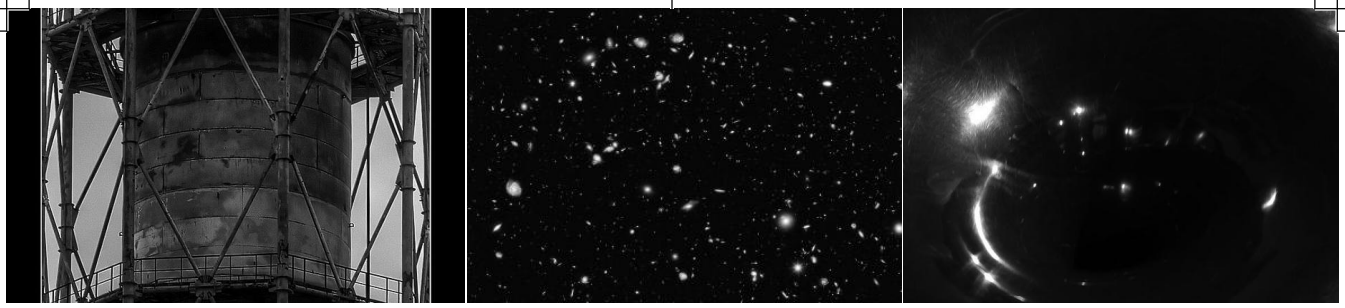
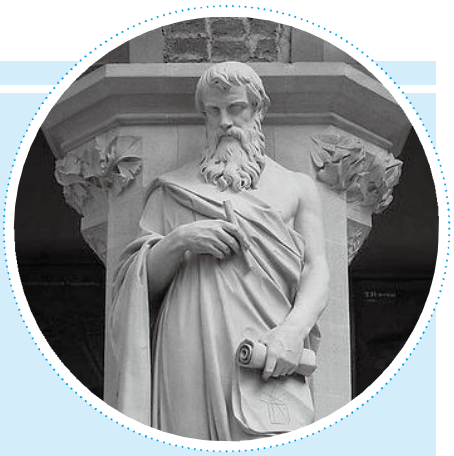


Part I 科学

黄金分割

Golden Section



黄金比例，是一种数学上的比例关系。它具有严格的比例性、艺术性、和谐性，蕴藏着丰富的美学价值。应用时一般取 0.618 或 1.618 ，就像圆周率在应用时取 3.14 一样。黄金分割蕴于大自然中，呈现于不少动物和植物外观。现今很多工业产品、电子产品、建筑物或艺术品均普遍应用黄金分割，呈现其功能性与美观性。

The golden ratio is also called the golden section (Latin: sectio aurea) or golden mean. Other names include extreme and mean ratio, medial section, **divine** proportion, divine section (Latin: sectio divina), golden proportion, golden cut, golden number, and mean of Phidias.

In **mathematics** and the arts, two quantities are in the golden ratio if the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one.

Many 20th century artists and architects

黄金比例又被称为黄金分割（拉丁语：sectio aurea）或者黄金平衡。还有其他的一些叫法包括：中末比，平均分割，圣神比例，圣神分割（拉丁语：sectio divina），黄金比率，黄金切割，黄金数和菲狄亚斯平均。

在数学和艺术中，对于两个数量来说，如果两个数的总和与那个较大数的比值等于那个较大数与较小数的比值，那么这两个数就符合黄金分割比。

20 世纪许多艺术家、建筑家都

have **proportioned** their works to approximate the golden ratio—especially in the form of the golden rectangle, in which the ratio of the longer side to the shorter is the golden ratio—believing this proportion to be aesthetically pleasing. Mathematicians since Euclid have studied the properties of the golden ratio, including its appearance in the **dimensions** of a regular pentagon and in a golden rectangle, which can be cut into a square and a smaller rectangle with the same aspect ratio. The golden ratio has also been used to analyze the proportions of natural objects as well as man-made systems, such as financial markets.

