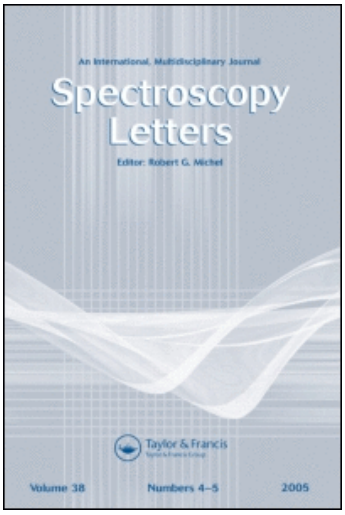


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# Research on Spectroscopy in Morocco from 1984 to 2006

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# Research on Spectroscopy in Morocco from 1984 to 2006

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**Abstract:** The evolution of spectroscopy-based research activity in Morocco was evaluated on the basis of publications that have appeared in the Science Citation Index, Expanded (SCI), during the cumulative period 1984–2006 (September). The most active research groups, and their universities or centers, were identified in this subject from their scientific production in the first years of this century. The preference to publish in specific journals, the main areas of interest to Moroccan authors, and the spectroscopy techniques most commonly employed for their studies were also appraised. This scientometric study was undertaken to introduce a group of papers in a special issue of *Spectroscopy Letters* on Moroccan research in spectroscopy.

**Keywords:** Morocco, scientometrics, spectroscopy

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The authors were invited to contribute this paper to a special issue of the journal entitled "Research on Spectroscopy in Morocco." This special issue was organized by Miguel de la Guardia, Professor of Analytical Chemistry at Valencia University, Spain.

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## INTRODUCTION

Nowadays, there is an increasing interest in using bibliometric information for assessing or monitoring research activities. The discipline devoted to the quantitative study and evaluation of the scientific literature is called scientometrics or bibliometrics.[1] Bibliometrics has been applied to the evaluation of scientific disciplines,[2,3] national scientific production,[4,5] and bibliographic databases,[6,7] and it provides valuable tools to describe the scientific activity in the past and to orient future research.

The most common scientometric indices used for charting research activities and performance are (i) the number of publications in scientific journals, (ii) the impact factor, which is a spin-off from citation counts and is a measure of the citation frequency, (iii) the citation rate, and (iv) the activity index.[8]

Research activities in developing countries are characterized by isolated researchers or small groups. Geographic and, in some cases, political isolation and limited funds cut researchers off from formal and informal international communication. This isolation has resulted in a publication pattern in which authors from these countries publish in local journals. However, the installation of electronic mail networks and the developments in information and communication technologies in recent years have brought wider exposure of the researchers in these countries to international communication and collaboration. The ease of communication and increased access to international journals has led to a significant shift of publications by authors from national journals to international ones particularly in the European or North American areas.

Morocco, which was in the past a colony of Spain and France, is now a developing country. It is active and tries to improve its economic and scientific levels.

In this study, we have tried to characterize the evolution of the research performance in the field of spectroscopy in Morocco through the analysis of the number of papers published in scientific journals from 1984 to 2006 (September).

We have tried to evaluate the development of the different spectroscopy disciplines in this country and to identify the main research groups in the field.

In fact, the main objective of this study is to provide to the reader a good picture of the state of the art of spectroscopy in Morocco and to contribute to the redefinition of scientific objectives in spectroscopy in the modern Morocco from a consideration of the recent story. Also, this scientometric study was undertaken to precede a group of papers in this special issue of *Spectroscopy Letters* on Moroccan research in spectroscopy.

## DATA SOURCE

The Science Citation Index, Expanded (SCI), of the Institute for Scientific Information (ISI, Philadelphia, PA USA), through an online computer

search, was selected as the most appropriate data source. This study takes into account all types of publications in the database indexing process. Although SCI shows a considerable bias in favor of periodicals published in the English language and against periodicals with non-Roman alphabets,[9] it is still the most comprehensive and frequently used source database of choice for a broad review of national science (more than 5000 journals are indexed, spanning more than 150 scientific disciplines). The time period covered by our study was from 1984 to 2006 (September).

