

***International Conference
on the
Applications of the Mössbauer Effect***

1976

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on the
Applications of the Mössbauer Effect***

**Conférence Internationale
sur les
Applications de l'Effet Mössbauer**

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PREFACE

This volume contains a collection of the invited and contributed papers presented at the International Conference on the Applications of the Mössbauer Effect, which took place in the island of Corfu, Greece from September 13 to 17, 1976. This was the third of a series of Conferences of this type which were initiated in Ayelet Hashahar in 1972 and was followed by the Bendor Conference in 1974. The attendance was approximately the same as in Bendor but the number of contributed papers accepted by the program committee was considerably greater. In addition to 12 invited talks there were 218 contributed papers which are included in this volume. It may be seen, by an examination of the papers published here, that the voluminous response to the conference corresponds both to increased activity in established areas of application of Mössbauer spectroscopy as well as to its extension to new and interesting problems.

The limited time of the scientific program forced a selection of papers by the program committee for oral presentation. We believe, however, that the informal contacts during the conference and the publication of the extended version of all the papers within a few months after the conference will complete effectively the diffusion of information on the current activity in the field which has been the main purpose of these conferences.

We take this opportunity to thank the members of the program committee whose efforts and expertise at all stages of the planning have been essential to the success of the conference. We should like also to acknowledge the interest and suggestions of the international scientific advisory committee in the formulation of the scientific program. Thanks are due, furthermore, to the authors of invited talks whose contributions have provided reviews of progress in various areas of application of Mössbauer spectroscopy.

The Conference could not have been realized without the moral and financial support of several organizations and institutions. We acknowledge specifically the financial support of the Ministry of Culture and Sciences of Greece under whose auspices the Conference was organized. The Nuclear Research Center «Demokritos» has provided institutional and financial support at all the stages of organization. The contribution and interest of the International Atomic Energy Agency is also gratefully acknowledged.

We are thankful to the staff of the Solid State Spectroscopy group at Demokritos which has provided the technical and secretarial support which was essential for the preparation and smooth running of the Conference. Finally, it is a pleasure to acknowledge the cooperation and effectiveness of the editorial staff of the Journal de Physique which made possible the publication of the proceedings in a very short time after the Conference.

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OPENING REMARKS

J. DANON

Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil

Mr. Chairman,
Dear friends and colleagues,
Ladies and gentlemen,

I was particularly honoured when I received the invitation to present the opening words of this conference.

In order to inspire myself, I looked to see how my predecessors achieved this task and I found that this has been done in two different ways.

Either the opening remarks are limited to a welcoming address, a few words on the certitude that this conference will be an absolute success, etc., or it is a lengthy presentation of the major achievements and future perspectives in our field.

Clearly, I would much more prefer the first way, but it seems to be privilege limited to Rectors, Presidents or similar notabilities.

As regards the other way I have found myself facing a different set of difficulties.

At the beginning of this year, we received the Proceedings of the Cracow Conference, with a full 8 page opening talk by Vitali Goldanskii on major achievements and developments on the applications of Mössbauer spectroscopy. You will agree that, although we have been very active, it is hard to add much significant news to a list made a few months ago.

Moreover, since April of this year, we have received regularly the Mössbauer Spectroscopy Newsletter, sponsored by ICAME, thanks to the efforts of G. Shenoy, M. Kalvius and J. Stevens.

Thus, I believe that we are well informed about the general activities and main progress in our field.

It is interesting to observe that around 50 % of the news in the Letters is related to meetings and conferences. This supports the remark made by U. Gonser in this concluding words at the Cracow conference that we are really in the C-age of the Mössbauer effect. Unfortunately, the C here is not a recently discovered carbon Mössbauer isotope but stands for Conference age.

On looking on our previous Conferences I have noticed an interesting tendency.

From the first Conference in 1960, through 1963, our conferences had for title *Mössbauer Effect*, for instance in Saclay (1961) or in Dubna (1962). After the Cornell Conference in 1963, we decided that the number and relevance of the applications of the Mössbauer Effect were such that the name of future

meetings should display this aspect. Thus, the first Panel sponsored by the International Atomic Energy Agency in 1965 in Vienna was called *Applications of the Mössbauer Effect to Chemistry and Solid State Physics*.

By 1968, the term *Mössbauer Spectroscopy* made its appearance in works such as the Goldanskii-Herber book, in a clear recognition that a new spectroscopy was born. From 1968 until 1972, the titles of numerous meetings and books were variants of *Mössbauer Spectroscopy and its Applications*. Since 1972, the names of our Conferences have stressed the importance of Applications, putting this word first in the title.

One sees that each 4 or 5 years important changes have been introduced in the contents of our Conferences.

There have been some predictions for the next 4 or 5 years as well. For instance, it was predicted in the 2nd Panel held in 1971 at the IAEA in Vienna that Mössbauer Spectroscopy would be increasingly used in conjunction with other techniques and that Mössbauer results would be a simply part of a larger picture. This would be equivalent to dropping Mössbauer Spectroscopy leaving just the term Applications !

However, even though the variety of the applications have largely increased in the recent years, this splitting has not occurred.

Perhaps one of the reasons for this is that we still do not understand satisfactorily the hyperfine interactions which are relatively easily measured in the Mössbauer effect. We still have a lot to learn from our mutual contact.

In this respect, I selected a few topics which illustrate this idea, from the areas of Mössbauer Spectroscopy close to my own interests.

The very fundamental problem of overlap distortion versus charge transfer in chemical bonding is still an open question. A beautiful example is presented in this Conference by the work of the Soreq people on the isomer shifts of the matrix isolated alkali iodides.

