HEP World's Classics

Opticks:

Or, a Treatise of the Reflections, Refractions, Inflections and Colours of Light

牛顿光学

SIR ISAAC NEWTON

HIGHER EDUCATION PRESS

HEP World's Classics

Opticks:

Or, a Treatise of the Reflections, Refractions, Inflections and Colours of Light

牛顿光学

SIR ISAAC NEWTON

HIGHER EDUCATION PRESS

This edition first published 1730, London

This book reproduces the text of the original edition. The content and language reflect the beliefs, practices and terminology of their time, and have not been updated.

图书在版编目（CIP）数据

牛顿光学 = Opticks: Or, a Treatise of the Reflections, Refractions, Inflections and Colours of Light: 英文 / (英) 牛顿 (Newton, S. I.) 著. -- 北京 : 高等教育出版社, 2016.6
ISBN 978-7-04-045316-4

Ⅰ. ①牛… Ⅱ. ①牛… Ⅲ. ①光学 - 英文 Ⅳ. ① O43

中国版本图书馆 CIP 数据核字（2016）第 103177 号

策划编辑 王 超　　责任编辑 刘占伟　　封面设计 王凌波　　责任印制 韩 刚

出版发行	高等教育出版社	网　址	http://www.hep.edu.cn
社　址	北京市西城区德外大街4号		http://www.hep.com.cn
邮政编码	100120	网上订购	http://www.hepmall.com.cn
印　刷	涿州市星河印刷有限公司		http://www.hepmall.com
开　本	787mm × 1092mm　1/16		http://www.hepmall.cn
印　张	15.75		
字　数	270 千字	版　次	2016 年 6 月第 1 版
购书热线	010-58581118	印　次	2016 年 6 月第 1 次印刷
咨询电话	400-810-0598	定　价	89.00 元

本书如有缺页、倒页、脱页等质量问题，请到所购图书销售部门联系调换

物 料 号　45316-00

HEP World's Classics

There is a Chinese saying: "It is beneficial to open any book." It is even more fruitful to open and read classic books. The world is keeping on changing, but really fundamental and essential things stay the same since there is nothing new under the sun. Great ideas have been discovered and re-discovered, and they should be learnt and re-learnt. Classic books are our inheritance from all the previous generations and contain the best of knowledge and wisdom of all the people before us. They are timeless and universal. We cannot travel back in time, but we can converse with the originators of current theories through reading their books. Classic books have withstood the test of time. They are reliable and contain a wealth of original ideas. More importantly, they are also books which have not finished what they wanted or hoped to say. Consequently, they contain unearthed treasures and hidden seeds of new theories, which are waiting to be discovered. As it is often said: history is today. Proper understanding of the past work of giants is necessary to carry out properly the current and future researches and to make them to be a part of the history of science and mathematics. Reading classic books is not easy, but it is rewarding. Some modern interpretations and beautiful reformulations of the classics often miss the subtle and crucial points. Reading classics is also more than only accumulating knowledge, and the reader can learn from masters on how they asked questions, how they struggled to come up with new notions and theories to overcome problems, and answers to questions. Above all, probably the best reason to open classic books is the curiosity: what did people know, how did they express and communicate them, why did they do what they did? It can simply be fun!

This series of classic books by Higher Education Press contains a selection of best classic books in natural history, mathematics, physics, chemistry, information technology, geography, etc. from the past two thousand years. They contain masterpieces by the great people such Archimedes, Newton, Lavoisier, Dalton, Gauss, Darwin, Maxwell, and hence give a panorama of science and mathematics. They have been typeset in modern fonts for easier and more enjoyable reading. To help

the reader understand difficult classics better, some volumes contain introductions and commentaries by experts. Though each classic book can stand in its own, reading them together will help the reader gain a bigger perspective of science and mathematics and understand better interconnection between seemingly unrelated topics and subjects.

Higher Education Press has been the largest publisher in China. Besides the long tradition of providing high quality books for proper education and training of university and graduate students, she has also set out to provide research monographs and references books to people at all levels around the world. Higher Education Press considers it her duty to keep the world science and mathematics community informed of what has been achieved in their subjects in easy and accessible formats. This series of classic books is an integral part of this effort.