将他们的作品设计为接近黄金比例，尤其是以黄金比例的矩形形式，这种矩形的长宽比为黄金比例——他们相信这种比例有美感。欧几里德那个时代的数学家们就研究了黄金分割的属性：其中包括正五边形和一个黄金比例矩形的尺寸，这个黄金比例矩形可以被分割成一个正方形和一个较小的矩形，而被分割出来的较小的矩形的长宽比也是黄金分割比。黄金比例也被用于分析一些自然物的比例，以及人造系统，如金融市场。

History
历史

The golden ratio has fascinated Western intellectuals of diverse interests for at least 2,400 years. According to Mario Livio:

黄金分割从各方面吸引着西方学者至少已经 2400 年了。马里奥·利维奥说过：

Some of the greatest mathematical minds of all ages, from Pythagoras and Euclid in ancient Greece, through the medieval Italian mathematician Leonardo Pisa and the Renaissance astronomer Johannes Kepler, to present-day scientific figures such as Oxford physicist Roger Penrose, have spent endless hours over this simple ratio and its properties. But the fascination with the golden ratio is not confined just to mathematicians. Biologists, artists, musicians, historians, architects, psychologists, and even mystics have pondered and debated the basis of its **ubiquity** and appeal. In fact, it is probably fair to say that the golden ratio has inspired thinkers of all disciplines like no other number in the history of mathematics.

从古至今的一些最伟大的数学思想，从古希腊的毕达哥拉斯和欧几里德，中世纪的意大利数学家李奥那多·比隆和文艺复兴时期的天文学家约翰尼斯·开普勒，到当今的科学家如牛津大学物理学家罗杰·彭罗斯，花了无数个小时在研究这个简单的比例和它的特性上。但是，黄金分割不仅仅吸引了数学家。生物学家、艺术家、音乐家、历史学家、建筑师、心理学家，甚至神秘主义者也一直在思考和讨论黄金分割普遍存在并且这么富有吸引力的原因是什么。

事实上，或许公平地说，黄金分割激发了思想家的想象力，这在数学史上是绝无仅有的。

Ancient Greek mathematicians first studied what we now call the golden ratio because of its frequent appearance in geometry. The division of a line into "extreme and mean ratio" (the golden section) is important in the geometry of regular pentagrams and **pentagons**. The Greeks usually attributed discovery of this concept to Pythagoras or his followers. The regular pentagram, which has a regular pentagon inscribed within it, was the Pythagoreans' symbol.

古希腊数学家们首先研究了我们现在称之为的黄金分割，因为它频繁出现在几何体中。一条线将一个整体划分为“中末比”（黄金分割）在几何学规则的五角星形和五边形中是非常重要的。希腊人通常认为发现这个概念的人是毕达哥拉斯或者他的追随者们。规则的五角星形里有内切的正五边形，这就是毕达哥拉斯学派的符号。

Euclid's Elements (Greek: Στοιχεῖα) provides the first known written definition of what is now called the golden ratio: "A straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater to the less." Euclid explains a construction for cutting (sectioning) a line "in extreme and mean ratio", i.e. the golden ratio. Throughout the Elements, several **propositions** (theorems in modern terminology) and their proofs employ the golden ratio. Some of these propositions show that the golden ratio is an **irrational** number.

欧几里得原理（希腊语：Στοιχεῖα）第一次以书面的形式定义了什么是现在我们称之为的黄金分割：“一条直线以中末比来将一个整体做分割，整体与较大部分之比等于较大部分与较小部分之比。”欧几里得说明了一个建筑物用一条线以“中末比”将其分割，例如黄金比例。在整个欧几里得原理中，几个命题（现代术语中的定理）的证明采用了黄金比例。其中的一些命题表明，黄金比例是一个无理数。

The name "extreme and mean ratio" was the principal term used from the 3rd century BC until about the 18th century.

从公元前 3 世纪到 18 世纪主要用“中末比”这个名字。

The modern history of the golden ratio started with Luca Pacioli's De Divina Proportion of 1509, which captured the imagination of artists, architects, scientists, and mystics with the properties, mathematical and otherwise, of the golden ratio.

现代史的黄金比例从 1509 年卢卡·巴乔阿勒的圣神比例论开始，黄金分割的数学特性等激发了艺术家、建筑师、科学家和神秘主义者的想象力。

Michael Maestlin, first to publish a decimal approximation of the golden ratio, in 1597.

