God and modern physics: Facts about the beginning and design of the universe

神與現代物理學：有關宇宙的設計和起源的事實

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In the past ten years, implications of **transcendence** in physics, philosophy of mathematics, and **metaphysics** have become more pronounced. Indeed, no other decade in history has revealed more or better evidence for God. So what is this evidence?

在過去的十年，物理學、數學哲學和形而上學所蘊含的超越性意義，比從前更加明顯。事實上，這十年間所發現的證據，比以往任何時期，更能揭示神的存在。那麼，是什麼證據呢？

In astrophysics, several major discoveries pointing to a beginning and creation of the universe have been made. Three discoveries are very significant here:

1) The likelihood that our universe is inflationary (expanding) and will continue to expand forever.

2) The strong implication that inflationary universes have a beginning of time. This is critical, because anything with a beginning requires a cause for its beginning. Otherwise matter would have to come into being out of nothing, which defies logic.

3) The extremely high improbability that our universe would be able to sustain any form of life without extraordinarily complex fine-tuning.

在天體物理學中，有幾個主要的發現均指向宇宙有其起始及創造。現在列出當中三大極其重要的發現：

1）我們的宇宙極有可能是一個不斷膨脹的宇宙，並且將會繼續膨脹下去。

2）膨脹的宇宙強烈意味著有一個時間上的開始。這一點至關重要，因爲任何有開始的東西均有其成因（一個引發）。否則，萬物的出現就會變成是由無中生有，這不合乎邏輯。

3）若說我們的宇宙沒有經過非常複雜的微調，便能做就一個環境生態適合生命持續生存，是極之不可能的。

As you will see from this fact sheet, if you put all this evidence together, it strongly leads to the conclusion that the universe was created by a trans-universal (supernatural) power. The evidence also indicates that this transuniversal power is highly intelligent. Fred Hoyle, one of the world's most prominent astrophysists and an ardent atheist, completely changed his mind when he examined some of this evidence. According to Hoyle:

正如你即將看到下文把事實一一述說，如果你把這些證據歸納一起，便會強烈地指向一個結論，宇宙是由一個超越宇宙（超自然的）的力量所創造的。證據還表明，該超自然的力量是極有智慧的。Fred Hoyle，一位世界上最突出的天體物理學家和殷切的無神論者，當他檢查了一些這方面的證據後，徹底改變了他的想法。他說：

> *Would you not say to yourself,* **"Some super-calculating intellect must have designed the properties of the carbon atom, otherwise the chance of my finding such an atom through the blind forces of nature would be utterly miniscule?"** *Of course you would... A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry*

and biology, and that there are no ***blind forces*** *worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question.*
(Fred Hoyle. "The Universe: Past and Present Reflections." Engineering and Science, November, 1981.)

「你會不這樣對自己說嗎：『想必有一些超強計算能力的智慧設計了碳原子的特性，否則，我能發現自然界從各種偶然的力量中形成這碳原子的機會，將是極度微乎其微』？當然你會這樣說...。運用常理去理解這些事實，便會得出這想法，有一超級智慧在擺弄物理學、化學和生物學，並且使人明白自然界沒有甚麼所謂的偶然力量。人們透過這些論證所得出的數據，是如此壓倒性地令人信服，這個結論幾乎是毫無疑問的。」
（Fred Hoyle.『宇宙：歷史與現狀的反思』。工程與科學學術期刊，1981 年 11 月）。

While this information is readily available to those who know where to look, very few people are aware of these breakthroughs in our ability to understand Creation scientifically. The Magis Center is working on a wide range of initiatives designed to deliver this information to the public, from documentaries to academic curricula and new media. This fact sheet provides a brief overview of the argument for a Creator combining physics and basic logic.

爲那些懂得在何處查找的人，這些資料其實垂手可得，可是事實上甚少人知道已有這些突破，能令我們從科學角度了解「創造」。Magis Center 正在進行一系列的計劃，從紀錄片到學術課程以至利用新媒體，把這些信息提供給公眾。本文提供了簡要概述，結合了物理學和基本邏輯，提出宇宙有造物主的論據。

Information in this fact sheet is taken from the book, by Fr. Robert Spitzer, S.J., Ph.D. All quotations cited in this fact sheet are referenced in that book. The podcasts referred to in this fact sheet may be found and downloaded free of charge through the Magis Center website, www.magisreasonfaith.org.

