water Vapour Computation for Hydrological Purposes" (edited by the World Meteorological Organization, 1973) and "Dynamic Hydrometeorology" (edited by the Geophysical Institute Infant D. Luís, 1972).

He also published a great number of research papers and monographies, not only in a variety (which shows the wide spectrum of his interdisciplinary research interests) of reputable international journals, but also in Portuguese publications such as the "Memories of the Academy of Sciences of Lisbon (Class of Sciences), "Portugaliae Physica" and "Física" (the journal of the Portuguese Society of Physics).

Moreover he was also the author of various books on divulgence of science, in particular within the series "Man, Climate and Environment" (Secretary of State for the Environment and Natural Resources) and "the Environment and Man" (National Commission for the Environment), in which he addressed to the essential environmental elements as Saint Francis of Assisi in his "Canticle of the Sun" [19]:

*"Blessed be, my Lord, with all your creatures,  
especially our brother the Sun, that makes the day and gives us the light,  
And he is beautiful and radiant with its splendour,*

*.....  
Blessed by, my Lord, for our brother the wind  
and the air and clouds, and the serene heaven and all kinds of weather  
through which You sustains your creatures*

*.....  
Blessed be, my Lord, for the daughter the Water,  
that is so useful and humble, so precious and chaste,*

*.....  
Blessed be, my Lord, for our sister and mother Earth  
that feed and govern us  
and produces various fruits, grasses and colourful flowers"*

In addition, the problems of the university education and teaching, the science policy and the history of science in Portugal also attracted his attention and were the object of a number of publications and conference lectures.

*The Academy of Sciences of Lisbon*

Prof. Pinto Peixoto was elected President of the Academy of Sciences of Lisbon for eight times (all the possible ones), in the odd number years starting in 1981, until his death. During this period (1981-96) he was always the President of the Class of Sciences but, according to the alternation principle of the by-laws of the Academy, he had to alternate, in the Presidency, with the President of the Class of Letters, Professor Jacinto Nunes and, more recently, Professor Pina Martins.

The role of Prof. Pinto Peixoto was of a paramount relevance since he was elected for the first time, succeeding to another outstanding academician, General Luís Maria da Câmara Pina who started the overall bicentenary celebrations of the Academy and launched the series "Frontiers of Knowledge" comprising the organization of international symposia, at the highest scientific level, on selected topics of current interest, and the publication of the corresponding books with the involvement of an international publisher.

Prof. Pinto Peixoto continued with enthusiasm the celebrations initiated by General Câmara Pina. He organized, within the abovementioned series, a symposium on the “Theory of Climate” and published its book. Under his initiative, a celebration stamp was printed and a medal with the Queen Maria I, the founder of the Academy, was coined.

He defended the Academy’s premises (just in the beginning of his presidency) against a governmental project towards their partial occupation by some public services. He succeeded in strengthening the budget and establishing a remarkable renovation period. The chaos was ordered and he recovered and renovated many rooms and the library, the cloister and its garden, the Maynense museum (a random pile of uncataloged pieces were then inventoried by Prof. Rómulo de Carvalho) that was reorganised and reinstalled in a new place, the enclosure of the Academy, etc.; he created a pleasant Gallery of Exhibitions and a wide store for deposit of books, he restored paintings, books and other art and science pieces, he founded in 1987 the “Institute of Lexicology and Lexicography of the Portuguese Language (with Professors Lindley Sintra and Malaca Casteleiro as its Directors); he promoted the revision of the by-laws of the Academy (in particular the extension of the membership *numerus clausus*, the enlargement of the staff, and the administrative and financial autonomies of the institution were some of the points that he supported more actively), the reorganization of its services (namely the publication ones, allowing the recovery and re-establishment, as a regular publication, of the “Memories” of both the Sciences and Letters Classes, as well as the publication of symposia proceedings and other books, of *fac-simile* editions of rare books, etc.), and the organization of various symposia (within the “High Studies Institute” of the Academy) either on advanced research topics (included in the above “Frontiers of Science” series) or on social interest matters. He also promoted (in particular with Prof. Dias Agudo), the international co-operation, namely with the ICSU, the European Science Foundation and the Royal Society, as well as the collaboration with other scientific organizations, even national ones.

Of particular significance to the Portuguese electrochemical community, and since these biographical notes are prepared for an electrochemistry journal, it is noteworthy to mention the support awarded by Prof. Peixoto to the foundation of the Portuguese Electrochemical Society and its journal, *Portugaliae Electrochimica Acta*.

He offered the premises of the Academy for the organisation of the III National Meeting on Electrochemistry which was held in 1982, and it was then that a group of participants took the

decision to found the Portuguese Electrochemical Society, an initiative that was welcome by Prof. Pinto Peixoto.

Moreover, the first issue of *Portugaliae Electrochimica Acta* was published by the Academy in 1983, within the bicentenary celebrations of this institution.

Later on, after the Society has already been fully established, Prof. Pinto Peixoto also had quite a favourable influence on the selection of the University of Beira Interior, that he recommended, for the organization of the VIII Meeting of the Society held in the end of September, 1996. On that occasion (only slightly more than two months before his death), he was working actively at that University and managed to attend the conference dinner after a tiring day with oral examinations. He arrived somewhat late, rushing from the exams, and his fatigue was evident. Nevertheless, he made the effort for not missing the opportunity to meet friends and show again, by his presence and pleasant conviviality, his support to that initiative of one of his Universities and of the Portuguese Electrochemical Society.