内容简介

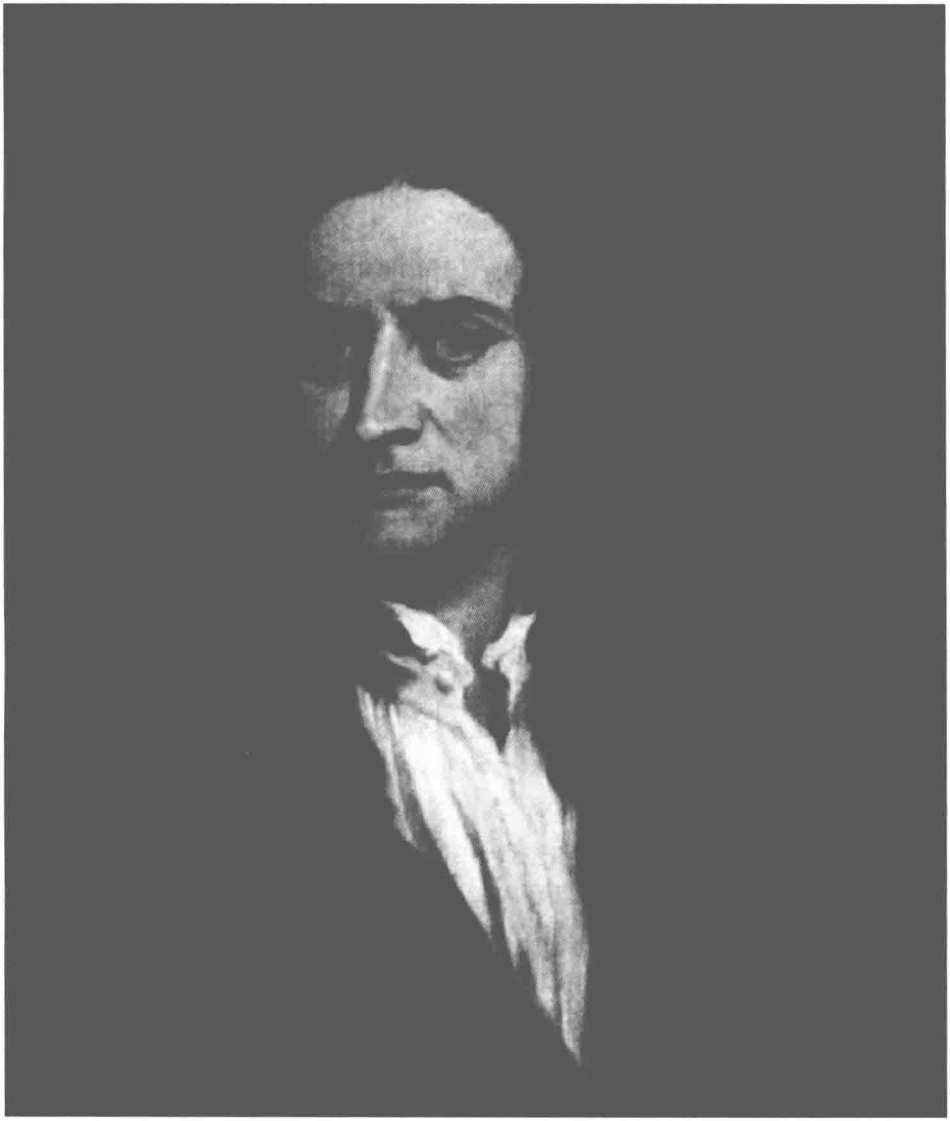
本书为牛顿系统地阐述其光学研究成果的经典著作, 也是光学研究从几何光学向近代光学转变的标志之一。在本书中, 牛顿以微粒说解释光的直线传播, 以及反射、折射现象。牛顿的光微粒说与其创立的经典力学的概念框架是一致的。在本书中, 牛顿设计了许多非常巧妙的实验来证实自己的理论, 使得该书成为实验科学的优秀范本, 而实验科学的思想对于整个近代科学体系的建立是至关重要的。