本文的信息來自施比哲神父的新書New Proofs for the Existence of God: Contributions of Contemporary Physics and Philosophy (Eerdmans, 2010)。本文中的引述來自此書，你亦可在Magis Center的網站www.magisreasonfaith.org免費下載相關的聲音檔。

Can science show God created the universe?
科學能否證明神創造了宇宙？

Scientific theories and conclusions are subject to modification because of the possibility of new discoveries. Nevertheless, certain theories and conclusions are considered well-grounded and highly probable because they rest on multiple, distinct, bases of evidence which mutually corroborate one another. There are three mutually corroborative bases of evidence that indicate the existence of a superintellectual creator (God) from the vantage point of modern physics:

- Evidence of a beginning of the universe from the law of entropy;
- Evidence of a beginning of the universe (or any multiverse in which it might be situated) from the vantage point of space-time geometry; and
- Evidence of supernatural design from our low-entropy universe and the anthropic values of cosmological [physical] constants.

科學理論和結論都可能因應新的發現而需要作出修改。然而，某些理論和結論被認爲是非常合理

及有充分根據的，因爲它們是從多個、獨立、而且相互印證的實據構建而成的。現代物理學當中有三個證據，考妙地相互佐證，顯示世上存在一個超自然的創造者（神）：

- 從熵（熱力學函數）定律，爲宇宙有其起始的說法，提供證據；
- 從時空幾何提供的證據，表明宇宙（或其處於的任何多重宇宙中）有其起始；和
- 從我們宇宙的「低熵」狀況，及物理常數中的人擇(準確調控)數值中，能爲宇宙有超自然設計的論點，提供證據。

When all three are seen in their mutually corroborative relationship, the conclusion of Balor Institute Scholar in Residence Bruce Gordon is quite reasonable: **"When the logical and metaphysical necessity of an efficient cause, the demonstrable absence of a material one, and the proof that there was an absolute beginning to any universe or multiverse are all conjoined with the fact that our universe exists and its conditions are finetuned immeasurably beyond the capacity of any mindless process, the scientific evidence points inexorably toward transcendent intelligent agency as the most plausible, if not the only reasonable explanation."**

當把這三個互有佐證關係的論據結合考慮，Bruce Gordon（Balor Institute 駐研究所學者）得出的結論顯得很合理，他說：「當明顯缺乏一個物質因，而邏輯及形而上學必需要一個動力因，加上任何宇宙或多重宇宙存在一個絕對的起始點的論證，與我們的宇宙之所以存在及它如何無可量度地精密調較，且超越了偶發過程所能產生的狀態，是不謀而合的時候，這科學證據無可避免地指出，「超然而上智的仲介」確實存在，這若不是唯一合理的解釋，也是極度可信的了。」

I. The standard Big Bang model

一.宇宙大爆炸標準模型

The **SBBM** assumes that the Big Bang could be the beginning of the universe. This assumption has not been proven, but there is no evidence against it. If it is true, then the universe is 13.7 billion years old (the age of the Big Bang). The universe is limited in **mass-energy**: 4.6% of the universe is **visible matter** (emits and absorbs light/ electromagnetic radiation); 23% is **dark matter** (does not emit and absorb light/ electromagnetic radiation, but has gravitational effects); and 72.4% is **dark energy** (a field which causes repulsion). With respect to visible matter there is 10^{53} kg of mass, which is approximately 10^{80} baryons (protons and neutrons). This is configured in about 10^{22} stars in 10^{11} galaxies. **Thus the Big Bang Model shows the universe to have finite parameters, which is different from previous assumptions which held the universe to be infinite in time and mass.**

「宇宙大爆炸標準模型」假定宇宙大爆炸可能就是宇宙的起始。這種假設並沒有得到證實，但也沒有證據能否定它。如果假設是真確的，那麼宇宙有13.7億歲（由大爆炸起計）。宇宙的物質能量是有限的：當中百分之4.6是可見物質（會發出和吸收光／電磁輻射），百分之23是暗物質（不會發出和吸收光／電磁輻射，但有引力作用）；以及百分之72.4是暗能量（一個引至宇宙加快膨脹的排斥力場）。可見的物質共重10^{53}千克，即大約有重子（質子和中子）10^{80}個。這些物質構成了10^{22}顆星，並分布在10^{11}個星系中。因此，大爆炸模型推斷宇宙中的參數是有限的，這有別於從前認爲宇宙在時間和物質能量上是無限的假設。

