自然与希腊

Nature and the Greeks

袅袅
大家小书

[奥]E·薛定谔 著 李泳 评注

湖南科学技术出版社

『自然与希腊』是薛定谔1948年2月在都柏林大学学院的系列演讲，同年5月在伦敦大学学院作为Shearman讲座又讲了一次，是他最优秀的作品之一。虽然今天的我们无缘听他的讲座，不过幸运的是，据薛定谔的传记作者摩尔（Walter Moore）说，现在的这个文本比讲座还好。『其丰富的思想和优美的语言，值得一读再读。』的确，本书的趣味要读过几页才有感觉；它的思想精神要读过几遍才好把握。它的文字，不像多数科学期刊的『洋八股』，更像一个散文家的作品。它保留了许多古典的风味，像我们读培根和弥尔顿。这是因为，作者不单是『学理』的，『学文』的成绩也很好。薛定谔（1887～1961）是奥地利人，但母亲有一半的英国血统，英语也是一家人的『母语』。他从小同时学德语和英语，喜欢『古代语法的逻辑』，喜欢德国的诗歌和戏剧，擅长彼特拉克（Petrarch）体十四行诗，出过诗集，还把荷马史诗翻译成英文，把法国古普罗旺斯的诗歌译成德文。

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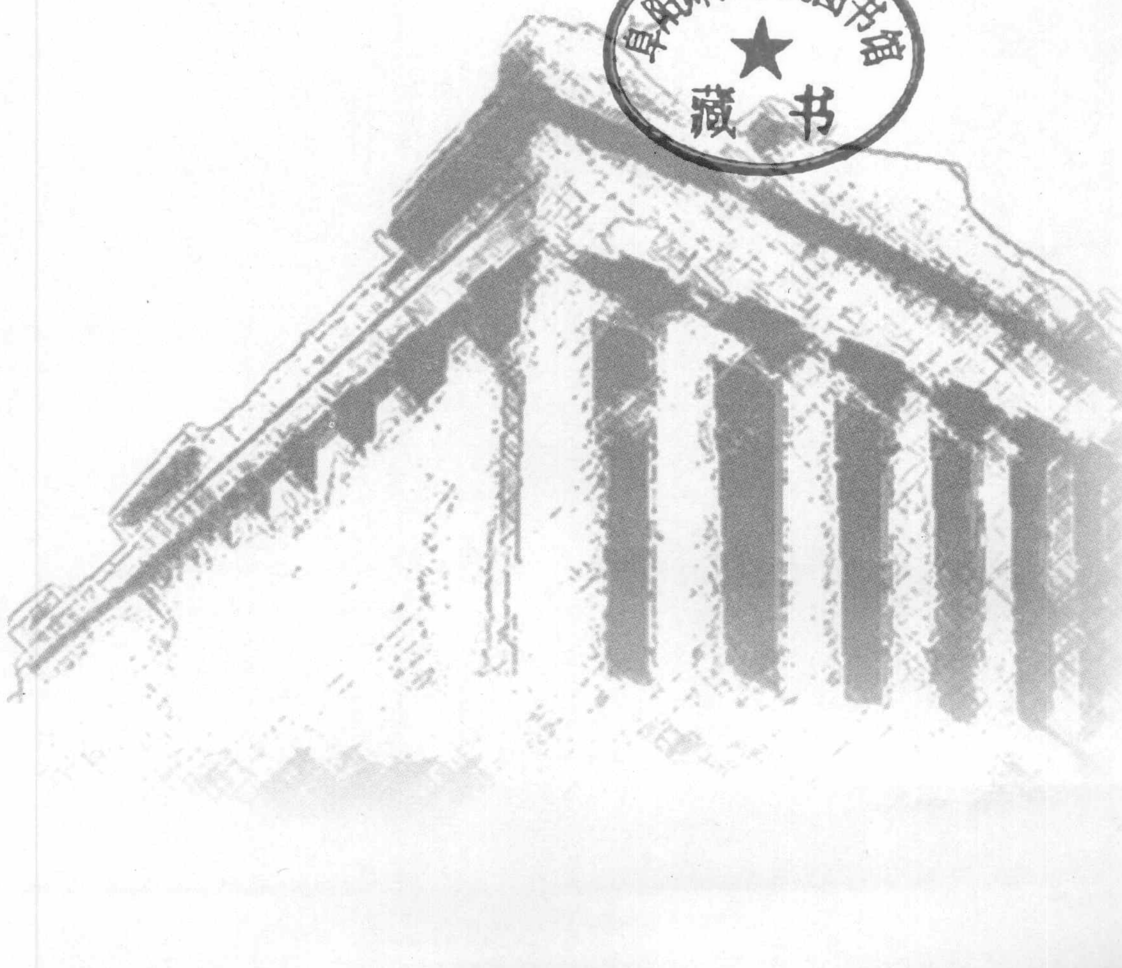