## RESULTS

### Evolution of the Spectroscopy Literature from Morocco

Figure 1 shows the growth trends in the number of published papers between 1984 and September 2006. It must be stated that the papers considered were those that included at least one author with an address from Morocco. It means that papers are included written by authors working abroad, whether on sabbatical or foreign exchange programs, which guaranteed that equal credit was given to all of the contributors.

As can be seen, the first paper from Morocco covered by SCI was published in 1989, and SCI indicated a clear change in the rate of Moroccan scientific literature production in the middle of the 1990s. Thus, an average rate of 19 papers per year to 1996 was established, and an average rate of 65 published papers per year from that date to today, showing the tremendous development of spectroscopy in Morocco over the years. Several factors are responsible for the evolution of the spectroscopy literature in Morocco:

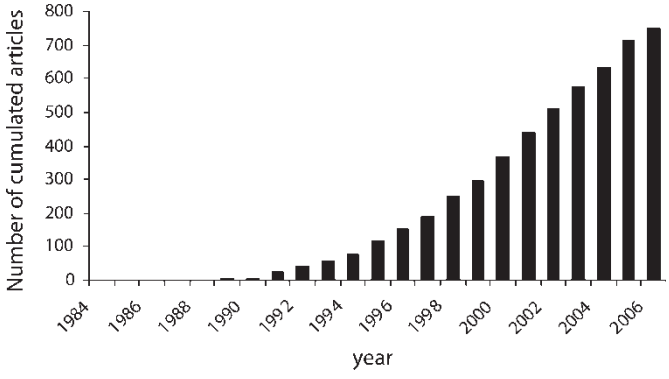



***Figure 1.*** Evolution of the published literature on spectroscopy from Morocco. (Source: Science Citation Index, Expanded [SCI], 1984–2006.)

The extension of Moroccan university studies made in the 1980s involved the creation of new faculties, schools, and institutes in the sciences and/or technology in the big cities. This fact increased the number and level of students and young professors who teach in these new centers. On the other hand, the process of reorganization of the universities by the Moroccan government also contributed to improvement in the quality of research in both the basic and applied sciences. In 1997, scientific activities were structured through an accreditation process from which the "Formation and Research Units" (UFR, or Unites de Formation et de Recherche) were established. In that year, the Moroccan government created four national programs for the financial support of research projects: PARS and PROTARS I, II and III.

In consideration of the scientific development of Morocco, international cooperation must be taken into consideration, which started by strong links with French laboratories through the so-called integrated action programs that have been extended to other European Countries like Spain, Italy, and Portugal. This was in addition to Moroccan participation in the European programs INCO and MEDA. In this sense, it must be noticed that the International Exhibition of 1992 in Sevilla was a good opportunity to improve the cooperation between Spain and Morocco, which was financed by the Spanish Agency of International Cooperation.

The year 1997 is a key date for the development of science in Morocco due to the reorganization of the status of university professors and researchers. New criteria, based on merit and publications, were applied to access the different positions of professors instead of the past parameters based on age. That, together with the new national Ph.D. thesis, established in a 1997 law, contributed to increase the productivity of Moroccan researchers.

All the aforementioned items explain that during the external evaluation of the National Research System in 2003, it was shown that the Moroccan productivity occupied third place among African countries.



## Sources for the Literature Published

The distribution of the 413 papers that include authors from Morocco published from 2000 until 2006 (September) is given in Fig. 2. In this figure, the titles of the 43 journals are listed in which there appeared at least three Moroccan papers over this 5-year period (in decreasing order by the number of published papers). The 43 journals indicated in Figure 2 represent only 26.3% of the total number of journals (167), which shows the wide distribution of Moroccan spectroscopy papers in the first years of this century.