虽然牛顿的主要光学研究是在 17 世纪 70 年代进行的, 但本书第一版迟至 1704 年才出版, 其主要原因是他的光本性理论受到同时代的胡克和惠更斯等人的强烈批评, 牛顿不愿意发生论争, 而胡克的离世 (1703) 意味着牛顿少了一个最执拗的对手。牛顿生前还出版了第二版 (1717) 和第三版 (1721)。在第二版中, 牛顿删去了第一版末尾的数学短文, 因为它不属于本书的主题, 并在第三编的末尾增补了若干疑问。牛顿还亲自校订了第四版, 并在逝世前交给了书商, 于 1730 年出版。

本书最有价值的部分是书末的 "疑问 (Query)" 部分。其中, 牛顿提到物体会导致远距离光线弯曲: 热包含有物体的振动; 热辐射由以太振动传递; 光线由发光物体发射的微小颗粒组成; 光线由于其微小颗粒的引力或其他的力会引起它所作用的物体的振动; 振动是引起视觉的原因。

本书通俗易懂, 读者可以从中领略到牛顿的个人魅力, 而那些精巧的实验设计所体现的科学思想与科学方法又使其超出了光学领域而在科学史上具有重要的地位, 对今天的读者具有重要的参考价值。

本书根据 1730 年第四版重排。



艾萨克·牛顿爵士 (Sir Isaac Newton, 1643. 01. 04—1727. 03. 31)

艾萨克·牛顿爵士 (Sir Isaac Newton, 1643. 01. 04—1727. 03. 31), 英国著名物理学家、数学家、自然哲学家和天文学家, 经典物理学理论体系的建立者。生于英国林肯郡伍尔索普镇, 卒于伦敦。

生平 生父是一个小农场主, 死于牛顿出生前三个月。牛顿是早产儿, 幼年体质羸弱。三岁时母亲改嫁一位富裕的牧师, 牛顿被寄养在外祖母家中, 并在那里接受启蒙和小学教育。在中学阶段, 他广泛阅读各类书籍, 制作各种玩具, 从事多种化学、物理实验。他的学习成绩不好, 一度排在班里倒数第二。直到有一次他赢得了一场与欺负他的同学之间本来实力悬殊的殴斗, 才萌发出强烈的上进心, 天才的一面开始展现出来, 成绩也跃升前茅。1661 年, 牛顿以优异的成绩被推荐到剑桥大学三一学院。在剑桥, 牛顿极其勤奋地读书、思考, 研究了大量古代和当代人的著作, 特别是有关自然哲学、数学和光学方面的, 并写下大量读书笔记和手稿。1665 年, 牛顿获得学士学位, 但大学为了预防伦敦大瘟疫而关闭了, 牛顿回到家乡。在此后两年里, 牛顿思考并记录了他一生最重要的科学思想和创造, 包括微积分学、光学和万有引力定律。

科学成就与贡献 牛顿对代数学、数论、古典几何学与分析几何学、曲线分类、计算方法与近似求解以及概率论等都有重要贡献, 他的最重要的贡献是微积分和无限级数理论, 特别是二项式展开式。

牛顿曾致力于颜色的现象和光的本性的研究。1666年, 他用三棱镜研究日光, 得出结论: 白光是由不同颜色 (即不同波长) 的光混合而成的, 不同波长的光有不同的折射率。在可见光中, 红光波长最长, 折射率最小; 紫光波长最短, 折射率最大。牛顿的这一重要发现成为光谱分析的基础, 揭示了光色的秘密。牛顿还曾把一个磨得很精、曲率半径较大的凸透镜的凸面压在一个十分光洁的平面玻璃上, 在白光照射下可看到, 中心的接触点是一个暗点, 周围则是明暗相间的同心圆圈。后人把这一现象称为 "牛顿环"。他创立了光的 "微粒说", 从一个侧面反映了光的运动性质, 但牛顿对光的 "波动说" 并不持反对态度。虽然牛顿的主要光学研究在 17 世纪 70 年代进行, 但是他的最重要的光学著作《光学》出版于 1704 年, 其主要原因是他的光本性理论受到同时代的胡克和惠更斯等人的强烈批评。直到胡克和惠更斯去世后, 牛顿在《光学》中论述的光本性及其微粒说才得以成为主流学说, 直到 19 世纪初托马斯·杨实验验证光的波动说。20 世纪量子力学提出后光的波粒二象性得到公认, 微粒学说又再次得到确认。