Nature and the Greeks and Science and Humanism

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著　　者：［奥］E·薛定谔
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NATURE AND THE GREEKS

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SCIENCE AND HUMANISM

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致 读 者

帝子降兮北渚，目眇眇兮愁予。

袅袅兮秋风，洞庭波兮木叶下。

——屈原《湘夫人》

你思念的人儿已经飘然来到了水边，你却望不到她的身影，

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数完最后一片落叶，留下永恒；

人生是小草，

撷取每一点缤纷，拥抱蓝天。

目录

CONTENTS

FOREWORD

I vividly recall reading Erwin Schrödinger's slim volume *Science and Humanism* some forty years ago, probably at a time while I was still a research student in Cambridge. It had a powerful influence on my subsequent thinking. *Nature and the Greeks*, although based on slightly earlier lectures, was not published until somewhat later, and I have to confess that I did not come across it then. Having only now read it for the first time, I find a remarkable work, of a similar force and elegance.

The two volumes go well together. Their themes relate closely to each other, being concerned with the nature of reality and with the ways in which reality has been humanly perceived since antiquity. Both books are beautifully written, and they have a particular value in enabling us to share in some of the insights of one of the most profound thinkers of this century. Not only was Schrödinger a great physicist, having given us the equation that bears his name — an equation which, according to the principles of quantum mechanics, governs the behaviour of the very basic constituents of all matter — but he thought deeply on questions of philosophy, human history and on many other issues of social importance.

In each of these works Schrödinger starts by discussing pertinent social issues concerning the role of science and of

同一本书，不同的人可以抒发不同的感想。

scientists in society. He makes it clear that, whereas there is no doubt that science has had a profound influence on the modern world, this influence is by no means the real reason for doing science; nor is it clear that this influence is itself always positive. However, his main purpose is not just to discuss issues of this kind. He is primarily concerned with the very nature of physical reality, of humanity's place in relation to this 'reality' and with the historical question of how great thinkers of the past have come to terms with these issues. Schrödinger clearly believes that there is more to the study of ancient history than mere factual curiosity and a concern with the origins of present-day thinking. His fascinatingly insightful study of the views of the philosopher/scientists of antiquity, in *Nature and the Greeks*, makes clear that he also believes there is something directly to be gained from the Greeks' own insights, and what led them to their views, despite the undoubtedly enormous advances that modern science has made over what had been available to them at the time. Have we really made any progress at all concerning the really deep question: 'Whence come I and whither go I'? Schrödinger evidently believes not, though he appears to remain optimistic that genuine insights into such issues may become available to us in the future.

Having himself been one of the prime movers in the revolutionary changes that have taken place in our understanding of Nature at the scale of its tiniest ingredients, he is well placed to understand the importance of these changes in relation to what had been the views of physicists and philosophers immediately before him. Moreover, in my personal view, the more 'objective' philosophical standpoints of Schrödinger and Einstein with respect to quantum mechanics, are immeasurably superior to 'subjective' ones of Heisenberg and Bohr. While it is often held that the remarkable successes of quantum physics have led us to doubt the very existence of an 'objective reality' at the quantum level of molecules, atoms and their constituent particles, the extraordinary precision of the quantum formalism — which means, essentially, of the Schrödinger equation — signals to us that there must indeed be a 'reality' at the quantum level, albeit an unfamiliar one, in order that there can be a 'something' so accurately described by that very formalism.

爱因斯坦认为存在一个不玩儿骰子的上帝，玻尔认为我们既是观众也是演员。

薛定谔方程的精确就意味着存在某种它精确描述的"实在"。

Yet the formalism itself reveals a quantum-level reality that is strikingly different from the one that we experience at ordinary macroscopic scales. In a masterly way, Schrödinger paints for us a picture of that reality. I vividly recall, from my reading of *Science and Humanism* of forty years ago, Schrödinger's description of an iron letter-weight in the shape of a *Great Dane* that he had known as a small child, and that he retrieved after many years, having had to leave it behind in Austria when the Nazis came. What does it mean to say that it is the same dog as he had had before? There is no meaning to be attached to the 'sameness' of any of its individual particles. Schrödinger points out a remarkable irony. For over two thousand years, since the time of Leucippus and Democritus, there had been the fundamental idea that matter is composed of basic individual units, with empty space in between. Yet, this had been essentially a postulate, based on indirect inferences of widely differing acceptability. Then just as the first *direct* evi-

Great Dane 是一种丹麦大狗。

古希腊原子论的两个创始人。

Wilson 云室里看到的并非一个个寻常意义的粒子。

dence of the atomistic nature of matter was beginning to come to light (such as in the Wilson cloud chamber and other experimental devices), quantum theory pulled the rug from beneath us. The particles that the theory revealed to us were not at all like the hard grains that we had come to expect, but were spread out in incomprehensible ways; worse still, they had no individuality whatever!