This mass energy is united through a dynamic space-time field. Space is not an empty vacuum (as Newton and others conceived it), but rather a dynamic field (which may be likened to a sheet of elastic) which has properties, conditions, and constants. It is dimensional and orientable; its geometry is compressed and reconfigured through the

density of mass-energy in it; it can warp and vibrate, and it can affect the mass energy in it. For this reason, the universe can be likened to a balloon which has paint on its elastic surface.

物質能量是透過一個動態的時空場聯繫起來的。空間並不是未被佔有的真空（這是牛頓及當時其他科學家所認爲的），而是一個具有特性、條件和常數的動態力場（可比喻爲一塊有彈性的薄片）。它是有維度的，而且可定向的。它經在它內的物質能量密度的變化，可以被壓縮和重整其幾何形態。它可以扭曲和震動，並可影響在它內的物質能量。因此，宇宙可以比喻爲一個具彈性表面塗上油漆的氣球。

At the Big Bang, the balloon had a very tiny radius, and as it continues to expand, the matter on it (e.g. the paint molecules) move away from one another. Note that space-time itself (e.g. the elastic of the balloon) is expanding and this causes the clusters of matter to move away from one another. There is no true center, because everything is a "center" and nothing is at "the center." It is highly likely that the universe will continue to expand like this forever because of the abundance of dark energy causing repulsion within it.

在大爆炸發生時，氣球的半徑非常細小。當它繼續擴大時，這個氣球上的物質（例如油漆分子）開始分散。請注意，時空本身（例如氣球的橡皮表面）正在擴大，這使物質群漸漸分散。宇宙是沒有真正的中心點的，因爲每樣東西都是"中心點"，而"中心點"是沒有東西的。由於宇宙含有大量暗能量引起排斥作用，宇宙很有可能將繼續如此無止境的膨脹下去。

*(See **New Proofs** Chapter One, Section 1: and Podcast 1)* ***(參閱New Proofs第一課的第一節及網站提供的Podcast1)***

The Big Bang
*The explosion of matter from a state of very high density and temperature and the expansion of space-time from a **singularity**, marking the origin of the universe.*
大爆炸
物質從一個非常高的密度及高溫狀態下擴散，與及時間空間從一個「奇點」膨脹，標誌著宇宙的起源。

II. The Big Bang model: A well-corroborated theory

II. 大爆炸模型：一個獲良好印證的理論

The Standard Big Bang Theory was first formulated by a Belgian priest, Fr. Georges Lemaitre, to answer questions about radial velocity of extra galactic nebulae (with respect to Einstein's General Theory of Relativity). At first glance, Einstein discounted this theory because he believed the universe to be in a steady state. He initially told Lemaitre, "your calculation is correct, but your physics is abominable." After subsequent confirmations, Einstein changed his mind, saying, "This is the most beautiful and satisfactory explanation of creation to which I have ever listened."

大爆炸標準理論最先由一位比利時籍的神父Fr. Georges Lemaitre創制的，用來回答與愛因斯坦相對論有關的銀河系外星雲的徑向速度問題。愛因斯坦最初對這理論不以爲然，因爲愛因斯坦原先相信宇宙是呈靜止狀態的，他最初告訴Fr. Lemaitre：「你的計算正確，但你的物理則很爛。」但經過多次確定後，愛因斯坦改了想法，並說：「這是我所聽過關於創造，最美麗而令人滿意的解釋。」

Lemaitre's model – dubbed somewhat sarcastically by Fred Hoyle as "the Big Bang" – was confirmed by Hubble's red shifts; Penzias and Wilson's discovery of a 2.7 degree kelvin virtually uniformly distributed radiation; observations from the COBE satellite; MAP satellite; and other observations. It was subsequently adjusted to account for a brief period of inflation and a possible period of quantum cosmology. Virtually all contemporary physicists accept this theory.