On the other hand, Fig. 2 clearly shows that only five journals have published 10 or more articles from Morocco in the field of spectroscopy during the 21st century. *Annales de Chimie-Science des Materiaux*, *Materials Research Bulletin*, *Journal de Physique IV*, *Journal of Molecular Spectroscopy*, and *Journal of Solid State Chemistry* are the journals that

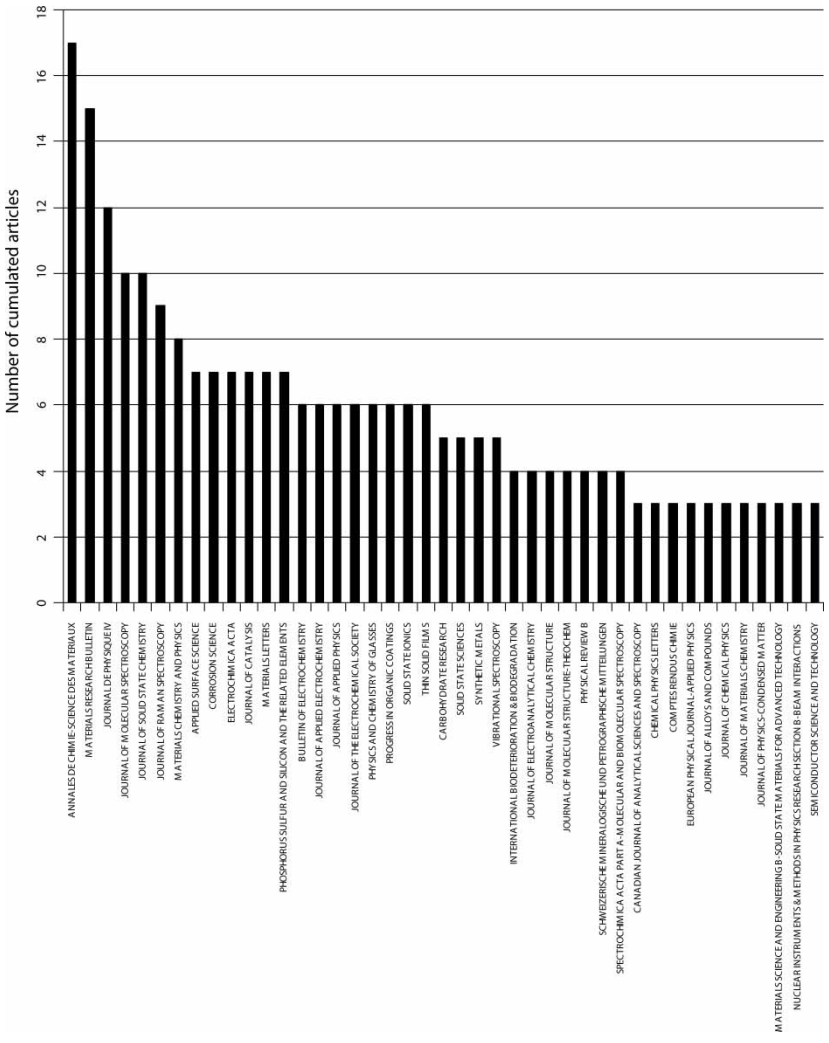


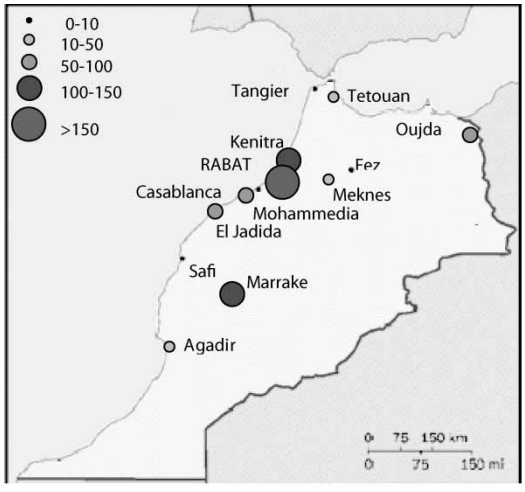

***Figure 2.*** Distribution of the research papers published in the 21st century (2000–2006) as a function of the journal in which they were published. (Source: Science Citation Index, Expanded [SCI], 1984–2006.)

have accumulated the main part of the Moroccan contribution to spectroscopy. It is noteworthy that the main part of the spectroscopy studies are characterizations of materials, which explains that the topic of the journals selected would be materials research or similar.

