

第四统计力学

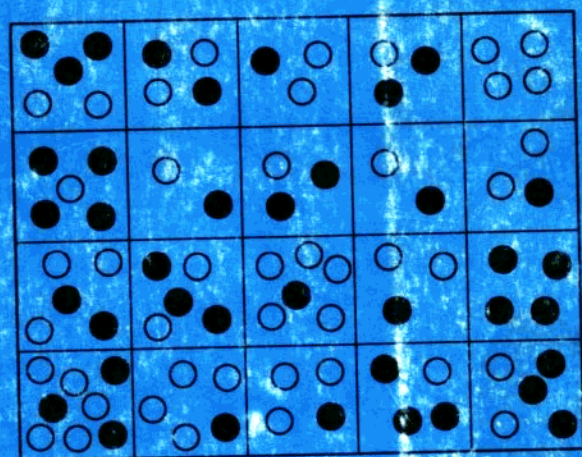
—JRG 群子统计理论

The Fourth Statistics

—JRG Sub-cluster Statistics Theory

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序 言

在当代自然科学领域里,有三大统计力学,即 Boltzmann—Maxwell 经典统计力学理论、Bose—Einstein 量子统计力学理论和 Fermi—Dirac 量子统计力学理论。这些理论对某些非量子统计体系及量子统计体系的研究,作出了不可磨灭的贡献。但是在自然界中许多群体所处的状态数并不象 Boltzmann—Maxwell 统计体系那样,远远地大于其中的粒子数目;也不象 Bose—Einstein 统计体系那样在一个状态中可以无所限制地容纳粒子;也不象 Fermi—Dirac 统计体系那样,一个状态最多只能容纳一个粒子。如果将上述体系的状态看作是一种客观实体(“场子”)来看,这就变成“场子”和粒子在空间线性排列分布的问题。在这种情况下 Bose—Einstein 统计体系变成一个“场子”后头可以跟上许多粒子的问题;而 Fermi—Dirac 统计体系则变成一个或者若干个“场子”后头只能跟上一个粒子的问题;Boltzmann—Maxwell 统计体系只不过是“场子”的数目远远超过粒子数目的问题,而这三种统计力学理论都不能处理若干个“场子”和若干个粒子同时共存或者它们互为共存并交替长串排列的问题。例如实际存在的非理想气体(非量子气体),可以看成由两部分组成:一是气体分子群体;二是空间“场子”(简称“空子”)的群体。这两者间可以互相作用。这样就会发生气体分子间互相“缔合”成更大粒子群或者被“空子”所隔开,这样最终形成若干个气体分子和若干个空子共存的最佳状态。这种气体的行为是无法用上述三种统计力学来加以研究和探讨的,更无法从这三种统计

力学理论来直接推导出 Van der Waals 非理想气体方程。又如在汽-液相平衡中,即在二元体系的溶液中,如从局部的微观尺寸上看,也有若干个第一类分子和若干个第二类分子共存的问题。同样对这种体系用上述三种统计力学理论是无法加以研究的。在自然界和社会现象中这种群对群的情形远远超过了三种统计力学所代表的有限群作用的情形。这里不再举具体实例了,请读者只要看看本书目录所列的那些实例,就足以了解这一问题。正因为这些原因,促使作者思考了第四统计力学理论—JRG 群子统计理论问题。本书的主要使命就在于通过许多实例来证实第四统计力学理论的客观存在性和研究它的必要性,同时证明上述三种统计力学理论的方程是第四统计力学理论方程的某种特例。本书为了使读者能够便于理解,分三大篇来进行了详细的论述;其中第一篇是基本概念和基本理论部分;第二篇是第四统计力学与物理化学理论之间衔接问题;通过这一部分来说明第四统计力学在处理群对群的问题上的优越性。第三篇是有关应用部分,这里着重举出了高分子材料领域里有关高强超韧问题的实例,以示这一理论的实际意义。在这三篇中处处有“群子”、“对立统一”、“群对群的竞争”、“群子的活化能”、“群子标度”等概念,也涉及到自然界自由秩序的能量最低原理和规整秩序的能量最高原理。这些都是核心概念,请读者阅读这本书时细细思考其内涵,这将对了解全书的实质是大有益处的。

本书的原型为“模糊群子论”,这是一本线性群子理论的书,1985年由黑龙江科学技术出版社出版,当时只印了2000多本,很快就销售完毕。此后许多读者提出能否再版,但考虑到这本书只论线性理论,而不涉及群子和群子间次级作用的非线性问题,加之等

