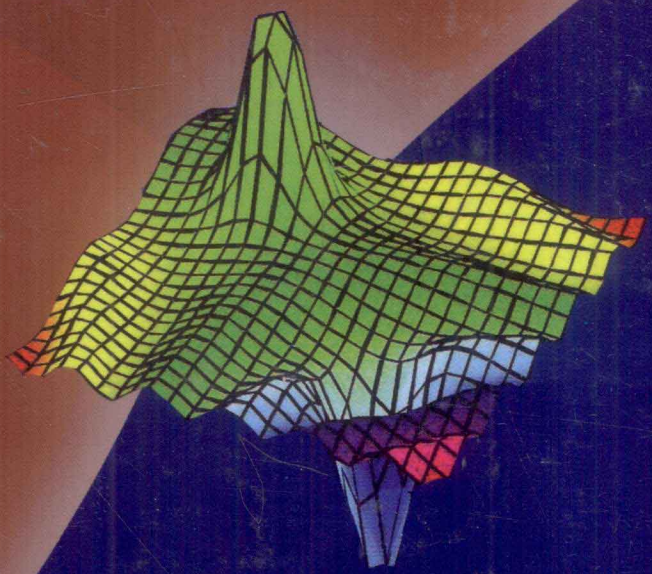
献给郭友中教授75岁寿辰暨55年科研与教育生涯！

Dedicated to Professor Youzhong Guo on his 75th birthday and 55 years scientific career!



数理科学若干领域进展

PROGRESSES IN SOME FIELDS OF MATHEMATICAL SCIENCES

主编 EDITORS

章国华(Kok Wah Chang, University of Calgary, GARY T2N IN4, 加拿大)

卢绍芳(Shaofang Lu, 中国科学院福建物质结构研究所，福州 350002，中国)

陆淑兰(Shulan Lu, 清华大学数学科学系，北京 100084，中国)

谢干权(Ganquan Xie, GL Geophysical Laboratory, Berkeley, CA 94708，美国)

科学出版社

献给郭友中教授75岁寿辰暨55年科研与教育生涯！

Dedicated to Professor Youzhong Guo on his 75th birthday and 55 years scientific career!

数理科学若干领域进展

PROGRESSES IN SOME FIELDS OF MATHEMATICAL SCIENCES

主编 EDITORS

章国华 (Kok Wah Chang)

卢绍芳 (Shaofang Lu)

陆淑兰 (Shulan Lu)

谢干权 (Ganquan Xie)

科学出版社

内 容 简 介

数理科学是数学与其他学科的边缘交叉科学，包括数字技术，它在信息社会中扮演着越来越重要的角色，高科技产品本质上几乎都是数字技术的硬化. 数学在研究物理科学、事理科学、管理科学、生理科学、心理科学和哲理科学的复杂问题中是不可或缺的分析手段，它们的交叉结缘丰富着数理科学的内容. 本书主体是数学边缘性科学论文，反映了范围广泛的当代数学与其他科学交叉的思想和研究成果. 本书对范围广泛的研究活动给出了评价，论述了最新的成就，提出了某些未来研究的方向. 郭友中教授作为这些领域的领头专家，他的贡献将得到庆贺，前言和后语都将用来专门介绍他的科学成就和事业人生. 联结各章使之成为整体的基本主题是来自偏微分方程和动力系统的深刻思想和专精技巧.

本书可供数学、力学、物理学、工程科学、生命科学、信息科学、金融科学、交叉科学各分支的研究者和教育工作者参考，也可以作为自然科学其他各分支研究者的参考书.