迈克尔·马斯特林在 1597 年第一个公开了黄金分割的小数近似值。

The first known approximation of the (inverse) golden ratio by a **decimal**

fraction, stated as "about 0.6180340" was written in 1597 by Michael Maestlin of the University of Tübingen in a letter to his former student Johannes Kepler.

黄金比例（倒数）第一个已知的近似小数值，规定为“约 0.6180340”，在 1597 年杜本根大学的迈克尔·马斯特林在他写给他以前的一名学生约翰尼斯·开普勒的信上写了这个数值。

Since the twentieth century, the golden ratio has been represented by the Greek letter Φ or φ (phi, after Phidias, a sculptor who is said to have employed it) or less commonly by τ (tau, the first letter of the ancient Greek root τομή—meaning cut).

二十世纪以来，黄金分割一般用希腊字母 Φ 或 φ 来表示（phi，在雕塑家菲迪亚斯宣布使用这个希腊字母来代表黄金分割之后）或者有时候用字母 τ 来表示（tau，第一个古希腊词根 τομή——切的意思）。

Aesthetics
美学

De Divina Proportione, a three-volume work by Luca Pacioli, was published in 1509. Pacioli, a Franciscan friar, was known mostly as a mathematician, but he was also trained and **keenly** interested in art. De Divina Proportion explored the mathematics of the golden ratio. Though it is often said that Pacioli advocated the golden ratio's application to yield pleasing, **harmonious** proportions, Livio points out that the interpretation has been traced to an error in 1799, and that Pacioli actually advocated the Vitruvian system of rational proportions.

圣神比例论，一部由卢卡·巴乔阿勒创作的三卷的作品，在 1509 年出版。巴乔阿勒是一名天主教方济会男修士，他是一名著名的数学家，但是他在艺术方面也接受过培训，他对艺术也非常热爱。圣神比例论探索黄金分割的数学特性。虽然人们常说，巴乔阿勒提倡黄金比例的应用来产生美感和协调的比例，而利维奥指出如果追溯到 1799 年前面那种说法是错误的，那个时候巴乔阿勒事实上是提倡维特鲁威系统的有理数比例的。

Industrial Design
工业设计

Some sources claim that the golden ratio is commonly used in everyday design, for example in the shapes of **postcards**, playing cards, posters, wide-screen televisions, photographs, and light switch plates.

有消息称，在日常设计中经常会用到黄金比例，例如明信片、扑克牌、海报、宽屏电视、照片、和灯的开关面板的形状。

Music
音乐

Ernő Lendvaï analyzes Béla Bartók's works as being based on two opposing systems, that of the golden ratio and the acoustic scale, though other music scholars reject that analysis. In Bartok's music for Strings, Percussion and Celesta, the xylophone **progression** occurs at the intervals 1:2:3:5:8:5:3:2:1. French composer Erik Satie used the golden ratio in several of his pieces, including Sonneries de la Rose+Croix. The golden ratio is also apparent in the organization of the sections in the music of Debussy's Reflets dans l'eau (Reflections in Water), in which "the sequence of keys is marked out by the intervals 34, 21, 13 and 8, and the main climax sits at the phi position."

根据艾尔诺·兰德卫的分析，巴托克·贝拉的作品是基于两个相反的系统：黄金分割和声音尺度，不过其他的音乐学者反对这个分析结果。在巴托克的弦乐、打击乐、钢片琴音乐当中，木琴以 1:2:3:5:8:5:3:2:1 这样的间隔比例重现。法国作曲家埃里克·萨迪在他的几部作品中都采用了黄金分割，其中就包括了他的那部《来自玫瑰和十字架的钟声》。同样法国作曲家德彪西的那部《水中倒影》各个段落的组织也采用了黄金分割，这部作品的调子的序列间隔是以 34,21,13 和 8 标识出来的，它的高潮主要就在 phi（Φ）这个位置上。

The **musicologist** Roy Howat has observed that the formal boundaries of La Mer correspond exactly to the golden section. Trezise finds the intrinsic evidence "remarkable", but cautions that no written or reported evidence suggests that Debussy **consciously** sought such proportions.

