

Proceedings of
the International Conference on

**Applications of Physics
to Medicine and Biology**

Trieste, Italy
30 March — 3 April 1982

Edited by **G Alberi**
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World Scientific Publishing Co Pte Ltd
P O Box 128
Farrer Road
Singapore 9128

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ISBN 9971-950-42-1
9971-950-43-X pbk

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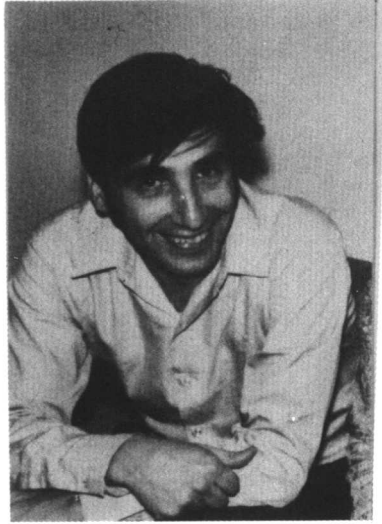
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Let this volume be an everlasting remembrance of our Friend and Colleague Giorgio Alberi. Let the memory remain with us of the dedication with which he worked during the last few years of his life towards the realization of the International Conference on Applications of Physics to Medicine and Biology.

Let us always remember his enthusiasm, his courage, his strength, as a driving force for all of us, Biologists, Doctors and Physicists, to unite our efforts for the welfare of mankind.

Editorial Preface

The International Conference on Applications of Physics to Medicine and Biology was held at the International Centre for Theoretical Physics, Miramare-Trieste from 30 March to 3 April 1982.

The main scope of this Conference was to encourage the application of contemporary physical methods to medicine and biology, through the world and especially in developing countries. For this purpose, emphasis was laid on giving a realistic picture of the stage of development of various fields in biochemical applications of physics. The Conference was devoted to i) general overviews on the subjects, including perspectives, ii) "hot spots", i.e. most interesting achievements and unresolved problems and iii) comparison of different physical methods applied to medicine and biology, bearing in mind actual medical application. Following this line, the core of the Conference were the invited talks selected to cover a wide range of related topics, such as radiotherapy with heavy particles, thermotherapy, radiobiology, physics in physiology, CT and radiography, isotope imaging, radioimmunoassay, ultrasonic and NMR imaging.

In addition to the invited talks there were contributed papers presented in four poster sessions. These reflected specific problems and achievements in a very broad spectrum of various biomedical applications of physics.

These proceedings contains an introduction written by C. Franconi, invited papers and summaries of the contributed papers which were submitted and accepted to be presented at the Conference. All manuscripts prepared in camera-ready form and received up to September 1982 are included. The programme of the Conference, list of participants and authors index are added at the end of this volume.

We should like to acknowledge continued support, assistance and effort in solving the organizational problems of all staff members of the International Centre for Theoretical Physics. We are especially grateful to Professor Abdus Salam, Director of the Centre, Professor L. Bertocchi and Dr. A. Hamende. Our gratitude is due to the secretaries and technicians who spared no effort to make the conference successful.

We also wish to acknowledge the invaluable scientific support and assistance in organisation of Professors C. Franconi, J. Clifton and L. Kaufman.

Finally, thanks are due to the World Scientific Publication Co., Singapore for facilitating and rapid publication of this proceedings.

The Editors

INTRODUCTION

The impact of medical physics is widespread and with it countless innovations have been brought into clinical practice besides new knowledge to the scientific world.

The introduction of physical scientists into the medical world is modifying clinical practice in various ways. The most striking change lies in the introduction of new responsibilities and modifications in the distribution of existing ones to a point that physicists now share the physician's role in many diagnostic, therapeutic and rehabilitation processes. Thus, after some forty years of outstanding progress with brilliant contributions, the physicist is no longer considered the "back room boy", unknown to the patient and regarded to many clinicians as just another paramedic accessory. The introduction of physicists and technological innovations in medicine has been shown to have also a more direct impact on clinical practice. The clinicians themselves are involved in every step of the innovative process in the creation of new methods and devices and their diffusion at professional level. They are involved in this process from the very beginning since they only know how and where the innovation can be introduced in the exploration and/or treatment of patients, and they must ascertain at which specific point of the pathological process an innovation might affect the evolution of the disease.