The language employed in the evaluated articles was mainly English in 382 scientific papers (92.5%), whereas the rest of the papers were written in French.

## Identification of the Most Productive Research Groups

For each city, the total number of publications and the number of publications in SCI journals per million of population are presented in Fig. 3. It can be seen that Rabat is the most productive spectroscopy city in Morocco (178 articles) followed by Marrakech (146 articles) and Kenitra (126 articles). Other important cities like Oujda (61 articles), El Jadida (55), Meknes (42), and




| City | Published papers | Population (2004) | Papers/ population[a] |
|---|---|---|---|
| Rabat | 178 | 1.600.000 | 111.2 |
| Marrakech | 146 | 450.000 | 324.4 |
| Kenitra | 126 | 359.142 | 350.8 |
| Casablanca | 63 | 3.500.000 | 18.0 |
| Oujda | 61 | 500.000 | 122.0 |
| El Jadida | 55 | 144.440 | 380.8 |
| Meknes | 42 | 536.322 | 78.3 |
| Tetouan | 19 | 320.539 | 59.3 |
| Agadir | 16 | 678.596 | 23.6 |
| Tangier | 5 | 669.685 | 7.5 |
| Safi | 4 | 284.750 | 14.0 |
| Mohammedia | 2 | 188.619 | 10.6 |
| Fez | 1 | 946.815 | 1.1 |

[a]Papers published on spectrscopy in different Moroccan cities from 1984 to 2006 per million inhabitants.

***Figure 3.*** Distribution of the published papers on spectroscopy from Morocco as a function of the different cities in which the research teams have their permanent addresses.

Casablanca (63) complete the list. It can be seen that the sum of articles published in those cities (671) represents 94.4% of the total published papers from Morocco. On the other hand, El Jadida is in a leading position with aproximately 381 published scientific papers on spectroscopy per million inhabitants. Kenitra and Marrakech follow with approximately 351 and 325 papers per million inhabitants, respectively. On the other side, the less productive cities according to this index are Tangier and Fez with less than 10 papers per population unit. However, it must be considered that the distribution of public universities in Morocco is actually the reason for the concentration of the research production in a few cities and that the distribution of published papers per inhabitant cannot be considered a good parameter to identify excellent research teams.

Table 1 indicates a probably incomplete list of the Moroccan authors identified in the SCI from their productivity in spectroscopy this century. These authors are listed as a function of the number of published papers.

First of all, it must be noticed that the most productive research teams in spectroscopy are at universities, and thus a big effort must be made to promote research on spectroscopy in public nonuniversity laboratories and in private enterprises.

Four research teams who have published more than 10 papers can be identified; Prof. Hammouti in the Faculty of Sciences in Oujda, Prof. Et Tabirou at the Ibn Tofail University of Kenitra, Prof. Hafidi at the Cadi Ayyad University in Marrakech, and Prof. E.A. Bazzaoui in the Mohammed Ier University in Oujda. A second group, composed of authors who published between 8 and 10 papers in this period, includes three members of the Mohammed 1$^{er}$ University in Oujda, three members of the Ibn Tofail University in Kenitra, Prof. Mernari from El Jadida University, Prof. El Omari from the Moulay Ismail University in Meknes, and Prof. M. Kacimi from Rabat. A third group composed of authors with six and seven published papers includes three members of the Cadi Ayyad University in Marrakech, six investigators at the Ibn Tofail University in Kenitra, two members from the Mohammed V-Agdal University and one of the "Ecole Normale Superieure de Takaddoum" in Rabat, and finally Prof. Sahibed-Dine from the Chouaib Doukkali University in El Jadida. Thus, it can be concluded that there are active research teams on spectroscopy located in the universities of four cities (Rabat, Marrakech, Kenitra, and Oujda) who guarantee a critical mass of scientific knowledge and the continuity of the effort looking for new advances in spectroscopy in addition to the emerging activity in other public institutions.