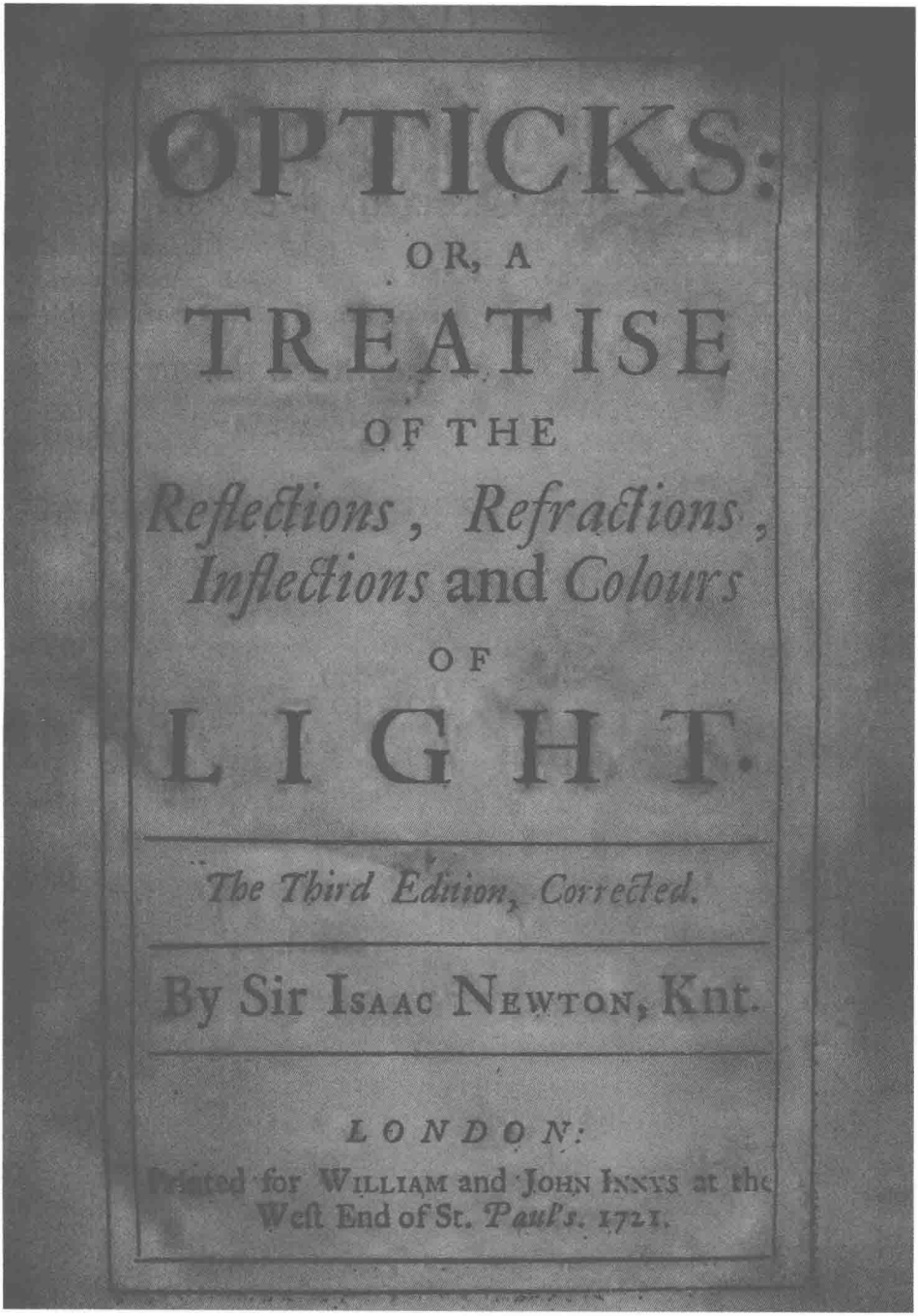
牛顿的最高科学成就体现在运动学和天体力学中, 1679 年, 牛顿证明了引力的平方反比关系与行星椭圆轨道之间的对应关联。至此, 牛顿的整个宇宙体系和力学理论的框架基本完成。1684 年, 牛顿写出论文《论轨道上物体的运动》。文中证明, 天上与地上的物体服从完全相同的运动规律, 引力的存在使得行星及其卫星必定沿椭圆轨道运动, 展示出一种全新的力学理论框架。这篇论文成为

