任法融大师讲述

《道德经》启示录

◎樊光春 撰文
◎任兴之 李郁 整理

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Preface

Advanced mathematics that we refer to contains mainly calculus. Calculus is the mathematics of motion and change. It was first invented to meet the mathematical needs of the scientists of the sixteenth and seventeenth centuries, and the needs that were mainly mechanical in nature. Differential calculus deals with the problem of calculating rates of change. It enables people to define slopes of curves, to calculate velocities and accelerations of moving bodies etc.. Integral calculus deals with the problem of determining a function from information about its rate of change. It enables people to calculate the future location of a body from its present position and a knowledge of the forces acting on it, to find the areas of irregular regions in the plane, to measure the lengths of curves, and so on. Now advanced mathematics becomes one of the most important courses of the college students in natural science and engineering.

The second edition of the book is revised based on implementation experience of its first edition. The contents of the book are written by the authors as follows: Professor Ping Zhu, Professor Jianhua Yuan, Associate Professor Xiaohua Li and Associate Professor Huixia Mo. All the Chapters of the book is organized and proofread by Professor Wenbao Ai. The new edition is contributed as logically and intuitively as possible. Its Chinese and English versions and a corresponding exercise book form a family-united system, which is very useful to the bilingual-teaching. For any errors remaining in the book, the authors would be grateful if they were sent to: jianhuayuan@bupt.edu.cn.

Authors

任法融，祖籍甘肃天水，1936年出生于书香门第之家，自幼聪慧好学，熟读四书五经，仰慕神仙之学。19岁时厌弃名利，遂到宝鸡龙门洞出家学道，后赴终南山古楼观研习《道德经》50余载，尤迷《老》、《庄》、《易》《三玄》，为印证道教义理遍游名山大川，博览群书，兼习书法，先后应邀东南亚诸国及港澳台地区讲学。现已出版《道德经释义》《阴符经·黄石公素书释义》《周易参同契释义》及《道衍全真》等作品，发表道教学术论文50余篇。其颇具仙风道骨的书法作品，也被多家名录收录其中。

中国道教协会原会长，陕西省道教协会原会长。中国道教协会咨议委员会主席、亚洲宗教和平委员会主席、全国政协常委、全国政协民族宗教事务委员会副主任。


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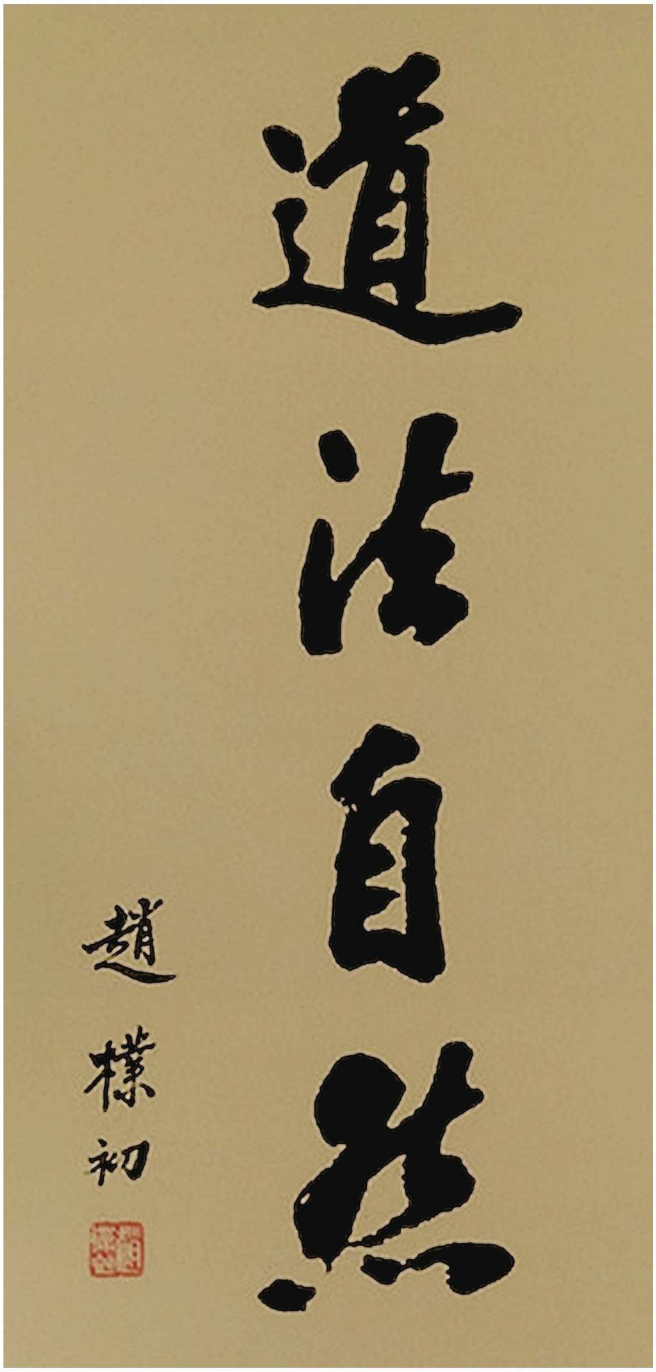