图书在版编目(CIP)数据

数理科学若干领域进展/章国华等主编. 北京：科学出版社，2011.11

ISBN 978-7-03-032787-1

Ⅰ.数… Ⅱ.章… Ⅲ.数学－数学进展 Ⅳ.O1

中国版本图书馆 CIP 数据核字(2011)第 233908 号

责任编辑：张颖兵 梅 莹/责任校对：闫 陶

责任印制：彭 超

科学出版社 出版

北京东黄城根北街 16 号

邮政编码：100717

http: www.sciencep.com

武汉中远印务有限公司印刷

科学出版社发行 各地新华书店经销

*

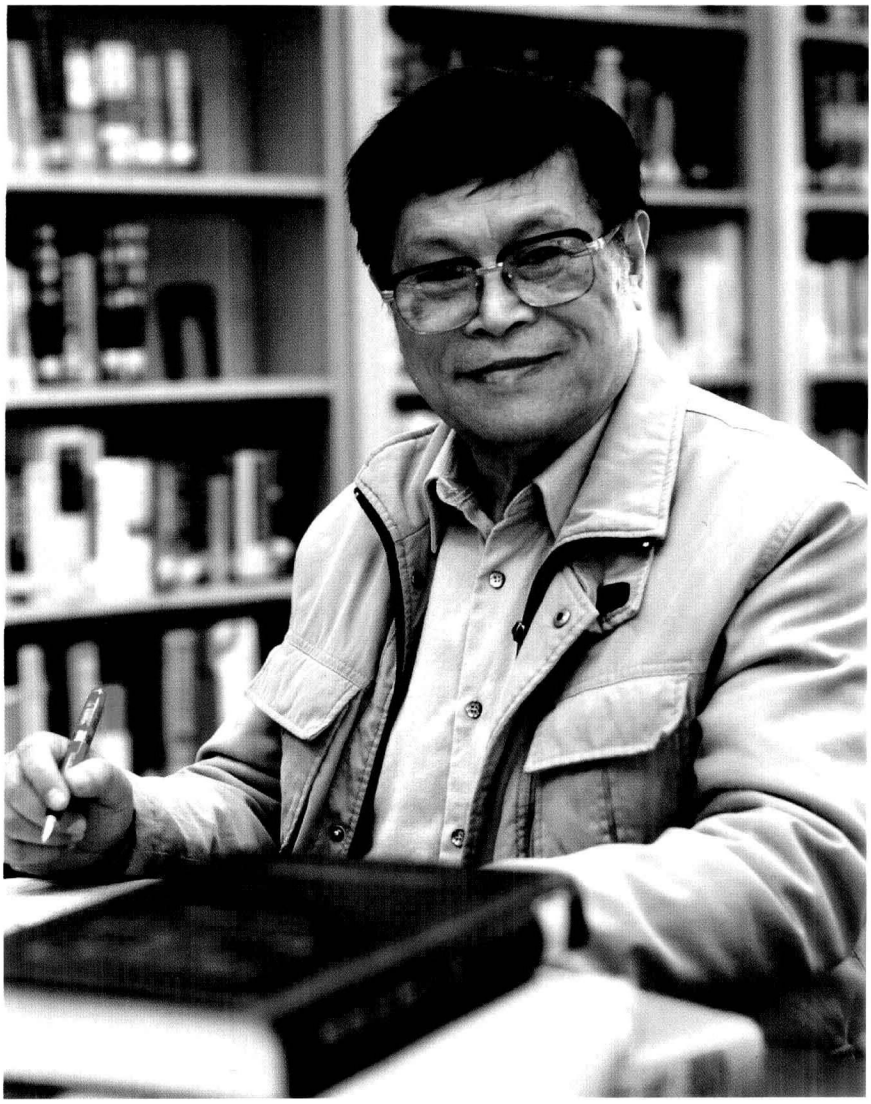
开本：B5(720×1000)

2011 年 11 月第 一 版 印张：20 1/4

2011 年 11 月第一次印刷 字数：455 000

定价：98.00 元

(如有印装质量问题，我社负责调换)



郭友中教授 (Professor Youzhong Guo)

数理科学若干领域进展
Progresses in Some Fields of Mathematical Sciences
献给郭友中教授75岁寿辰暨55年科研与教育生涯!

主编的话(Editorial Foreword)

本书与英国世界科学出版公司最新出版发行的 *Prospectives in Mathematical Sciences*(数理科学展望)、中国国际文化出版社出版发行的《数理科学纪录(*Memorials in Mathematical Sciences*)》是三个姊妹篇. 精选入本集的论文反映了数理科学范围广泛的当代学科前沿的研究活动,包括数学与数理科学、曲梁驱动器的大变形电动力学特性分析、非标准非齐次热传导方程的非齐次项识别与正则化、随机动力系统与现代应用数学、常系数偏微分算子不适定 Cauchy 问题的正则性、带时间窗的允许工件重复中断情况下排序问题的处理、隐蔽被覆和宽频 GL 被覆内激发不了 Maxwell 电磁波、结合材料的裂缝问题、随机矩阵特征值的近似计算及其应用、非 Gauss 振荡下力系统展望、科学洞察力与新型簇合物的合成及结构特征、泛系论与泛数学、并发软件的图形化设计方法研究、整体与局部场 EM 模型及新的双层电磁 GL 被覆、系统演化与演化经济学、4S 一体化监测预警系统、正则二维非齐次后向热问题的正则化、圈引力中的 Gauss 编织态的度量算符,以及《数理科学展望》与《数理科学纪录》两书的简介.