写作名著《自然哲学的数学原理》(简称《原理》) 的必要准备。《原理》这部科学巨著于 1687 年在哈雷的私人资助下正式出版。《原理》的出版震动了整个英国和欧洲学术界, 使牛顿一跃成为当时欧洲最负盛名的数学家、天文学家和自然哲学家。

主要荣誉 牛顿的科学创造生涯持续到《原理》发表, 当时牛顿 45 岁。其后近 40 年, 牛顿主要以科学界领袖、社会贤达、政府官员身份活动。他从未离开过英国, 《原理》出版带给他世界声誉。他是剑桥大学三一学院硕士和院士, 卢卡斯数学讲座教授, 皇家学会会员, 法国科学院外籍院士, 英国皇家学会主席, 被册封为英国历史上第一个自然哲学家爵士。

牛顿是最有影响的科学家, 他是经典力学基础的牛顿运动定律的建立者。他发现的运动三定律和万有引力定律为近代物理学和力学奠定了基础, 他的万有引力定律和哥白尼的日心说奠定了现代天文学的理论基础, 实现了人类对自然认识的巨大飞跃。直到今天, 人造地球卫星、火箭、宇宙飞船的发射升空和运行轨道的计算, 仍以牛顿运动定律作为理论根据。

摘自《中国大百科全书 (第二版)》



TITLE PAGE OF THE 1721 EDITION

SIR ISAAC NEWTON'S ADVERTISEMENTS

Advertisement I

Part of the ensuing Discourse about Light was written at the Desire of some Gentlemen of the Royal-Society, in the Year 1675, and then sent to their Secretary, and read at their Meetings, and the rest was added about twelve Years after to complete the Theory; except the third Book, and the last Proposition of the Second, which were since put together out of scattered Papers. To avoid being engaged in Disputes about these Matters, I have hitherto delayed the printing, and should still have delayed it, had not the Importunity of Friends prevailed upon me. If any other Papers writ on this Subject are got out of my Hands they are imperfect, and were perhaps written before I had tried all the Experiments here set down, and fully satisfied myself about the Laws of Refractions and Composition of Colors. I have here published what I think proper to come abroad, wishing that it may not be translated into another Language without my Consent.

The Crowns of Colors, which sometimes appear about the Sun and Moon, I have endeavoured to give an Account of; but for want of sufficient Observations leave that Matter to be farther examined. The Subject of the Third Book I have also left imperfect, not having tried all the Experiments which I intended when I was about these Matters, nor repeated some of those which I did try, until I had satisfied myself about all their Circumstances. To communicate what I have tried, and leave the rest to others for farther Enquiry, is all my Design in publishing these Papers.

In a Letter written to Mr. Leibnitz in the year 1679, and published by Dr. Wallis, I mentioned a Method by which I had found some general Theorems about squaring Curvilinear Figures, or comparing them with the Conic Sections, or other the simplest Figures with which they may be compared. And some Years ago I lent out a Manuscript containing such Theorems, and having since met with some Things copied out of it, I have on this Occasion made it public, prefixing to it

an Introduction, and subjoining a *Scholium* concerning that Method. And I have joined with it another small Tract concerning the Curvilinear Figures of the Second Kind, which was also written many Years ago, and made known to some Friends, who have solicited the making it public.

I.N.

April 1, 1704.