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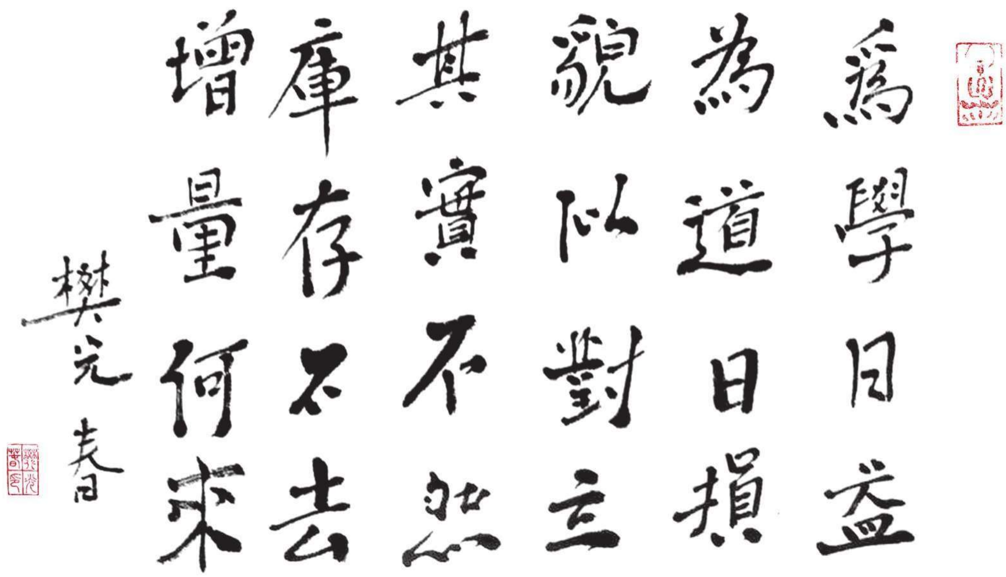

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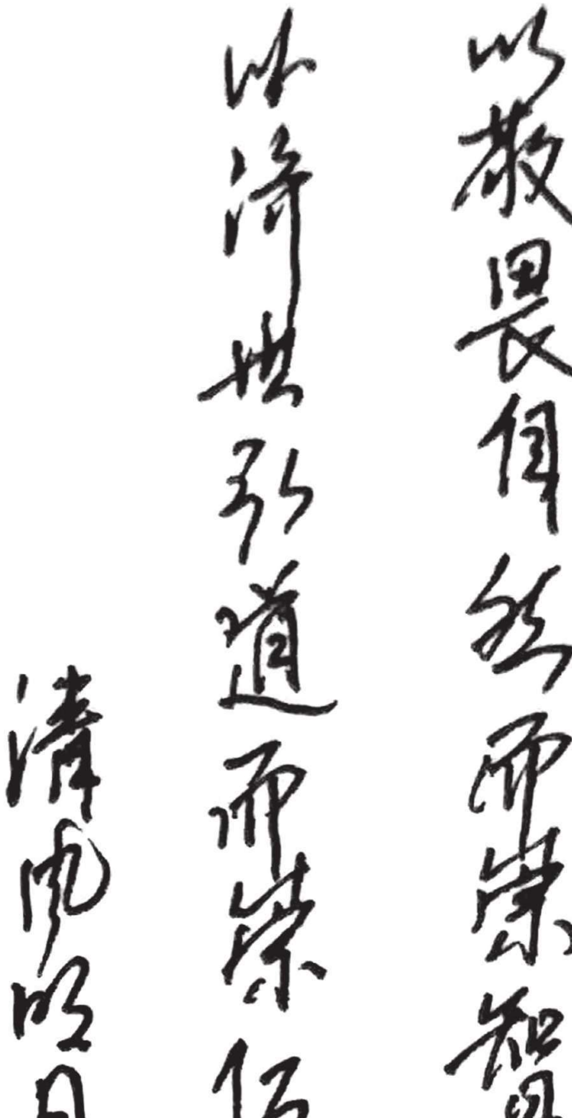