书中各章的先后也是基本按照第一作者的姓氏拼音字母为序排列的.

我们非常感谢为本书做出贡献的所有作者,他们大多是论题的原创者或该领域的领军人物. 我们要特别感谢为此次庆祝活动的出版物专门撰写前言和后语的侯振挺教授和金汉平博士,他们分别向读者提供了对郭友中教授的光辉事迹和传奇人生的生动介绍. 我们还要感谢科学出版社对本书的编辑出版.

我们深感荣幸,在我们的同事和终身的朋友——郭友中教授75岁寿辰和教学研究数理科学55年的时候,将本书献给他!

章国华(Kok Wah Chang, University of Calgary, Calgary T2N 1N4, 加拿大)
卢绍芳(Shao-Fang Lu, 中国科学院福建物质结构研究所, 福州 350002, 中国)
陆淑兰(Shulan Lu, 清华大学数学科学系, 北京 100084, 中国)
谢干权(Ganquan Xie, GL Geophysical Laboratory, Berkeley CA94708, 美国)

数理科学若干领域进展
Progresses in Some Fields of Mathematical Sciences
献给郭友中教授 75 岁寿辰暨 55 年科研与教育生涯!

Preface(前言)

Zhenting Hou(侯振挺)

This festschrift volume is dedicated to Youzhong Guo on his 75th birthday and 55 years of scientific career.

Youzhong Guo Born in Hangzhou, China, on 25 October 1935 and graduated from Nanjing University of Technology in 1955, whereupon he was assigned to Institute of Mathematical Sciences, Academia Sinica, as mathematician Professor Guoping Li, academician of Academia Sinica. As an active scientist with great influence, Professor Guo has been engaging in mathematical sciences research over a long period of time, with many well-known achievements. His published theses, treatises and translations number over one hundred, referring in pure, applied mathematics and others, especially in mathematical physics, system science and mathematical economics, eleven of them prize-winning, were highly praised by the senior scientists Guoping Li, Buqing Su, Zhaozhi Guan, Wei-Zang Chien, Jia-Xi Lu, Jian-Kang Liu, Min-de Cheng, Shisheng Ding et al., and his colleagues Deren Li, Zhenting Hou, Zhongheng Guo, Haichang Hu, Kaiyuan Ye, Xuemo Wu, Shiqiang Dai et al., academicians of Academia Sinica and renowned scientists. His influence through lectures and seminars was strong and beneficial far beyond his fields.

Since 1979 Professor and Executive Vice-Director of the Institute of Mathematical Sciences, Academia Sinica, and Chairman of the Institute's Academic Committee; then Youzhong Guo was elected as Vice-Chairman of the Chinese Society of Industrial and Applied Mathematics, Chairman of the Rational Mechanics and Modern Mathematics Commission of the Chinese Society of Mechanics. He serveded Chairman of Wuhan Municipal Commission of Science in 1987. Among his other past and present positions, too numerous to list in full, are: Honorary Professor and Honorary Director of various universities at home and abroad; Editor-in-Chief or Editor of Lecture Notes for Mathematics, Acta Mathematica Scientia, Applied Mathematics and Mechanics, Structural Analysis Systems and Engineering Analysis International; Director of the

System Engineering Society of China etc., Chairman of Wuhan Society of Industrial and Applied Mathematics and Wuhan Society Of System Engineering, Chairman of the Central University Wuhan Alumni Association, etc.

In the 1950's

He successfully replenished and transformed all his knowledge for an architect to that of a mathematician, committed to mathematical sciences, under the guide of Professor Guoping Li. He studied mainly the theory of constructing and approximating functions, analytical theory of differential equation; and generalized the variational principles; researched the error estimates of differential equation's solutions in Sobolv space and its transformation to another spaces with different topologies. Designed Wuhan Laboratory of Electrostatic Acceralator, Chinese Academy of Sciences. With Professor Guoping Li, to take a cooperative research task between the Academy of Sciences of Soviet Union and the Chinese Academy of Sciences, studied the theory and application of Minkowski function for a long time. Have supplied the lack of all proves need for all theorems contained in the cooperation project, developed and researched the relationship among autormorphic functions and Minkovski functions, differential equations, quantum theory and elastity, gerneralized especially the Hilbert boundary value problem in regard with Muskhelshvili school on the theory of continuum mechanics to the boundary value problem of automorphic functions (including multiply connected regions), and incloding the closed solutions. The results were published as the first monograph of its kind in the world, the Theory of Autormorphic Functions and Minkovski Functions 1978.

