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Book Reviews

Mathematical Models of Gravity Effects on Pulmonary Functions. (Matematicheskie Modeli Deectviya Gravitatsie na Funktsie Legkich.) Vol. No. 51 of a series on *Problems of Space Biology*. (Problemi Kosmicheskoe Biology, A. M. Genin, Editor.) A. I. Dyachenko and V. G. Shabelnicov, Institute of Biomedical Problems. Ministry of Health of the USSR, Khoroshevskoye Shosse 76A, Moscow D-7 (Director of the Institute, Academician Oleg G. Gazenko, M.D.), Published by Moscow, Nauka, 1985, pp. 279

REVIEWED BY Y. C. FUNG[1]

This is an interesting book presenting a thorough review of the subject in its relationship to space flight. I am grateful to Dr. Gazenko for sending me a copy. The scope of the book is clearly seen from its chapter headings:

1. Mathematical models and experimental methods for investigating gravitational effects on pulmonary function.
2. Pulmonary gas exchange and its modeling.
3. Effect of gravity on pulmonary circulation.
4. Biomechanics of the lung under gravitational influence.
5. Effect of gravity on the distribution of ventilation and ventilation/perfusion ratio.
6. Influence of gravitation on the ventilation/perfusion inequality in stationary pulmonary gas exchange.
7. Dynamics of gas transport in the lung.
8. Mixing of gases in airway and lung.

The treatment is comprehensive, but brief, with emphasis on mathematical models. It is delightful to see that the authors begin each subject with the general governing partial differential equations, much as we do in our class rooms, but almost always advised by the editors of *Circulation Research* or *Journal of Applied Physiology* to omit or to put in an Appendix. The mathematical development given in this book is, however, extremely brief. Some topics, such as high frequency ventilation, were given only a short verbal discussion.

The list of references quotes 98 Russian publications and 372 papers written in English and German. Hence, it is fairly easy for an American reader to follow the General Review and Summary. Most of the numerical results are from the Russian literature, however, and to a Western reader the book is an excellent introduction to the Russian literature not only on the gravitational effect, but on pulmonary physiology in general.

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Electrocardiographic Body Surface Mapping, *Proc. of the Third Intern. Symp. on Body Surface Mapping*. Edited by R. Th. van Dam and A. van Oosterom, Univ. of Nijmegan. A volume in the series on Developments in *Cardiovascular Medicine*. Martinus Nijhoff Publishers, Dordrecht/Boston/Lancaster. Price: Cloth Dfl 175, US $75. £ 54.25 ISBN, 0-898 38-834-1. xviii + 311 pp. Publication date Jan. 86.

REVIEWED BY Y. C. FUNG

The objective of studying body surface distribution of electric potential is to solve the *inverse problem* of determining what is happening to the heart, similar to the study of seismological waves in order to learn about the structure of the earth. Clinically, the 12-lead electrocardiogram has been one of the most important methods for the diagnosis of myocardial infarction. It is natural then to inquire whether a large increase in the number of electrodes to cover the surface of the body more completely would yield more precise information about the heart. The answer is, of course, yes. But the practical utility depends not only on the gathering of the data, but also on the processing of the data, and more profoundly, on knowing what data to collect, and how to process the data. Thus body surface mapping of ECG faces the same basic problems of information theory as any other large scale information processing and discrimination programs, such as the evaluation of the patients in the intensive care units, the diagnosis of diabetics, or the forecasting of stock market.

The present volume presents an assessment of the present status and future prospects of body surface mapping of electric potential by 118 authors in 37 papers. There are 33 first authors, all invited by the Scientific Committee of the meeting, the members of which are B. Taccardi of Parma, Italy, F. A. Roberge of Montreal, Canada, and A. van Oosterom of Nijmegen, Holland. The first authors from the U.S.A. are Larry S. Green and R. L. Lux, from Salt Lake City, J. Liebman and Y. Rudy from Cleveland, D. M. Mirvis from Memphis, and R. Sylvester from Los Angeles.

The book is divided into 6 parts. (1) Normals, 4 chapters. (2) Myocardial Infarction, 5 chapters. (3) Conduction Disturbances, 8 chapters. (4) Recording and Display Techniques, 6 chapters. (5) Data Analysis, 8 chapters. (6) Model Studies, 6 chapters.

In Chapter 1, Taccardi describes the current instrumentation that enable the heart potentials to be recorded simultaneously up to 256 points. From these recordings various kinds of maps are produced: *Equipotential contour maps* at different instants of time, *Iso-integral* contour maps which display the time integral of the electrocardiogram, integrated over parts or all of the QRST interval, the *Departure Maps* that record departure from the normal population, and the *Isochrone contour maps* that depict the sequence of excitation on the heart surface or in the heart walls. The isochrones are usually obtained by determining the time of occurrence of the negative peak in the first derivative of the unipolar QRS complex. He then describes the experimental and clinical applications, and points out that the lack of standardization in instrumentation and method of analysis is the most serious problem.

In Chapter 2, L. Green et al. describe the study of 800 normal subjects and the determination of 216 coefficients characterizing each map. In Chapter 3, Spekhorst et al. presented some data on the healthy newborn.