待许多方面的应用,所以没有再版上面一书。此次这本书兼顾了线性和非线性理论及其它各个方面的应用,故比较完整。但也应当特别指出作者所从事的工作,主要与高分子科学与工程、流变相态学及其工程技术有关,且作者运用这些理论研制了许许多多高强超韧高分子合金、电流变材料等,荣幸地获得了中国各级政府的许多奖励,所以在整书中这一部分的内容最多,有些内容还涉及到统计体系的“研制”问题。似乎是多余的,但是考虑到制备方法对统计体系的影响很大,所以尽可能作详细的论述。故请其它领域的读者给予谅解。

还应该指出,感谢 IUPAC 在国际学术会议(1993)上首次接受这一群子理论为第四统计力学理论;还感谢 Chemical Abstract (1994)刊登了作者发表的有关“第四统计力学理论的现状与展望”的详细摘要;还有美国 ABI“Five Hundred Leaders of Influence ”中介绍了第四统计力学的由来。这些都为这本书的出版开辟了道路;特别是韩国宣文梅地亚(株)出版社敢于出版这本书,并将译成英文出版的精神,可为敬佩,这将是这本书走向世界的重要步骤。我相信中国人特有的“对立统一”的理论一定能够融会到世界科技和工程中。

在写作这本书时,我所指导过的三十多名博士生,在他们的博士学位论文中都涉及到第四统计力学问题,而且用这一理论来顺利地解释和预测了他们自己的研究结果,而这些内容也正是这本书的第一手素材,也是他们提供的。为了纪念这些内容的来源,在相关的地方都提到了他们的名字,在这里不一一列举了,在此向他们再次表示真挚的感谢。

还要感谢中国北京化工大学高分子材料国家重点学科和应用化学学科的张玉川教授、曾宪玉老师及我的学生胡孝义、杨明山、袁兵、孙明云、陈松、付谣等为本书而作的艰苦的打字、编排工作。还要特别感谢唐敖庆院士、徐禧院士、徐端夫院士、沈家骢院士、汤心颐教授、武冠英教授、卢焕章教授等前辈们对我第四统计力学理论所给予的高度评价。

还要感谢韩国尹汝伯先生为出版这本书而作的多方面的努力。感谢为出版这本书在经济上给予帮助的北京生态动力素制造有限公司的董事长兼总经理尹吉山先生。

最后,值得特别提到的是,根据作者在过去十几年中所得到的经验,感到这一理论开始不易被人们所接受,很难掌握住这一理论的广义性、普遍性和实用性,难以将这一理论具体应用到实际问题,但一旦掌握了,用起来非常顺当。因此,在应用部分不得不有些重复性论述,以便通过相似的处理方法使读者真正掌握基本的方法。建议初学的读者和性急的读者要采取耐心的态度,以便进行独立思考。作者相信,读者只要踏入这种境界,那么肯定会提出许多有益的问题,并联想到如何将这一理论应用到自己的研究领域中,乃至做出更好的研究成果,这便是作者最大的愿望。

作者:金日光

一九九八年七月于中国北京

Preface

In the current natural scientific field, there are three statistical mechanics, i. e. , Boltzmann — Maxwell classical statistical mechanic theory, Bose — Einstein quantum statistical mechanic theory and Fermi — Dirac quantum statistical mechanic theory. These statistical theories have being made many indelible contributions to the studies on the system of non — quantum statistics and some systems of quantum. But in the nature, not being the same as presented in Boltzmann — Maxwell statistical theory, the state numbers of many systems are not more than that of their particles; not being the same as presented in Bose — Einstein statistical theory, particles indefinitely come into a state; also not being the same as presented in Fermi — Dirac statistical theory, a particle enters at most one state. If the state mentioned in above theories is regarded as a objective substance, i. e. , "unit space" of field, it become to be the problem how particles and "unit space" arrange and distribute linearly in space. Under this condition the Bose — Einstein system become the problem that many particles can follow after a "unit space" of field, whereas the Fermi — Dirac system become to be the problem that only one particle can follow after one "unit space" of field or some "units space" of field and the Boltzmann — Maxwell system become to be the problem that the number of "unit space" is much more than that of particles. But none of above three statistical theories can cope with the situation under which some "unit space " of field and particles coexist or arrange by long strings in turn. For example, non — ideal gas i. e. non — quan-