## Research Subject

To classify papers into subjects is probably the most problematic task in bibliometric data processing. Subject classification is generally based on journal assignment to subjects, and problems arise when a broad range of topics is

***Table 1.*** Identification of the most productive research groups on spectroscopy in Morocco at the beginning of the 21st century

| Author | No. publications | Address |
|---|---|---|
| Hammouti, B | 17 | Fac Sci, Lab Chim Eaux & Corros, BP 717, Oujjda |
| Et-Tabirou, M | 15 | Univ Ibn Tofail, LPCS, Fac Sci, BP 133, Kenitra |
| Hafidi, M | 13 | Fac Sci Semlalia, Equipe Ecol Vegetale & Environm, Dept Biol, BP 2390, Marrakech |
| Bazzaoui, EA | 13 | Univ Mohammed Ier, Fac Sci, Dept Chim, Oujda, 60000 |
| Mernari, B | 10 | Fac Sci Eljadida, Lab Chim Coordinat & Analty, BP 20, El Jadida, 2400 |
| Ramdani, A | 10 | Univ Mohammed First, Fac Sci, Dept Chem, Lab Phys Organ Chem, BP 524, Oujda, 60000 |
| Rhandour, A | 10 | Univ Ibn Tofail, Fac Sci, Lab Phys Chim Mat Inorgan, BP 133, Kenitra |
| Srhiri, A | 10 | Fac Sci, Electrochem Lab, BP 133, Kenitra, 14000 |
| Addou, M | 10 | Univ Mohammed 1, Fac Sci, Dept Math & Informat, Oujda |
| Bazzaoui, M | 10 | Univ Mohammed Ier, Fac Sci, Dept Chim, Oujda, 60000 |
| El Omari, M | 8 | Moulay Ismail Univ, Fac Sci, Dept Chem, Meknes, 50000 |
| Harcharras, M | 8 | Univ Ibn Tofail, Fac Sci, Dept Chem, Lab Spectroscopy, BP 133 |
| Kacimi, M | 8 | Faculté des Sciences, Laboratoire de Physico-Chimie des Matériaux et Catalyse, Département de chimie, Rabat |
| Ammar, A | 7 | Laboratoire de Chimie du Solide Minéral, Faculté des Sciences, av. My Abdellah, B.P. 2390, Marrakech |
| Ben Sari-Zizi, N | 7 | Laboratoire de Spectronomie Physique Appliquée, Faculté des Sciences, Université Mohammed V-Agdal, B. P. 1014, Rabat |
| Habibi, Y | 7 | Unité de chimie agroalimentaire, faculté des sciences Semlalia, université Cadi-Ayyad, BP 2390, Marrakech |
| Mahrouz, M | 7 | Unité de chimie agroalimentaire, faculté des sciences Semlalia, université Cadi-Ayyad, BP 2390, Marrakech |
| Ouasri, A | 7 | Laboratoire de Physico-Chimie des Matériaux Inorganiques, Université Ibn Tofail, Faculté des Sciences, B.P. 133, Kénitra |

(*continued*)

***Table 1.*** Continued

| Author | No. publications | Address |
|---|---|---|
| Sahibed-Dine, A | 7 | Faculté des Sciences, Université Chouaib Doukkali |
| Kertit, S | 7 | Laboratoire de Physico-chimie des Matériaux, E N S Takaddoum, BP. 5118, Rabat |
| Ziyad, M | 7 | Laboratoire de Physico-Chimie des Matériaux et Catalyse, Faculté des Sciences, Département de Chimie, Rabat |
| Benali, O | 6 | Département de Chimie, Faculté des Sciences, Université Ibn Tofail, BP 133, Kénitra |
| Bougrine, A | 6 | Univ Ibn Tofail, Fac Sci, Lab Optoelect & PhysChim Mat, BP 133 |
| Chahine, A | 6 | Laboratoire de Physico-Chimie du Solide (LPCS), Université Ibn Tofail, Faculté des Sciences BP 133, 14000, Kénitra |
| Hafid, M | 6 | Laboratoire des verres et céramiques (LVC), Faculté des Sciences, Université Ibn Tofail, B.P. 133, 14000, Kénitra |
| Regragui, M | 6 | LOPCM, Université Ibn Tofail, BP 133, Kénitra |