The introduction of medical physics is, however, bringing with it various problems. One side effect of technological innovation, for instance, is the introduction of an economical parameter in the organization of health care services which has to be taken into account in each step of any innovative process in order to avoid too heavy a burden on the national economy.

The presence of physical scientists in the operative field of medicine requires an efficient integration of the activities of physicists and engineers with those of clinicians and biologists. When a clinician or biologist needs to effectively communicate with the physicist involved in the development of an innovation, it is essential that they speak a common language. The language of science should, therefore, be used when this integration is to occur and this we know will play an important role in the development of both medical and physical sciences. In our opinion, after centuries of independent development of the various branches of the experimental sciences, the recent technological advances and achievements in physics and mathematics have created the opportunity for new approaches in many branches of research. These are now completely revolutionized in their aims and perspectives, but we feel that the impact is far greater on medicine and biology than on any other branch of science.

The close proximity of this meeting to the University of Padua, should remind us that the present high scientific achievements in medicine and biology have a parallel some four hundred years ago, when, at the beginning of the era of the experimental sciences, the experimental method was introduced into medicine. Let us not forget that the birthplace of modern medicine - and of medical physics - was the University of Padua. There Galileo, who was a student of medicine before being a student of mathematics, gave birth to a School which was as fruitful for medicine as for the experimental sciences. What might be considered the first modern experiments in medical physics were performed by Santorio Santorio - a pupil of Galileo - who converted some of the illuminating experiences of his tutor into methods of measure useful in medicine. Thus while on a memorable occasion Galileo, observing a swinging lamp in Pisa Cathedral, found the isochronism law of the pendulum by counting his heart beats, Santorio inverted the procedure and counted the heart beats of his patients by

using a variable length pendulum.

The physical basis of medicine remained the only scientific basis of diagnosis and therapy until the last century. The physical approach of this period was brought to the extreme consequences by Borelli, Malpighi and others, when they conceived the explanations of all physiological and medical phenomena in purely mechanical or physical terms. At a certain time, however, developments in medicine and biology came to a halt, and physics no longer played a useful role until the advances in biochemistry brought new vigor to medical research with the participation again of physical scientists who began to apply the new knowledge of radiation physics to diagnosis and therapy, with startling results. To make a long exciting story short, we have, over the last fifty years, watched the birth of a new era for biomedicine which has had recently the tremendous impulse that we observe today.

Looking at these developments in perspective, medical physics can be seen to have developed more as a branch of medicine and biology than as a branch of physics. This is proved by the steadily increasing number of physicists - well over several thousands - now working in medical environments as an integral part of the biomedical community. On the other hand, a gradual increase can be seen in the number of important projects on advanced physics of significance to medicine and biology, developed within Physics Departments. This interest indicates that developments in this applied field will enjoy enduring support by the physics community. A full fruitful cooperation between pure and applied physics is in fact the dream of all of us, and hopefully this occasion will help to convince those few colleagues who still fight a rearguard battle to maintain a net separation between pure and applied physics and who appear to confuse science with academic life.

The fact that this important was sponsored by the International Center for Theoretical Physics, is an expression of the

increasing involvement of the international physics community in medical physics, and we are most grateful to Professor Salam for the sensible attention and for his deep commitment.

On behalf of the Associazione Italiana di Fisica Biomedica I wish to thank Professor Giorgio Alberi, a sensitive and brilliant scientist whom we like to consider as the last, but not the least, addition to the medical physics community of this country, for the competent dedication and sacrifice with which he, his colleagues and staff, organized this meeting.

The presence of the distinguished physicists convened here, to whom medical physics owe so much and to whom I have the honour of extending the warmest welcome makes this meeting a very memorable occasion not only for the international community of medical physicists but also for our country.

C. Franconi
Istituto di Fisica Medica
Universita' di Roma

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