A fairly large number of papers then evaluated the achievements of the method in clinical applications. It is useful to quote a summary by Taccardi (pp. 295–297) in a se-tion on "proven and promising applications of mapping". In the *proven column* are

1. Basic research tool. Superior to ECG.
2. Myocardial infarction.
3. Myocardial infarction in combination with left bundle branch block.
4. Right bundle branch block.
5. Partial right bundle branch block.
6. Myocardial infarction without Q-waves.
7. Acute myocardial infarction.
8. Coronary artery disease.
9. Induced ischemia, pacing and exercise test.
10. WPW. Noninvasive, better than cath lab studies.
11. Premature ventricular beats.
12. Right arterial enlargement.

In the *Promising* (further study needed) column are

1. Coronary artery disease.
2. Serial comparisons.
3. Hypertropy, obstructive cardiomyopathy.
4. Low level potentials, late potentials.

Details and more precise statements must be referred to the original papers presented in the book. Many articles contain informative computer graphics. The discussions on recording and display techniques and data analysis are impressive.

To the reviewer, the last six papers are the most interesting because they touch upon the *inverse problem*. In Chapter 32, R. M. Gulrajani, M. Lorange and F. A. Roberge of Montreal summarized the existing computing methods of the forward problem. In Chapter 33, Y. Rudy of Cleveland, Ohio presents an analysis of both the forward and the inverse problem of an idealized model of the heart and torso system as an eccentric spheres system: the torso being a large sphere enclosing a small sphere which represents the heart. The model is simple enough to be solved analytically, yet sophisticated to include torso inhomogeneities. It is a simple and attractive model.

In Chapter 34, Y. Yamashita of Tokai University, Japan used the finite elements method to solve the inverse problem. He examined the accuracy of the solution and the ill-posedness of the inverse problem. The problem formulated is the static cauchy problem, not a wave propagation.

In Chapter 35, E. Nyssen et al. of Brussels compared the solutions of a centered horizontal dipole in a homogeneous finite cylinder by three methods described in the literature, found that two solutions are equal, whereas the third one is different, and decided that the third one is wrong. It is an interesting story of sleuthing.

In Chapter 36, M. Aoki et al. of Tokyo insisted that the inverse problem is too difficult to solve without the input of all we know about the ventricle. Hence they developed computer simulation of the propagation of depolarization and repolarization in the myocardium. They used the model to compute the 12 lead ECG, the VCG, and the body surface map throughout the QRSt period. It is a very good paper, but it does not solve the invese problem except to complain that "the inverse problem is not very promising".

As a mathematical problem the inverse problem in many specific fields is attracting a great deal of attention these days. The reveiewer is sure that all the details of the body surface mapping method in electrocardiography will be sorted out some day and will be brought to the clinics of the world.

Foundations of Aerodynamics, *Bases of Aerodynamics Design*, Fourth edition, by *Arnold M. Kuethe* and *Chuen-Yen Chow*, Univ. of Michigan and Univ. of Colorado, John Wiley & Sons, New York 1986, ISBN 0-471-80694-3, xiii + 555 pp.

REVIEWED BY Y. C. FUNG

I own a copy of the first edition of Arnold Kuethe and John Schetzer's *Foundations of Aerodynamics*, and it has been one of my favorite books over the years. It is therefore a special delight to receive this fourth edition. This is a much thicker book than the previous editions, in many ways more advanced in mathematical treatment, and to my delight, contains an Appendix entitled "*Prototypes in Nature*." In this chapter Dr. Kuethe discusses the evolution of flight, the control and maneuvering in bird flight, the flight of small insects, and the mechanism of generating lift by the little moth which use the "clap-and-fling" motion of the wings. In the mid-seventies Dr. Kuethe became interested in the flight of birds and insects. He wrote an interesting paper "On the mechanics of flight of small insects" which was published in *Swimming and Flying in Nature*, Vol. 2, pp. 803–814, (ed. by T. Y. Wu, C. J. Brokaw, and C. Brennen), putting forward a theory of the wings of thrips with supporting experimental data. His delightful article in the *Technicum*, (a Univ. of Michigan Pub., 1975) bearing the same title "Prototype in Nature"goes much deeper into the subject than the Appendix C in the same present book; but this Appendix will do for a beginner.

This book contains a wide range of subjects. The chapter headings are: 1) The fluid motion, 2) Kinematics of a flow field, 3) dynamics of flow fields, 4) Flow about a body, 5) Aerodynamic characteristics of airfoils, 6) The finite wing, 7) Introduction to compressible fluids, 8) The energy relations, 9) Some applications of one-dimensional compressible flow, 10) Waves, 11) Linearized compressible flow, 12) Airfoils in compressible flows, 13) Wings and wing-body combinations in comressible flow, 14) The dynamics of viscous fluids, 15) Incompressible laminar flow in tubes and boundary layers, 16) Laminar boundary layer in compressible flow, 17) Flow instabilities and transition from laminar to turbulent flow, 18) Turbulent shear flows, 19) Airfoil design, multiple surfaces, vortex-lift, secondary flows, viscous effects. With such a broad coverage, the presentation is generally succinct. Dr. Kuethe's life time experience in teaching makes the presentation extremely lucid.

Bioengineers need to know external flow when they deal with locomotion. They need to know internal flow when they deal with circulation, respiration, and body fluid movements. The relevant chapters in this book can serve as an introduction to these subjects. We can pass over most of that stuff about compressible fluids, of course. That's for aeronautical engineers.