What is the present status of the particles that were known in Schrödinger's day? Electrons are still thought of as indivisible, but they belong to a larger family of particles, collectively called *leptons*. Protons, on the other hand, are not indivisible, being regarded as composed of still smaller units: the *quarks*. Modern particle physics is described in terms of these new kinds of element (quarks, leptons, gluons), which are the basic elements of what is referred to as the 'standard model'. In this model, the quarks and leptons are taken as structureless point-like objects. Are these the true atomic elements that physicists from the time of Leucippus and Democritus had sought?

弦理论的意义也许在于突破了"点"粒子的思维路线。

I doubt that many present-day physicists would hold firmly to such a view. One prevalent line of thinking pins faith on the ideas of *string theory* according to which the basic units would not be point-like at all, but little loops referred to as 'strings'. These, however, would be far far tinier than the scales that are currently accessible to modern experimental techniques. There are some recent experimental indications that quarks may exhibit structure at much larger scales than those that would be required for string theory—in contradiction with the point-like expectations of the standard model.

One must be cautious about drawing such conclusions, however, pending further results which may confirm or contradict them. This notwithstanding, it is fully to be expected that we are yet far from a final understanding of these matters.

In both of these books, Schrödinger shows himself to be deeply troubled, moreover, by the actual continuous nature of our pictures of space and time. According to quantum theory, the state of a material particle can undergo discontinuous jumps. In his attempts to reconcile this odd behaviour with the desirable feature that an individual particle ought really to retain some rudimentary sort of identity, Schrödinger is guided to the idea that it should be space itself, rather than the particles, which is discontinuous. I cannot help remarking, here, that this 'oddness' in the behaviour of quantum particles is now known to be even weirder than was imagined in Schrödinger's day. Schrödinger himself had pointed out, in 1935 (as a follow-up from some work by Einstein, Podolsky and Rosen), the puzzling phenomenon of *quantum entanglement*, according to which, in a system composed of more than one particle, the individual particles are not actually individual, but must be thought of as constituting an indivisible whole. In the mid-1960s John Bell showed that this entanglement could actually be directly measured, with consequences for our picture of reality that have still, in my opinion, not been adequately resolved.

Schrödinger, with considerable insight, goes back to ancient Greek times to try to examine the underlying reasons for our present firm beliefs in space-time continuity. He considers the picture of continuity that mathematicians, over the inter-

为时空图景的连续性感到困惑。

量子缠绕现象是今天的一个热点问题。

量子时空现在已正式成为物理学的一个工作概念。

vening centuries, have finally come to, and he points out the puzzling, almost paradoxical nature of this very picture. I had referred earlier to the powerful influence that Schrödinger had had on my own thinking. The idea that space and time are, at root, not what they 'seem' to be—perhaps themselves being discrete rather than continuous—is indeed something that took hold of me at that time, and the influence from Schrödinger's writings was great. I spent much time in trying to construct a theory in which spatial notions arose from an entirely discrete combinatorial structure. Although these attempts had some success, the thrust of underlying mathematical conceptions has been, instead, to drive us in the direction of that curiously elegant form of continuity that is provided by *complex numbers* (numbers in which $\sqrt{-1}$ features). Complex numbers are fundamental to quantum theory (and $\sqrt{-1}$ occurs explicitly in Schrödinger's equation). They are fundamental to the 'twistor theory' that my own deliberations led me to, and they are fundamental also to string theory. Moreover, they are fundamental to the deepest results of number theory (such as in Wiles's recent proof of Fermat's last theorem), which is the epitome of discrete mathematics. Perhaps, in complex numbers will ultimately be found the resolution between the discrete and continuous, in physics that Schrödinger found so profoundly puzzling. Only time will tell.

彭罗斯创立了"扭量理论"。

Roger Penrose, March 1996

NATURE AND THE GREEKS

自然与希腊

Shearman Lectures,
delivered at University College, London
on 24, 26, 28, and 31 May 1948

To my friend

A. B. CLERY

in gratitude for his

invaluable aid

Ancient GREECE
0 100
Miles
MACEDONIA
THRACE
Byzantium
Pella
Therma
CHALCIDICE
Thasos
Chersonese
PHRYGIA
Ilium
OLYMPUS
EPIRUS
Larissa
MYSIA
Corcyra
THESSALY
Pergamum
Lesbos
LYDIA
EUBOEA
Sardis
Leucas
Ithaca
Delphi
Chalcis
Chios
Thebes
ACHAIA
Corinth
Athens
Samos
Ephesus
Olympia
Argos
Salamis
CARIA
PELO PONNESUS
Miletus
Halicarnassus
Sparta
Naxos
Melos
RHODES
Cythera
AEGEAN SEA
Cydonia
MT. IDA
Cnossus
CRETE
Raise

古希腊地图