covered by the same journal. In a classification of this type, several journals can, therefore, be assigned simultaneously as contributing to two or more subjects. In this sense, the subject classification scheme of the SCI of ISI was used to classify the papers into subjects. Table 2 shows the main areas of interest of Moroccan authors in decreasing order of the number of published papers. At first glance, it can be seen that research activity is concentrated in a small number of fields; nearly all the papers went to two fields at the top of the table, (i) physics and physical chemistry and (ii) material science, demonstrating the qualitative nature of these studies and the reduced number of specific analytical-based publications that could provide new quantitative methodologies for materials classification or applied studies in spectroscopy.

Papers published in 2002 and 2005 were analyzed in order to identify and to compare the evolution of the spectroscopy techniques employed. As can be seen in Fig. 4, FTIR (Fourier Transform Infra Red), X-ray, EIS (Electrochemical Impedance Spectroscopy), and Raman spectroscopy were the most used tools in published papers, thus showing once again that the characterization of materials previously synthesized is the main object of Moroccan studies, and there is a reduced activity in basic and applied research on spectroscopy.

This bibliographic research on the productivity of Morocco in spectroscopy has shown that spectroscopy is mainly used as an analytical tool to

***Table 2.*** Subject classification of published papers on spectroscopy from Morocco in the period 1984–2006

| Subject | Published papers | % Papers |
|---|---|---|
| Materials Science, Multidisciplinary | 96 | 23.2 |
| Chemistry, Physical | 88 | 21.3 |
| Physics, Condensed Matter | 56 | 13.6 |
| Physics, Applied | 36 | 8.7 |
| Spectroscopy | 36 | 8.7 |
| Electrochemistry | 34 | 8.2 |
| Chemistry, Multidisciplinary | 32 | 7.7 |
| Chemistry, Inorganic & Nuclear | 27 | 6.5 |
| Physics, Atomic, Molecular & Chemical | 25 | 6.1 |
| Materials Science, Coatings & Films | 21 | 5.1 |
| Chemistry, Analytical | 20 | 4.8 |
| Chemistry, Applied | 20 | 4.8 |
| Physics, Multidisciplinary | 18 | 4.4 |
| Chemistry, Organic | 17 | 4.1 |
| Polymer Science | 16 | 3.9 |
| Metallurgy & Metallurgical Engineering | 14 | 3.4 |
| Materials Science, Ceramics | 12 | 2.9 |
| Biochemistry & Molecular Biology | 11 | 2.7 |
| Engineering, Chemical | 11 | 2.7 |
| Environmental Sciences | 11 | 2.7 |
| Biotechnology & Applied Microbiology | 8 | 1.9 |
| Physics, Nuclear | 8 | 1.9 |
| Mineralogy | 7 | 1.7 |
| Agriculture, Soil Science | 5 | 1.2 |
| Engineering, Electrical & Electronic | 5 | 1.2 |
| Biophysics | 4 | 1.0 |
| Crystallography | 4 | 1.0 |
| Engineering, Environmental | 4 | 1.0 |
| Food Science & Technology | 4 | 1.0 |
| Geology | 4 | 1.0 |
| Instruments & Instrumentation | 4 | 1.0 |
| Nuclear Science & Technology | 4 | 1.0 |
| Pharmacology & Pharmacy | 4 | 1.0 |
| Urology & Nephrology | 4 | 1.0 |
| Ecology | 3 | 0.7 |
| Geochemistry & Geophysics | 3 | 0.7 |
| Geosciences, Multidisciplinary | 3 | 0.7 |
| Agriculture, Multidisciplinary | 2 | 0.5 |
| Agronomy | 2 | 0.5 |
| Chemistry, Medicinal | 2 | 0.5 |
| Engineering, Biomedical | 2 | 0.5 |