His dedication to the Academy led him to take care of any type of situation, ranking his patent from “general” to ordinary “private soldier”, without any hesitation. Nearly everyday he visited the Academy and often he stayed therein working until late in the evening or even night.

He was not dominated by time restrictions and used to convoke his closest collaborators at any time during the day, and if he could not succeed in finding them, he used to let them know, in a joyful way, that he had registered their absence (“*marcado falta*”, as if a student failed to attend his classes).

At the Academy he chaired the sessions in a very polite and bright manner, keeping the other members informed about the various matters for joint analyses and discussions, without imposing his own view, always directing towards a courteous consensus. The sessions were a pleasure to attend, although frequently delayed as a result of his multiple commitments.

Moreover, he actively encouraged the other members of the Academy to present regularly communications (“Memories”) of their research work and himself gave the example with the presentation of a high number of them, always with the highest interest and delivered magnificently in a way that everyone could follow. Some of them were scheduled at the last moment if there was nobody registered to present a “memory” at a session, therefore filling the gap and preserving the continuity of the scientific programme.

As an overall concluding remark, one can mention that from the benefits to science, culture, education and human behaviour derived from Prof. Pinto Peixoto's activities, his admirable life (not only inside but also outside the Academy of Sciences) fulfilled the Academy's motto (which guided this Academy particularly in the original times, since its foundation on December 24<sup>th</sup>, 1779):

*Nisi utile est quod facimus, stulta est gloria,*

*i.e.* “unless what we do is useful, our fame is vain”.

### Post-mortem memorials

The light irradiated from this so pleasant man who had the power to “immediately brighten the atmosphere whenever he entered a room” (as expressed by Prof. Edward Lorenz of MIT) [6] still shines intensively beyond his death, and a few of his many friends are gathering their efforts in a Commission to perpetuate his memory, in particular by raising funds for the erection of a monument in Lisbon (possibly close to the main entrance of the Academy of Sciences of Lisbon) and by organising an international symposium (under his name) on Geophysics and Climate, to be held on November 9<sup>th</sup>, 1998 (at the Faculty of Sciences of the University of Lisbon, where he taught for many years), to celebrate his birthday (on the occasion of this congress, a visit to his tomb in Miuzela will also be organized). Other initiatives comprise the coinage of a medal and the publication of some of his inedited works including lessons (texts) on Thermodynamics and on Meteorology.

Moreover, other memorials are spreading and his name has been given to roads — namely in Lisbon (at Telheiras, Lumiar), Oeiras (at the Park of Science and Technology) and Almeida —, to a lecture room in which he used to deliver his lectures at the University of Beira Interior, to a University residence at Santos-o-Novo, in Lisbon, where he lived, and to a Culture House in Miuzela. A portrait is displayed at the University of Beira Interior and a legacy (comprising *e.g.* a portrait and some personal academic belongings) is being prepared by his family to be given to the Academy of Sciences. This Academy will also organise a special celebration on his memory.

We hope that the history of science in Portugal will not allow the application to Prof. Pinto Peixoto of one of his old observations concerning those nationals (in particular scientists) who are “well known beyond Vilar Formoso but ignored behind V. Franca de Xira” as a result of a restrictive and common complex in our country.

We believe this phenomenal Man of Science and Culture will be acknowledged by his nation in the way he deserves and as he has already been recognised abroad, as one of our greatest scientists of the XXth century.

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## A PITZER THEORY APPROACH TO ASSIGNMENT OF pH TO STANDARD BUFFER SOLUTIONS

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### Abstract

The quantity  $\text{pH} = -\lg a_{\text{H}}$  is immeasurable, as it involves a single ion activity. The IUPAC recommendations for the pH scale for aqueous solutions are based on the Bates-Guggenheim convention for the calculation of the chloride ion activity coefficient. The idea of this convention, intended to be applied to ionic strength not higher than  $0.1 \text{ mol kg}^{-1}$ , was to impart pH with as much fundamental meaning as possible while recognising that it is conventionally based.

The Pitzer theory, involving ionic specific interactions, may be applied in the calculation of single ion activity coefficients at ionic strengths higher than  $0.1 \text{ mol kg}^{-1}$ . This approach has the merit that all possible known buffers, with or without background electrolyte, and those yet to be developed, can be assigned pH values.

**Key Words:** Standard buffer solution; pH; Pitzer coefficients.

### Introduction

The quantity pH cannot be assigned without recourse to a non-thermodynamic convention. In an attempt to reconcile several different approaches to this problem, Bates and Guggenheim [1] proposed a convention for the single ion activity coefficient of the chloride ion,  $\gamma_{\text{Cl}}$ , that is based on the Debye-Hückel equation, with an assumed value for the ion size parameter,  $a$ ,

$$\lg \gamma_{\text{Cl}} = (A/\sqrt{I})/(1+Ba\sqrt{I}) \quad (1)$$

where  $I$  is the ionic strength,  $A$  and  $B$  are the Debye-Hückel parameters and  $Ba=1.5$ . This convention is valid for solutions with ionic strength not higher than  $0.1 \text{ mol kg}^{-1}$ . Recently the Pitzer theory [2] of ionic specific interactions has been proposed for the evaluation of the chloride ion activity coefficient in the standard buffer solutions [3], which enables the establishment of a self-consistent system of aqueous pH standards, not limited to  $0.1 \text{ mol kg}^{-1}$  in ionic strength. In this work, the

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