音乐家罗伊·霍瓦特观察发现《大海》条理清晰的边界正好和黄金分割完全吻合。特雷齐斯发现了“不寻常”的内在证据，但是也强调说并没有书面的或者以报告形式出现的证据来表明德彪西是有意识地在寻求这个比例。

Pearl Drums positions the air vents on its Masters Premium models based on the golden ratio. The company claims that this arrangement improves bass response and has applied for a patent on this **innovation**.

珍珠鼓的风道口的定位就取决于马斯特斯高级模型，而这个模型就是基于黄金分割。该公司声称，这种设计改善了低音频响应，这种创新设计已申请专利。

Though Heinz Bohlen proposed the non-octave-repeating 833 cents scale based on combination tones, the tuning features relations based on the golden ratio. As a musical interval the ratio 1.618... is 833.090... cents.

尽管海因茨波伦提出了基于组合音调的非重复八度音阶 833 森特等级，但是这种音调的特点之间的关系是基于黄金分割。作为一种音程，比例 1.618……表示 833.090……森特。

Nature
自然

Adolf Zeising, whose main interests were mathematics and philosophy, found the golden ratio expressed in the arrangement of branches along the stems of plants and of veins in leaves. He extended his research to the **skeletons** of animals and the branchings of their veins and nerves, to the proportions of chemical compounds and the geometry of crystals, even to the use of proportion in artistic endeavors. In these phenomena he saw the golden ratio operating as a universal law. In connection with his scheme for golden-ratio-based human body proportions, Zeising wrote in 1854 of a universal law "in which is contained the ground-principle of all formative striving for beauty and completeness in the realms of both nature and art, and which **permeates**, as a paramount spiritual ideal, all structures, forms and proportions, whether cosmic or individual, organic or inorganic, acoustic or optical; which finds its fullest realization, however, in the human form."

阿道夫·杰森，他的主要兴趣是数学和哲学，他发现植物的枝条、茎和叶的纹理都是以黄金分割来排列的。他将他的研究扩大到研究动物的骨骼和它们的静脉和神经，他还研究化合物的比例以及晶体几何形状的比例，他甚至尝试将黄金分割应用于艺术。在这些现象中他发现黄金分割的使用是一个普遍的规律。结合了他基于黄金分割的人体比例的预测，1854 年杰森在他的一篇文章中写了一个普遍规律“在自然界和艺术界所有包含了图形背景原则的构成要素，对漂亮和完美的追求都充斥于各种建筑、形式和比例中，无论是宇宙中自然存在的还是人为的，有机的还是无机的，听觉上的还是视觉上的；一种物体无论怎么去找它最充分的表现形式，最终都是以具有人类特征的表现方式来呈现。”

In 2010, the journal Science reported that the golden ratio is present at the atomic scale in the magnetic resonance of spins in cobalt niobate **crystals**.

2010 年，《科学》杂志上报道说，黄金分割存在于以原子尺度的磁共振的旋转的铌酸钴晶体里。

Several researchers have proposed connections between the golden ratio and human genome DNA.

一些研究者还提出将黄金分割和人类基因组 DNA 联系起来。

However, some have argued that many of the apparent manifestations of the golden mean in nature, especially in regard to animal dimensions, are in fact fictitious.

然而，一些人认为自然界中存在的许多明显的黄金分割，尤其是关于动物尺寸的论点，实际上是虚假的。

单词注解

- **divine** [dɪ'vaɪn] *adj.* 神圣的；非凡的；天赐的；极好的
- **mathematics** [ˌmæθə'mætɪks] *n.* 数学；数学运算
- **proportion** [prəʊ'pɔːʃən] *vt.* 使成比例；使均衡；分摊
- **dimension** [dɪ'menʃən] *n.* 维；尺寸；次元；容积
- **ubiquity** [juː'bɪkwətɪ] *n.* 普遍存在；到处存在
- **pentagon** ['pentəgən] *n.* 五角形
- **proposition** [ˌprɒpə'zɪʃən] *n.* 命题；提议；议题
- **irrational** [ɪ'ræʃənəl] *n.* 无理数
- **decimal** ['desɪməl] *adj.* 小数的；十进位的
- **keenly** ['kiːnlɪ] *adv.* 敏锐地；强烈地；锐利地
- **harmonious** [hɑː'məʊnjəs] *adj.* 和谐的，和睦的
- **postcard** ['pəʊstkɑːd] *n.* 明信片
- **progression** [prəʊ'greʃən] *n.* 前进；连续
- **musicologist** [ˌmjuːzɪ'kɒlədʒɪst] *n.* 音乐学者，音乐理论家
- **consciously** ['kɒnʃəslɪ] *adv.* 自觉地；有意识地
- **innovation** [ˌɪnəʊ'veɪʃən] *n.* 创新，革新；新方法
- **skeleton** ['skelɪtən] *n.* 骨架，骨骼；纲要；骨瘦如柴的人
- **permeate** ['pɜːmɪeɪt] *vi.* 弥漫；透入；散布
- **crystal** ['krɪstəl] *n.* 结晶，晶体；水晶；水晶饰品