Lemaitre的宇宙模型當初被天文學家Fred Hoyle譏諷爲"大爆炸"，但後來被不同的新發現所證實，包括Hubble發現的遙遠星系的紅移現象；Penzias及Wilson共同發現在宇宙中存在的2.7K的宇宙微波輻射；COBE 衛星（美國太空總署的衛星）的觀測發現；MAP衛星（微波各向異性探測衛星）的發現等。該模型後來稍爲調整，以兼顧短暫的暴漲期及可能存在的量子宇宙期。但無論如何，這模型幾乎被所有當代的物理學家所接受。

*(See **New Proofs** Chapter One, Section 1; and Podcast I and II)* ***(參閱New Proofs第一課的第一節及網站提供的Podcast I及II.)***

Ground-breaking physicist Albert Einstein said Georges Lemaitre's theory was "The most beautiful and satisfactory explanation of creation to which I have ever listened." 被視爲把物理學帶來大突破的物理學家愛因斯坦說喬治勒梅特的理論是「我所聽過關於創造的最美麗和令人滿意的解釋。」

III. What is the significance of a beginning?
III. 宇宙有它的起始有甚麼重要意義？

First we must ask, "What is the meaning of a beginning of the universe?"
首先我們必須問「宇宙有它的起始是甚麼意思？」

"Beginning" means that the universe came into existence. This means that prior to that beginning point, it did not exist – it was literally nothing. Now if we take "nothing" literally, then we should not import any reality into nothingness. Nothing is not a vacuum (which has dimensionality), nothing is not space, nothing is not a void – it is only nothing.
「起始」表示宇宙的開始存在，即在那起始點之前，宇宙是不存在的，是真真正正的一無所有。既然是一無所有，我們就不應在「一無所有」之上加上任何實在的東西。「一無所有」不是真空（真空是有維數的），「一無所有」也不是太空，也不是空間。「一無所有」就只是「一無所有」。

We may now proceed to the first principle of metaphysics, namely, "from nothing, only nothing comes." This means that prior to the beginning; the universe could not have caused itself to exist, because it was nothing. So, how could the universe have come into existence if it was nothing? The only answer can be that something real caused the universe to be, and that reality must be other than the universe. This "other reality" must be beyond the universe and, it must be capable of causing the universe (as a whole) to come into existence. This reality is frequently called "Creator" or "God." Thus, "beginning of the universe" implies a "Creator" or "God."
我們現在可以進行認識形而上學的第一項原則，即「從『一無所有』，只會帶出『一無所有』。」這意味著在「起始」以前，宇宙不可能令它自己出現或形成的，因爲之前根本「一無所有」。那

麼宇宙如何能從「一無所有」的境界出現呢？唯一的答案是，一些實存的東西引致宇宙形成，而且這「實存的東西」必須是宇宙以外的。這「以外的實存」必須超越宇宙，和它必須能夠導致（整個）宇宙從無中而生。這一「實存」是通常被稱爲「造物主」或「神」。因此，「宇宙的起始」意味著有「造物主」或「神」。

(See **New Proofs** *Chapter One, Section V, and Podcast IV)* ***(參閱New Proofs第一課的第五節及網站提供的****Podcast IV.****)***

Was there a beginning?

是否有一個起始？

The above implications of creation have incited some physicists to suggest that the Big Bang was not the beginning of the universe, and they have proposed some speculative models for a pre-big-bang period which might be infinite in duration.
由於宇宙有其起始可引申到「造物主」的結論，也就引起了一些物理學家希望推翻「大爆炸」是宇宙的起始，並試圖提出一些可能的模型，支持「大爆炸」之前是有其他時期的，且可能是無限長時間的。

Are these models of infinite time consistent with the current evidence of physics? During the last twenty years considerable evidence has been discovered showing the high likelihood of a beginning of every pre-big-bang period (of every expanding universe model). This evidence is discussed in Sections IV and V.
這些假想時間是無限的模型，是否合乎物理學的證據呢？在過去的20多年，已發現的證據顯示，每個（膨脹的宇宙模型）的「前大爆炸時期」，都極有可能有它的起始。（這方面的證據在第四和第五節加以論述）。

It means that it is highly likely that our universe (and any multiverse in which it might be situated) would have a beginning and by implication, would have been created by something beyond the universe. We will now examine this evidence in two parts:
- **Evidence of a beginning from the Law of Entropy (Section V)**
- **Evidence of a beginning from space-time geometry (Section VI)**