tum gas can be separated into two parts. One is the gas molecular group, and another is "unit space" of field named as "unit of hole". These two parts can interact and the gas molecules can integrate or be divided by "unit of holes", finally the state under which some gas molecules and some unit holes coexist come into being. This situation can not be described by above three statistical theories. Equally, the vapor—liquid equilibrium can not also be coped with by these theories, because this situation also involves in the coexistence of the first kind molecules and the second kind of molecules. In the nature and human society, this group—to—group(i. e. many particles to many particles) situation is universal and can not be included in above three statistical theories. For this reason, the author thinks and puts forward the fourth statistical mechanic, i. e. , JRG sub—cluster statistical theory. The task of this book is to verify the objective existence and necessity of this theory, and to verify that the equations presented in above three statistical theories are certain special examples of the fourth statistical theory. In order to understand easily JRG statistical theory for readers, systematic discussions have been conducted by three parts in this book. Part one contains basic concepts and theories about sub—cluster. Part two is the linkage between statistical mechanics and physic—chemistry theory, and demonstrate the uses of the fourth statistical theory for the group—to—group problems. Part three includes many applications. In this book, there are many core concepts such as "sub—cluster", "unity of opposites", "group—to—group competition", "activation energy of sub—cluster", "sub—cluster parameter", "principle of the lowest energy for free order", "principle of the highest energy for integration order" and so on. These concepts will help readers to understand deeply the essence of

sub—cluster theory.

The original edition of this book is the book of "On vague sub—cluster theory ", a book of linear sub—cluster theory published by Heilongjiang Scientific and Technological Press of China in 1985. Afterwards, many readers asked for re—edition. But considering that the book contained only linear theory and waiting for the results of many applications, it has not been re—published. Nowadays , this book includes linear and non—linear theories and their applications in many fields, and is comprehensive. Because the author mainly works on polymer science and engineering, rheomorphology and its engineering technology, and use sub—cluster theory to develop many high—strength and super—toughened polymer alloys, electrorheological materials, etc. , and obtain many awards granted by Government of China, so the contents about this field occupy the largest space in this book.

I must acknowledge for that IUPAC accepted the sub—cluster theory as the fourth statistical theory in 1993, and acknowledge for the editorial of Chemical Abstract published the abstract of "Present situation and prospect of the fourth statistical mechanics in 1994". I especially acknowledge for that Senmun Media Ltd. Co. of Korea publishes this book and plans to publish the English edition of this book, which is the important step for this book to go to the world.

During the writing of this book, more than 30 Ph. D. students I have advised have used the fourth statistical theory to solve their problem existing in their Ph. D. theses, which is the first material for this book, so I acknowledge for their contributions to this book. I also give my acknowledgments to Professor Zhang Yuchuan and Professor Zheng Xianyu in the department of polymer material and ap-

plied chemistry of Beijing University of Chemical Technology of China, to my students, Mr. Hu Xiaoyi, Mr. Yang Mingshan and Yuan Bing, and Ms. Sun Mingyun and Fu Yao, and Mr. Chen Song. All of them have made much work for the publication of this book. Particularly, I acknowledge for the highly appraising for the fourth statistical theory conducted by Academician Tang Aoqing, Academician Xu Xi, Academician Xu Duanfu, Academician Shen Jiacong, Professor Tang Xinyi, Professor Lu Huanzhang and Professor Wu Guanyin.

Finally, I acknowledge for the efforts made by Mr. Yin Rubo of Korea, and for the sponsoring made by Mr. Yin Jishan, the president and general manager of Beijing Ecology Power Agent Company, Ltd. , for the publication of this book .

In an addition, it is worth pointing out that according to my experience I feel that at the beginning the sub—cluster theory is not understood easily. Therefore I suggest that readers should keep patient and think independently. I believe that after entering the field of sub—cluster theory, readers can obtain much beneficial knowledge and apply this theory into oneselves' research fields to reach greater achievement, which is my best wish .

Jin Riguang (Kim Yrgoang)

July, 1998 in Beijing, China

著名学者评价

Appraisals Made by Famous Scholars

唐敖庆院士(国家自然科学基金委员会)在作者提出群子理论的初期就指出:“群子统计理论很有可能用来解决以往三种统计力学理论所不能解决的问题,只要持之以恒,必得硕果。”

Academician Tang Aoqing , Fund Committee of Natural Science of China , stated at the initial stage of the author's sub-cluster theory : “ It is very possible that the sub-cluster statistical theory can solve the problems which can not be solved by the former three statistical theories . Persistence can reach great achievement . ”

徐禧院士(四川联合大学)在评价意见中指出:“作者从一系列的自然和社会现象深入浅出地提出群子概念,在此基础上建立了模糊群子理论。大量的实例验证了这一理论的合理性和普遍性。本书是一部涉及范围广的跨学科专著,有创见,内容新颖,有很高学术水平,对实际工作有指导意义。”

Academician Xu Xi , United University of Sichuan of China , stated : “ The author puts forward the concepts of sub-cluster from a series of natural and social phenomena , and on this basis founds the vague sub-cluster theory . The rationality and universality of this theory have been verified by a large amount of experiments . This book is a cross-subject , creative , novel and high-level monograph involved in many fields , and has directive meaning for practical work ” .