In the 1960's

For field theory and the 3-Gorge Project, he studied the principles of transformation of fiber bundles for the general relativistic quantum field know as L-G method, presented a new natural representation of exterior differential much simplified calculations and analysis. He also put forward some new methods for analysis of large scale projects, such as rheology theoryof limit equilibrium, 1960 (generalized the theoryof limit equilibrium, Stalin Prize winning), stability analysis of side slopes, strass analysis of tunnels and dynamic analysis of blastings applied for the 3-Gorge. By conversing x-ray spectrum of the samples into visible one, manufactured sensitive film, multiply accelerated the Test Laue (Max von Laue, 1879～1960) in solid state physics. In so called "Cultural Revolution", Chinese Academy of Sciences was abolished, and he suffered 10 years (1968～1978) of unjust imprisonment and stray.

In the 1970's

In extreme difficult circumstances, he accomplished numerous designs for architecture and automatic system engineering, when he was behind bars. For example, from quantitative effective mass to tensional way, he developed the energy

band theory to the anisotropic energy belt theory of semi-conductor (1977), in Statistical Physics. Based the studying of stochastic character of rock and soil and similarity between transmission cables and earthquake waves, established statistical theory of rock and soil (1978) and mathematical seismology (1979). After the 'Cultural Revolution', he was appointed as a Executive Director in charged of restorating and reconstructing the Institute for Mathematical Sciences of Chinese Academy of Sciences, tried hard in formation of three platforms: Journal (Acta Mathematia Scientia), Association (the Chinese Association of Mathematical Sciences) and seminars(Annual Conference of Mathematical Sciences).

In the 1980's

Focusing on investigating the non-linear phenomenones, established the mathematical foundation for a method of structural analysis, and solved the open problem that had remained unsolved over half a century. He provided the variational representation theory of plastic dislocation, and the existence and uniqueness theorem of micro-elesto-visco-plasticity which was proved by variational inequality method. He also set up the saturated porous medium magneto-hydro-dynamics mathematically, corrected some major errors in electro-magnetic theory and generated a new model for seismology and bio-mechanics. Through studying by the asymptotic method, proved surprisingly the occurrence and propagation of global singularities in the gradient problems. And so he was elected the writer of main entry-Mathematical Physics, in Great Chinese Encyclopedia, Director of Wuhan Institute for Industrial and Applied Mathematics, Chairman of Wuhan Society of Industrial and Applied Mathematics and Wuhan Society of System Engineering, etc.

In the 1990's

He was selected as Vice-Chairman of the Chinese Society of Industrial and Applied Mathematics, Chairman of the Rational Mechanics and Modern Mathematics Commission of the Chinese Society of Mechanics. Because of his great achievements of natural science combining with social science, he was selected as Chairman of Wuhan Commission of Science and Technology, and then Vice Mayor of Wuhan City. He has exerted all his energy to the development of the local economy, education, sciences and culture. To raise the level of modernization, scientific planning and management of the city, a non-linear dynamic urban comprehensive planning and intelligent decision making system-Mayor Engineering was settled. Being responsible for the high-tech, he always did his best such as for raising comprehensive power of the city, for empowering the living standard of the urban poor and developing the human resources in a scientific, practice and persistent way. He helped to establish new university through a decade's efforts. Within his tenure, the East-Lake High-Tech Development Zone was approved by the Central Government and listed number one among manes. Busy though he was, he continued studying mathematics in his spare time, two monographs, named the Methods of Mathematical Physics and the Operations

Research and Applications, were published(with others).

In the New Century

From the beginning of 2000, he devoted himself sustainablly to developing education, modernizing the city, and improving the quality of the human resources. He was appointed as the leader of the national project, the Developing Strategy Research for Middle China Economic District along Yangtze River with a research group including 12 academic members, 36 professors and 38 young researchers, investigated the rapid developing of district and river economy and society systematically. As the result, in comparaing with thermodynamics evoluting, a series of 10 volumes were published. Through a mathematical research, Evolution Economics was developed and its mathematical foundations were reconstructed, the result was summarized in his new specialized work. As a reference of strategy decision making, it was submitted to Central Government, to make the district be a creative center in the country.