這表示我們的宇宙（及其可能存在的任何多重宇宙），都有一個起始，而且意味著這宇宙是被一些超越宇宙的事物所創造的。我們將以下列兩部份探討這方面的證據：
- 從「熵定律」所提供的證據，證明宇宙有一起始（第五節）
- 從「時空幾何」所提供的證據，證明宇宙有一起始（第六節）

*(See New Proofs, Chapter One)****(參閱 New Proofs第一課)***

IV. Three pre-Big Bang models

IV. 三個「前大爆炸」模型

Since the Big Bang has not been proven to be the beginning of the universe, some physicists have postulated some models of a pre-Big-Bang era with the potential for infinite duration (which could avert the need for a beginning and a creation). Three well known models are:
由於未能證明「大爆炸」是宇宙的起始，一些物理學家推想一些「前大爆炸」時期，而且是有無

盡時間的（這樣宇宙便可避免需要一個起始和創造）。三個著名的模型是：

- **An infinitely bouncing universe**
- **An eternally inflating multiverse; and**
- **An eternal universe in higher dimensional space (superstring theory).**

・一個無窮地反彈的宇宙
・一個不停地發生暴漲的多重宇宙；及
・一個永恆的高維空間的宇宙（超弦理論）。

There is substantial evidence to indicate the need for a beginning in each of these three hypothetical pre-Big-Bang models (as well as other possible pre-Big Bang models). This evidence for a beginning of the universe (or any multiverse in which it may be situated) will be given in two parts: three pieces of evidence from the law of entropy (Section V) and three pieces of evidence from space-time geometry (Section VI).
大量證據表明，這三個假設的「前大爆炸模型」（以及其他可能的「前大爆炸」模型）均需要一個起始。這方面關於宇宙（或其可能處於的任何多重宇宙）起始的證據，將分兩部份向大家提供：從熵定律所提供的三件證據（第五節）；和從時空幾何所提供的三件證據（第六節）。

*(See **New Proofs** Chapter One, Section III; and Podcast IV)* ***（參閱New Proofs第一課的第三節及網站提供的Podcast IV.）***

V. Evidence for a beginning from the law of entropy
V. 從熵的定律所提供有關宇宙起始的證據

There are three mutually corroborating pieces of evidence of a beginning of bouncing universes (assuming both three-dimensional and higher-dimensional space) that come from the law of entropy. We will first describe the law of entropy and then examine each of the three pieces of evidence.
從熵定律中，有三件相互佐證的證據，表明反彈宇宙（假設是三維和更高維空間）是有一個起始的。我們將首先描述熵的定律，然後逐一探討這些證據。

Definition of the law of entropy
「熵定律」的定義

Isolated energetic systems move from states of organized complexity to disorganized states; they do not move from disorganized states to organized complex ones (because the probability of disorganized states is far greater than that of organized complex ones). For this reason, isolated energetic systems run down. Examples: billiard balls move from a racked state to a scattered, disorganized state when struck, but not vice versa; a cup of coffee moves from hot state to cool state, but not vice versa; gas moves out of an uncorked bottle but does not flow back into it, etc... Inasmuch as the universe is an isolated system, it too will run down (increase in entropy).
「孤立」的能量系統會從有組織及複雜的系統狀態，演變至無序混亂狀態；他們不會從無序混亂的狀態反過來變成有組織而複雜的狀態（因爲變成混亂狀態的概率遠遠大於變成有組織而複雜的狀態）。基於這個原因，個別「孤立」的能量系統是會耗竭的。例子：桌球從原先排列整齊的狀態，在受到撞擊後變得分散而無序，而不會倒轉而行；一杯咖啡從熱變冷，而不會相反；氣體在開瓶時從瓶內向外流走，但不會流回，等等...。只要宇宙是一個「孤立」的系統，它一樣會耗竭的（即熵會增加）。

*(See **New Proofs** Chapter One, Section IV.A; and Podcast V)* ***（參閱New Proofs第一課的***

第四節甲部份，及網站提供的Podcast V.)

First indication of finite bouncing from law of entropy ratio of starlight to CMB radiation.