The attention on overlap contribution was raised in early Mössbauer studies, by W. Marshall at the Saclay conference in 1961. Proposals for matrix isolation experiments were made at the same meeting and 10 years later the developments made by P. Barret in Santa Barbara and H. Micklitz in Munich began to yield basic information about this unsolved problem.

Again in the field of chemical bonding, the shielding

problem or the relative contribution of s and d electrons to the isomer shift in transition element compounds is not yet solved.

We have now at our disposition a great wealth of data in the 3d (Fe), 4d (Ru) and 5d transition elements (Os, Ir, Au). The systematic investigations on the higher transition elements by F. Wagner and U. Wagner and the Munich staff have shown that many of the regularities observed in the iron case are reproduced in these elements, such as the back-bonding mechanism in π -bonding molecules. However, as regards the relative participation of s and d electrons, we have not made great progress since the L. Walker, G. Wertheim and V. Jaccarino interpretation of the isomer shift for iron in 1961.

I do not pretend that the solution of these basic problems on the electronic structure of molecules should arise necessarily from Mössbauer spectroscopy studies. Other techniques, such as ESCA for example, raised many hopes in this respect. However, these problems are yet unsolved and they are constantly raised by the need of interpretation of Mössbauer spectra, either in pure molecules or in semiconductors or metals, etc.

One of the items of our Conference also clearly illustrates this point, and this is the topic magnetic interactions and chemical bonding. The work on chromium iodides in Strasbourg shows how powerful is the Mössbauer spectroscopy by allowing the measurement of several hyperfine interactions simultaneously. However, similar measurements have been performed in EPR and the difficulty of correctly interpreting even the sign of the measured hyperfine contact term is well known.

There is no doubt that the solution of these problems will have a direct impact in several other areas of application of the Mössbauer spectroscopy such as in biology, geochemistry, etc.

There is also no doubt that similar and even more complex problems arise in fields other than chemistry, such as magnetism, for instance.

Let me now turn your attention to a different but perhaps not completely unrelated problem. This is what was called a few years ago by our scientific secretaries A. Kostikas and A. Simopoulos as the third Mössbauer effect.

Presumably we all know what the first Mössbauer effect is. As regards the second Mössbauer effect, we are still waiting from our German colleagues to tell us what it is or was. The third Mössbauer effect was defined by Kostikas and Simopoulos at the 2nd Panel on Mössbauer Spectroscopy as follows: *Mössbauer spectroscopy* has some distinct advantages in comparison with other methods of resonance spectroscopy, especially when considering the initiation of research activity in solid state spectroscopy in a developing country. Some of them are:

a) The wide area of application encompassing

nuclear and solid state physics and extending to applications to chemistry and biology.

b) The close connection of observed quantities to physically meaningful parameters which lends itself to training of students.

c) The relatively low investment cost.

For these reasons, Mössbauer spectroscopy groups have been formed in several developing countries; especially in nuclear research centres where expertise on nuclear electronics is usually found. A part from producing some very interesting work, as this Panel meeting has demonstrated, these groups contribute to the general promotion of research activity and education in a significant way. One might call this result the *third Mössbauer effect*.

What is the actual situation of the third Mössbauer effect? In other words, what are the prospects of doing good (original) research in developing countries in the Mössbauer area?

This question is of interest not only for those working in these countries but to an increasing number of colleagues involved in exchange programs, either by going to laboratories in developing countries or by receiving people from these areas in their laboratories. It is also relevant to executives and administrators in international and national organizations which support programs with developing countries.

In the years which immediately followed the discovery of the Mössbauer effect, let us say until about 1963, much of the work done in developing countries was competitive with that done in advanced laboratories. This was a consequence of the nature of the phenomenon itself, which can be detected by relatively simple techniques, and also to the circumstances in which the discovery was made, which according to Mössbauer's own words were under conditions not very much different from those prevailing in developing countries.

However, a few years after we have found ourselves in increasing difficulties, arising mostly from technological developments occurring in the advanced countries: use of multichannel analysers, large computer facilities, low temperatures, high pressures techniques, etc.

Since about the end of the sixties these techniques have been available at the commercial level, and at the present time no fundamental changes are occurring in our field as regards these general techniques.

However, in spite of these facts, the situation of laboratories in developing countries is *not* similar to that existing in the early 1960's as regards competitiveness. The main reason for this is the fact that in most cases the technological transfer has not been achieved in the frame of harmonious development in those countries. This means in practice that in developing countries you can find laboratories equipped

with latest model multichannel analyser, good computers, low temperatures facilities, etc., but, for example, no X-ray installations, no metallurgical conditions for preparing samples and many other basic facilities. Moreover, these basic facilities have themselves developed tremendously in the past 15 years and the use of more advanced techniques in the Mössbauer field necessarily requires the use of sophisticated analytical methods, which are themselves in constant development.

It is perhaps for these reasons that fields such as mineralogy, geochemistry and archeology are being increasingly investigated in laboratories located in developing countries. And, it is interesting to note, not only with the purpose of finding applications of the Mössbauer spectroscopy to these fields, but also to raise problems of physics and chemistry from these areas of study.

Several examples of such investigations can be found : the physico-chemical studies of the iron oxides

from the Greek researchers which arose from archeological pottery studies ; or the synthesis of the iron phosphates by E. Mattievich in our laboratory which was motivated by paleontological investigations with the Mössbauer effect.

I don't mean here that the people working in developing countries should accept limitations in their scientific development. They need to have good laboratories for preparing purified materials, the best methods for analytical control, etc. However, their best contributions will most probably come from those areas where the starting materials are unique and may lead to unexpected discoveries.

With these sociological remarks, I arrive to the end of my talk. Before leaving the podium I want to express our gratitude to our Greek hosts and friends, to the Organizing Committee of this Conference and above all to our scientific secretaries, A. Kostikas and A. Simopoulos whose efforts have been largely responsible for the organization of our meeting.