As an honorable member, consultant or chairman of steering or academic committee of many conferences and organizations, at home and abroud, Professor Guo has had frequent invitations for visiting and lecturing, and has been accorded a courteous reception by world-famous scientists. Academicians such as Gauss Prize winner Kiyoshi ITO, Fields Medal winner Heisuke Hironaka, Chang-Lin Tien and Chen-To Tai et al. , famous professors such as Kok-Wah Chang, Din-Yu Hsieh, Chio-Min Hsieh, David Kinderlehrer, P. D. Panagiotopoulos, Helmut Koster and Kiyoo Mogi et al. , have all become his close friends, regardless of significant age difference and nationality. Highly praised for his research works, which reflect the progress in inter-disciplines, he has received recognition for his valuable contributions in the fields of mathematical science and mechanics. In short, as a scientist and an administrator, he really contributed tremendously for his research works and for modernization and internationalization of Wuhan City, showing the ultimate fortitude. His main efforts of applying non-linear mathematical methods to transfer agriculture to industry, peaseant to worker and rural to urban, have been received special prize of the State Science and Technology Committee of China.

侯振挺

Zhenting Hou
Professor of Mathematical Science
Central South University
zthou@csu. edu. cn
2009-02-09

数理科学若干领域进展
Progresses in Some Fields of Mathematical Sciences
献给郭友中教授75岁寿辰暨55年科研与教育生涯!

前言(Preface)

郭友中 1935年10月生于杭州,1955年毕业于南京工学院,然后在中国科学院数理科学研究所,作为著名数学教授、中国科学院院士李国平所长的助手(1963年)从事研究工作. 郭友中教授是一位活跃而有广泛影响的科学家,长期从事数理科学研究,硕果累累. 他的论文、报告、著作和译作超过200篇,内容涉及数学、应用数学以及其他学科,特别是数学物理、系统科学和数理经济,其中11篇获奖,受到三代科学家、科技教育工作者的热情支持与高度称赞,影响通过报告和研讨会远远超出了他的研究领域.

1979年起,他任中国科学院数学计算技术研究所研究员、常务副所长、学术委员会主任;接着,他被选为中国工业与应用数学学会副理事长、中国力学学会现代数学与力学专业委员会主任. 1987年,他荣任武汉市科学技术委员会主任. 他过去和现在的职务,为数太多,无法一一列举,如国内外大学名誉教授和研究所名誉所长,《数理科学讲座》、《数学物理学报》、《应用数学和力学》、《法国结构系统》、《英国结构分析》等主编、执行副主编或国际编委,中国系统工程学会等理事,武汉工业与应用数学学会、武汉系统工程学会等理事长,武汉欧美同学会常务副会长,中央大学武汉校友会会长等.

20世纪50年代 师从李国平教授,他成功地将他原来作为建筑师的知识补充转变成了研究数学需要的基础,投身数理科学,主要从事函数构造与逼近理论、微分方程解析理论以及广义变分原理的研究;得到了Reimann映射定理的逼近误差、Sobolv空间中方程解的误差估计及其在不同拓扑空间中的转化. 他设计了中国科学院武汉静电加速器实验室,与李国平教授共同承担了中国科学院与苏联科学院的关于Denjoy-Minkowski函数的理论及应用的合作研究任务,经历了长期的思索与探究,补给了合作要求的全部证明,研究发展了与自守函数以及与微分方程、弹性理论和量子化的关系,将Muskhelshvili学派关于流体力学和弹性理论的Hilbert边值问题的研究结果放松条件推广到了自守函数边值问题(以多连通区域为特例),并得到闭合解,成果于1978年结集出版,成为世界上这一领域的第一部专著——《自守函数与闵可夫斯基函数》.

20世纪60年代 他研究场论,并参加三峡工程研究任务. 研究一般相对性量子场论,提出并证明了纤维丛转化原理(L-G方法),用以探讨基本粒子的内外运动场方程的纤维丛微积分关系,由于狭义相对论Maxwell方程的纤维丛积分有两种方式转化为广义相对论Maxwell方程,导致两种外运动方程分别描述正反两种光子的猜想:光子的

反光子不再是它自身;提出了外微分形式的一种新表示,大大简化了场论的分析与运算;对巨型工程项目提供了新的分析方法,如将获斯大林奖的极限平衡理论推广为极限平衡流变理论(1960 年),为三峡边坡稳定分析、隧洞应力分析和爆被动力分析等提出计算方法;利用将样品的 X-射线谱转化为可见光谱的方法,成倍地提高感光速度,加速了固体物质的 Laue (Max von Laue,1879～1960 年)试验,大大缩短了试验周期. 在"文化大革命"中,他蒙受不白之冤,因莫须有的罪名身陷囹圄.