沈家骢院士(吉林大学)在评价意见中指出:“群子论是以非特定属性的统计单元与模糊化概念相结合的统计理论,概念新颖,有独创性。从实用性来说在相当广泛的领域取得满意的成果,而且在应用上非常简便,如在汽(汽相平衡、高分子溶液第二维利系数、分子量与粒度分布、高分子共混体系等等。”

Academician Shen Jiacong, Jilin University, stated: “The sub-cluster theory is the statistical theory which integrate non-specific statistical units with vaguelization concepts, and is creative and novel. The theory has reached satisfied results in fairly wide fields, and its use is simple and convenient, and can be used in many systems such as of vapor-liquid equilibrium, the second Virial coefficient of polymer solution, distributions of molecule weight and particle size, polymer blending systems, etc. .”

远藤隆一教授(东京理科大学)在评价中指出:“群子论的确是中国哲学思想在自然科学方面的具体体现。国内外尚未有类似的理论,能够用于那么多体系,而且计算精度又那么高,是一种惊人的理论体系。”

Professor Eudo Liuichi, Scientific University of Tokyo of Japan, stated: “The sub-cluster theory gives the concrete expression of the Chinese philosophical thoughts in natural science, and so far similar theories have not reported in the world. The sub-cluster theory can treat many systems and has so high precision that it is a surprised theory. ”

一级教授卢焕章(中国环球化工公司)在评价意见中指出:“群子统计理论创立了新的非定域统计方法,既能从理论上概括了 Fei-mi-Dirac 和 Bose-Einstein 统计方程,又能在广泛实际应用领域

中(如高分子溶液第二维利系数、高分子材料流变性能、一般汽(液相平衡等)取得成果。”

Professor Lu Huanzhang , Global Chemical Engineering Company of China , stated : “The sub-cluster theory creates new non-region statistical method . It not only epitome the statistical equations of Fermi-Dirac and Bose-Einstein statistical theories theoretically , but also can be used in broad practical fields such as the second virial coefficient of polymer solution , rheological properties of polymer materials , vapor-liquid equilibrium , etc. . ”

汤心颐教授(吉林大学)在评价意见中指出:“群子理论具有下面的两个鲜明的特点:1、首创性和新颖性:群子理论不是在前人的类似理论的基础上发展而成的理论,是由作者在矛盾的对立和统一法则的指导下独立完成的。在国内外尚未注意到有类似的理论,群子理论在本质上平行于 Boltzmann 统计,但作者把共聚反应的竞争概念与统计巧妙地结合起来,从而解决了质点的相关问题。这种思想非常新颖。2、适用性:由于群子理论非常简明,不涉及过多的数学问题,从而便于在实际上应用。在汽(液相平衡、高分子溶液第二维利系数、分子量与粒度分布、高分子合金以及高分子应变方面用群子理论都获得了满意的结果。”

Professor Tang Xinyi , Jilin University of China , sated : “The sub-cluster theory has two distinct characteristics as following : First , it has originality and novelty . Having not been developed on the basis of similar theories conducted by the former researchers , the sub-cluster theory is independently created by the author under the guidance of the law of unity of opposites , and similar theories have not reported in the world . It is parallel to Boltzmann statistical theory in nature , but the author artfully integrates the concepts of com-

petition in copolymerization with statistics, and solve the problem of matter relevancy . This thought is very novel . Second , it has adaptability . Because the sub-cluster is very simple and convenient and is not involves too many mathematical problems , it is convenient to be used in practical , and satisfied results has reached during the applications in vapor-liquid equilibrium , the second virial coefficient , distributions of molecule weight and particle size , polymer alloys and polymer strain , etc. ”

武冠英教授(北京化工大学)在评价意见中指出:“1、群子这个概念是符合客观规律的,提出它,既便于讨论微观世界又便于研究宏观世界。2、群子理论的确是作者金日光教授首创的一种统计理论方法,有独创性、新颖性,与其他统计理论比较在某些方面有优越性(如准确性)。”

Professor Wu Guanyin , Beijing University of Chemical Technology , stated : “First , the concept of the sub-cluster accords with objective laws , and its presenting is convenient not only to discuss microcosmic world but also to study macroscopical world . Second , the sub-cluster theory is originated by Professor Jin Riguang and has originality and novelty . Compared to other statistical theories , the sub-cluster theory has the advantage in certain aspects such as precision , etc. . ”

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