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同門師兄白林鵬篆
都西安

Contents

Chapter 7

Infinite Series

The **infinite series** [无穷级数], which will be introduced in this chapter, is an important part of advance mathematics. The infinite series is closely related to the infinite sequence, and it is a new form of expression of the limit of the infinite sequence. Then, it can be studied by the theory of the limit of the series. With the establishment of the theorems for the convergence and divergence of the series, the theory of infinite series has also promoted the development of the limit theory. Infinite series provide a very useful tool for expressing functions, studying properties of functions, and doing some approximate computations.

We will first introduce the concepts and properties of an **infinite series with constant terms** [常数项级数] and then some convergence tests for series with constant terms. Later we use this as a basic for the study of **infinite series with function terms** [函数项级数]. Finally, two important types of series of functions, namely **power series** [幂级数] and **Fourier series** [傅里叶级数], will be investigated.

7.1 Concepts and Properties of Series with Constant Terms

7.1.1 Examples of the Sum of an Infinite Sequence

Example 7.1.1 (Length of perpendiculars) A right triangle ABC is given with $\angle A=\theta$, $\angle C=\frac{\pi}{2}$ and $|AC|=b$. CD is drawn perpendicular to AB, DE is drawn perpendicular to BC, EF is drawn perpendicular to AB, and this process is continued indefinitely as shown in Figure 7.1.1. Find the total length of all the perpendiculars

$$|CD|+|DE|+|EF|+|FG|+\cdots$$

in terms of b and θ.

Solution According to the assumption, the process of generating of perpendiculars is continued indefinitely. It is easy to see that when $\angle A=\theta$ and $|AC|=b$, the length of the first perpendicular CD is

$$L_0=|CD|=b\sin\theta;$$

The length of the second perpendicular DE is

$$L_1 = |DE| = b\sin^2\theta;$$

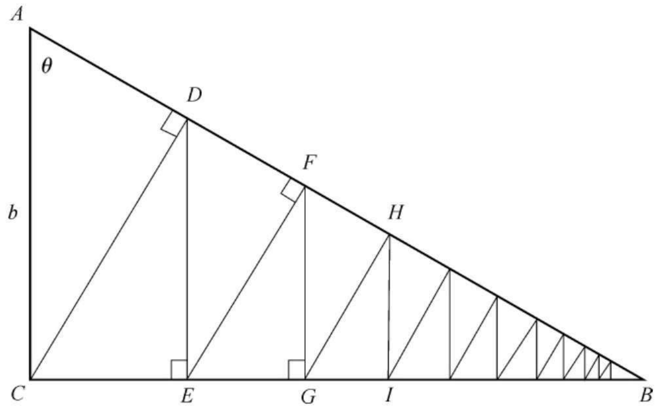

Figure 7.1.1

The length of the third perpendicular EF is

$$L_2 = |EF| = b\sin^3\theta;$$

$$\vdots$$

The length of the nth perpendicular is

$$L_n = b\sin^{(n+1)}\theta.$$

Hence, the total length L of all the perpendiculars is

$$L = b\sin\theta + b\sin^2\theta + b\sin^3\theta + \cdots + b\sin^{(n+1)}\theta + \cdots. \tag{7.1.1}$$

■

Example 7.1.2 (Problem of a ball with bounce) Drop a ball from H meters above a flat surface. Each time the ball hits the surface after falling a distance h, it rebounds a distance rh, where r is positive but less 1.

(1) Assuming that the ball continuous to bounce indefinitely, find the total distance of the ball's travel;

(2) Calculate the total time of the ball's travel. (Use the fact that the ball falls $\frac{1}{2}gt^2$ meters in t seconds.)

Solution (1) The distance of the ball to fall down from height H to the ground is

$$S_0 = H;$$

The distance of the ball to first bounce up and then fall down to the ground again is

$$S_1 = 2Hr;$$

Repeating the above process yields

$$S_2 = 2Hr^2;$$

$$\vdots$$

The distance of the ball to bounce up and fall down in the nth time is

$$S_n = 2Hr^n.$$

Therefore, the total distance of the ball travels up and down is

$$S = H + 2Hr + 2Hr^2 + \cdots + 2Hr^n + \cdots. \tag{7.1.2}$$