句子讲解

1. Mathematicians since Euclid have studied the properties of the golden ratio, including its appearance in the dimensions of a regular pentagon and in a golden rectangle, which can be cut into a square and a smaller rectangle with the same aspect ratio.

文中的 cut into 是英语中一个固定搭配，在文中是“切成，割成；锯成”的意思，比如：Cut potatoes into dice. 把马铃薯切成小方块。有时，该搭配还能表达“切入，割入，砍入”的意思，比如：He cut his name into the bark with his knife. 他用小刀把自己的名字刻在树皮上。此外，该搭配还有“插嘴，打断；减少；从…中占去时间”的意思，比如：She cut into our conversation several times. 她几次打断我们的谈话。

翻译：欧几里德那个时代的数学家们就研究了黄金分割的属性：其中包括正五边形和一个黄金比例矩形的尺寸，这个黄金比例矩形可以被分割成一个正方形和一个较小的矩形，而被分割出来的较小的矩形的长宽比也是黄金分割比。

2. The golden ratio is also apparent in the organization of the sections in the music of Debussy's Reflets dans l'eau (Reflections in Water), in which "the sequence of keys is marked out by the intervals 34, 21, 13 and 8, and the main climax sits at the phi position."

文中的 mark out 是英语中一个固定搭配，在文中是“制定出，规划出”的意思，比如：The directions of urban development have been marked out. 城市发展的规划已制定出来了。该搭配还有“画线标出界限范围；除，勾销，划掉”的意思，比如：I marked out an item in the list. 我从清单上划掉了一个项目。另外，该搭配常用于被动语态中，与介词 for, as 连用，表达“事先选定，看中，注定，勾出”的意思，比如：One of the graduate entry has been marked out as “likely to succeed”. 报考的研究生中有一个人事先被看中为“可能成功的人”。

翻译：同样法国作曲家德彪西的那部《水中倒影》各个段落的组织也采用了黄金分割，这部作品的调子的序列间隔是以 34,21,13 和 8 标识出来的，它的高潮主要就在 phi（Φ）这个位置上。

万有引力
Gravitational Force

我们都知道牛顿从苹果落地中发现了万有引力定律的故事，故事不一定是真的，但的确是牛顿发现了万有引力定律。在牛顿之前，人们已经知道有两种“力”：地面上的物体都受重力的作用，天上的月球和地球之间以及行星和太阳之间都存在引力。这两种力究竟是性质不同的两种力？还是同一种力的不同表现？

牛顿经过了整整七个春秋寒暑，到他 30 岁时终于把举世闻名的“万有引力定律”全面证明出来，奠定了理论天文学、天体力学的基础。万有引力定律的发现，宣告了天上地面的万物都遵循同一规律运动，彻底否定了亚里士多德以来宗教势力宣扬的天上地下不同的思想，这是人类认识史上的一次飞跃。

Newton's law of universal gravitation（万有引力定律）states that every point mass in the universe attracts every other point mass with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. (Separately it was shown that large **spherically symmetrical** masses attract and are attracted as if all their

牛顿的万有引力定律指出，宇宙中每个质点吸引其他质点，引力与它们的质量直接成正比，与它们之间距离的平方成反比。（它表现为大型质量均匀的球体分别吸引其他球体或者被吸引，这里假设球体质量都集中在球体中心。）这是一个源自经验观测，被牛顿称为“感