20 世纪 70 年代 在铁窗之后,极端困难的条件下,他仍然完成了大量建筑设计和自动控制系统工程,用将半导体中导带电子与价带空穴的有效质量分别推广成有效质量张量的方法,推广运输方程,合作建立了各向异性能带统计理论(1977 年);基于岩体与土壤组分的随机性和地震波传输线相似性的研究,他和李国平教授建立了统计岩体理论(1978 年)和数理地震学(1979 年).

"文化大革命"以后,他被任命为常务副所长,负责恢复和重建中国科学院武汉物理与数学研究所. 他为加快学科的发展,身体力行、竭尽努力,实现了刊物(数学物理学报)、学会(中国数学物理学学会)和研讨会(中国数学物理学研讨会)三个平台的建设.

20 世纪 80 年代 他建立了著名的力矩分配法的数学基础,解决了半个多世纪以来没有解决的收敛悬案;致力于非线性现象的考察,用变分不等方程,提供了塑性位错理论的变分表示,证明了微极弹粘塑性理论问题解的存在唯一性定理;建立了多孔饱和磁流体动力学数学模型,纠正了磁流体动力学中的某些重要错误,为地震和生物力学提供了新模型;通过渐近方法的研究,在一类梯度问题中,出人意料地(合作)发现了大范围奇性的传播. 他因之入选为《中国大百科全书》主条目数学物理的执笔人,当选为武汉工业与应用数学研究所所长、武汉工业与应用数学学会与武汉系统工程学会理事长等.

20 世纪 90 年代 他被选为中国工业与应用数学学会副理事长、中国力学学会现代数学与力学专业委员会主任. 由于在自然科学与社会科学结合上的成功,他被选为武汉市科学技术委员会主任,接着任武汉市副市长、武汉市东湖新技术开发区领导小组执行组长、武汉市海外交流协会会长. 他集中精力于区域经济、教育、科技与文化的发展;为了提升城市的现代化、科学规划与管理水平,设计了城市综合规划与智能决策非线性动力系统,被称为"市长工程",推动了演化经济学及其应用研究. 作为高科技方面的负责人,他对用科技力量提高城市综合实力、改善城市居民的生活、提高人力资源水平,不遗余力、持之以恒;他用 10 年的努力帮助呼吁新大学的建立;在他任职期间,他主管的东湖高新技术开发区被国务院批准,在 26 个国家级开发区中排名第一(1991 年). 他虽然很忙,但仍坚持利用业余时间研究数学,合作出版了两部专著:《数学物理方法》(1993 年)与《运筹学》(1992 年).

21 世纪 2000 年伊始,他即投入教育持续发展、城市现代化和人的素质的提高工作. 他被指定为"长江中游华中经济区发展战略研究"国家重点攻关项目负责人. 项目研究组有 12 位院士、36 位教授和 38 位中青年研究工作者,对比热力学的发展阶段和过程演化,系统研究城市、区域、流域经济社会的快速发展,成果总结成了一套 10 卷本的丛书出版(2003 年);重构了数学基础,发展了演化经济学,出版了专著;研究成果作

为决策参考提交给了国务院，促使区域加速成为国家的一个新的创新中心.

作为国内外许多会议和组织的学术或组织委员会的荣誉成员、顾问或主席，郭教授经常被邀请访问和作报告，受到世界各地著名科学家的礼遇，并不分年龄和国别与他们成为忘年之交和异邦好友. 他的研究工作反映交叉学科的进展，得到数理科学和力学界同行的广泛承认和高度评价. 总之，作为科学家，他为科学研究做出了卓越的贡献；作为管理者，他为武汉市的现代化和国际化不遗余力；他利用非线性方法于推动农业转化为工业、农民转化为工人、农村转化为城市的主要努力获得国家科学技术委员会的特别奖.

侯振挺　作
数理科学教授
中南大学
长沙市麓山南路
zthou@csu. edu. cn
2009 年 2 月 15 日

欧阳苏黎　译
理学博士
Cornell University
Ithaca. NY 14863. USA
suli. ouyang@gmail. con
2009 年 3 月 8 日

数理科学若干领域进展
Progresses in Some Fields of Mathematical Sciences
献给郭友中教授 75 岁寿辰暨 55 年科研与教育生涯!

目录(Contents)