(*continued*)

***Table 2.*** Continued

| Subject | Published papers | % Papers |
|---|---|---|
| Physics, Particles & Fields | 2 | 0.5 |
| Water Resources | 2 | 0.5 |
| Astronomy & Astrophysics | 1 | 0.2 |
| Construction & Building Technology | 1 | 0.2 |
| Energy & Fuels | 1 | 0.2 |
| Engineering, Civil | 1 | 0.2 |
| Materials Science, Composites | 1 | 0.2 |
| Mechanics | 1 | 0.2 |
| Medical Laboratory Technology | 1 | 0.2 |
| Medicine, Legal | 1 | 0.2 |
| Microbiology | 1 | 0.2 |
| Optics | 1 | 0.2 |
| Physiology | 1 | 0.2 |
| Plant Sciences | 1 | 0.2 |
| Radiology, Nuclear Medicine & Medical Imaging | 1 | 0.2 |
| Telecommunications | 1 | 0.2 |



support research in different fields, such as environmental studies, materials science, catalysis, or organic synthesis, and only a few works have been based on the spectroscopy itself. This fact could be explained by the lack of instrumentation in the Moroccan laboratories and the problems related to the maintenance of available instruments. Thus, it is indispensable not only to provide large facilities to university and research laboratories but also to guarantee their maintenance and correct use, through the appropriate assembly of engineers and technical supervisors able to properly use the

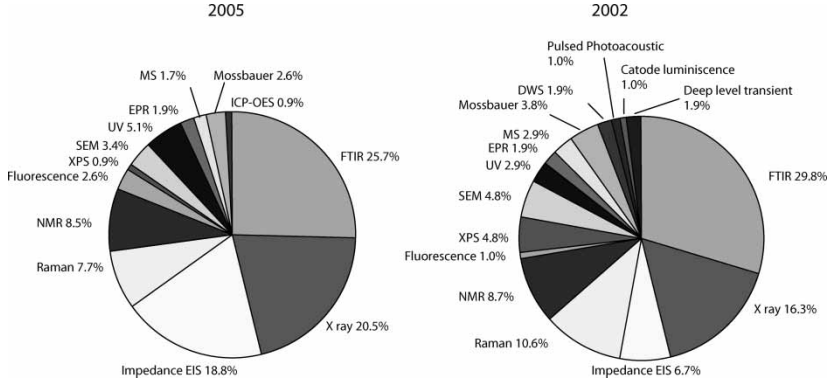



***Figure 4.*** Distribution of the literature published on spectroscopy from Morocco as a function of the different techniques employed.

instruments and to make them useful for research teams. The UATRS Centre in Rabat could be a good example of a clever structure that includes not only high-level instrumentation but also a good technical organization.

Future research on spectroscopy in Morocco could be linked to the general politics adopted by the authorities. The correct use of an increased budget for scientific research and high technical qualifications of technical operators will be the key issues to guarantee the correct use of funds and their direct effect on the research from both the qualitative and quantitative viewpoints.

## CONCLUSIONS

This study gives an overview of the development of spectroscopy in Morocco during the period 1984–2006 (September), covering research only in the journal articles indexed in the SCI database of ISI.

The most productive cities on the basis of total number of publications were Rabat, Marrakech, Kenitra, and Oujda, and this must be taken into consideration in order to organize scientific events in this field.

The research activity by Moroccan authors in spectroscopy is mainly focused on qualitative studies of characterization of new materials and it is concentrated in a small number of fields; physics and physical chemistry and materials science. Thus, it could be suggested that political actions need to be taken to create reference centers to support the activity of the research teams and to cover the required tools to properly characterize synthesized products. On the other hand, a big effort must be made, in our opinion, to reinforce the activity of the analytical chemistry teams and to make spectroscopy not only available for use by the academic sector, but also to transfer the technology of spectroscopy to make it available to the private sector and business enterprises.



## ACKNOWLEDGMENTS

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