Advertisement II

In this Second Edition of these Opticks I have omitted the Mathematical Tracts published at the End of the former Edition, as not belonging to the Subject. And at the End of the Third Book I have added some Questions. And to show that I do not take Gravity for an essential Property of Bodies, I have added one Question concerning its Cause, choosing to propose it by way of a Question, because I am not yet satisfied about it for want of Experiments.

I.N.

July 16, 1717.

Advertisement to this Fourth Editon

This new Edition of Sir Isaac Newton's Opticks is carefully printed from the Third Edition, as it was corrected by the Author's own Hand, and left before his Death with the Bookseller. Since Sir Isaac's *Lectiones Opticæ*, which he publicly read in the University of Cambridge in the Years 1669, 1670, and 1671, are lately printed, it has been thought proper to make at the bottom of the Pages several Citations from thence, where may be found the Demonstrations, which the Author omitted in these Opticks.

CONTENTS

SIR ISAAC NEWTON'S ADVERTISEMENTS i

Advertisement I i
Advertisement II iii
Advertisement to this Fourth Editon iv

THE FIRST BOOK OF OPTICKS 1

PART I. 1
PART II. 65

THE SECOND BOOK OF OPTICKS 109

PART I. 109
PART II. 128
PART III. 140
PART IV. 165

THE THIRD BOOK OF OPTICKS 181

PART I. 181

THE FIRST BOOK OF OPTICKS

PART I.

My Design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments: In order to which I shall premise the following Definitions and Axioms.

DEFINITIONS

DEFIN. I.

By the Rays of Light I understand its least Parts, and those as well Successive in the same Lines, as Contemporary in several Lines. For it is manifest that Light consists of Parts, both Successive and Contemporary; because in the same place you may stop that which comes one moment, and let pass that which comes presently after; and in the same time you may stop it in any one place, and let it pass in any other. For that part of Light which is stopped cannot be the same with that which is let pass. The least Light or part of Light, which may be stopped alone without the rest of the Light, or propagated alone, or do or suffer anything alone, which the rest of the Light doth not or suffers not, I call a Ray of Light.

DEFIN. II.

Refrangibility of the Rays of Light, is their Disposition to be refracted or turned out of their Way in passing out of one transparent Body or Medium into another. And a greater or less Refrangibility of Rays, is their Disposition to be turned more or less out of their Way in like Incidences on the same Medium. Mathematicians usually consider the Rays of Light to be Lines reaching from the luminous Body to the Body illuminated, and the refraction of those Rays to be the bending or breaking of those lines in their passing out of one Medium into another. And thus may Rays and Refractions be considered, if Light be propagated in an instant. But by an Argument taken from the Æquations of the times of the Eclipses of *Jupiter's Satellites*, it seems that Light is propagated in time, spending in its passage from the Sun to us about seven Minutes of time: And therefore I have

chosen to define Rays and Refractions in such general terms as may agree to Light in both cases.

DEFIN. III.

Reflexibility of Rays, is their Disposition to be reflected or turned back into the same Medium from any other Medium upon whose Surface they fall. And Rays are more or less reflexible, which are turned back more or less easily. As if Light pass out of a Glass into Air, and by being inclined more and more to the common Surface of the Glass and Air, begins at length to be totally reflected by that Surface; those sorts of Rays which at like Incidences are reflected most copiously, or by inclining the Rays begin soonest to be totally reflected, are most reflexible.

DEFIN. IV.

The Angle of Incidence is that Angle, which the Line described by the incident Ray contains with the Perpendicular to the reflecting or refracting Surface at the Point of Incidence.

DEFIN. V.

The Angle of Reflexion or Refraction, is the Angle which the line described by the reflected or refracted Ray containeth with the Perpendicular to the reflecting or refracting Surface at the Point of Incidence.

DEFIN. VI.

The Sines of Incidence, Reflexion, and Refraction, are the Sines of the Angles of Incidence, Reflexion, and Refraction.

DEFIN. VII.

The Light whose Rays are all alike Refrangible, I call Simple, Homogeneal and Similar; and that whose Rays are some more Refrangible than others, I call Compound, Heterogeneal and Dissimilar. The former Light I call Homogeneal, not because I would affirm it so in all respects, but because the Rays which agree in Refrangibility, agree at least in all those their other Properties which I consider in