跡象一：星光與宇宙微波輻射的比例--熵的定律顯示宇宙只能發生有限度的反彈

There are two kinds of electromagnetic energy in the universe: starlight (organized complex spectrum), and cosmic microwave background radiation (diffuse, homogeneous radiation). Every hypothetical bounce of the universe would convert all starlight into cosmic microwave background (CMB) radiation. Therefore, if the universe bounced a million times, then the CMB radiation would be a million times greater than starlight. Similarly, if the universe bounced a billion times, then the CMB radiation would be a billion times greater than starlight. If the universe bounced an infinite number of times, then all electromagnetic radiation would be CMB radiation, and there would be no starlight. **This is not the case in our universe where CMB radiation is only one hundred times greater than starlight indicating an upper limit of one hundred bounces, if, indeed, the universe bounced at all.**

在宇宙中有兩種電磁能量：星光（有秩序的複雜光譜）及宇宙微波輻射（散漫而均勻的輻射）。假想宇宙會反彈，每次的反彈會把所有星光轉變成宇宙微波背景（簡稱CMB）輻射。所以，如果宇宙反彈了一百萬次，CMB輻射量將是星光的一百萬倍。如此類推，如果宇宙反彈了十億次，CMB輻射量會是星光的十億倍。如果宇宙已反彈無限次，所有電磁能量都會是CMB輻射，再沒有星光。但我們的宇宙情況並非如此，CMB輻射量比星光的能量強只有一百倍。顯示即使宇宙真的曾發生反彈，亦只能發生一百次。

*(See **New Proofs** Chapter One, Section IV.B; and Podcast V)* ***(參閱New Proofs第一課的第四節乙部份，及網站提供的Podcast V.)***

|Bouncing universe反彈宇宙

A theorized model of the formation of the known universe derived from the cyclic model or "oscillatory universe" interpretation where the first cosmological event was the result of the collapse of a previous universe. 它是一個理論模型，指稱現時的宇宙是循環不息的，或可稱爲「振盪宇宙」，即宇宙是不斷重覆「終結」及「再生」的。]

Second indication of finite bouncing from law of entropy – Tolman's limit

跡象二：由「熵定律」顯示出有限的反彈—托爾曼的極限

Every bounce produces increased radiation in the universe; this increased radiation produces increased outward pressure. This increased outward pressure, in turn, produces longer and larger cycles (bounces). Therefore, if one goes back in time from today's finitely large and finitely long cycle, then one will reach an infinitely short cycle with an infinitely small radius (a beginning) in the finite past. This would constitute a beginning of bouncing, and a beginning of the universe.

每次反彈會使宇宙輻射增加，從而增加向外的壓力。這增加的向外壓力，會令反彈週期擴大。因此，如果從今天有限大和有限長的反彈週期追溯回去，那麼我們將回到一個無限小和無限短的反彈週期(一個起始)，並在有限的過去中出現。這將構成反彈的開始，即宇宙的起始。

*(See **New Proofs** Chapter One, Section IV.B; and Podcast VI)* ***(參閱New Proofs第一課***

的第四節乙部份，及網站提供的Podcast VI.）

Third indication of finite bouncing from law of entropy – low entropy of our Big Bang.

跡象三：由「熵定律」顯示出有限的反彈—大爆炸的低熵現象

If the universe were to collapse, there would be a tremendous increase in entropy (as independently calculated by Roger Penrose, Willy Fischler, and Thomas Banks). Therefore, if the universe had oscillated an infinite number of times prior to our Big Bang, entropy should have been at its highest possible level at the Big Bang. In point of fact, the entropy of the universe at the Big Bang was very low, indicating that it did not oscillate an infinite number of times. Indeed it does not seem likely that the universe bounced at all because the odds against our universe having its low entropy at the Big Bang (as calculated by Roger Penrose) is already $10^{10^{123}}$ to one (which is exceedingly, exceedingly improbable); and if there were a previous bounce, the entropy of the universe at the previous bounce would have been much lower (meaning that the odds against its occurrence would have been higher – if that can be imagined).
要是宇宙收縮，熵的值必定大幅增加（由 Roger Penrose, Willy Fischler 及 Thomas Banks 獨立計算得出）。因此，如果宇宙大爆炸以前已發生過無限次的振盪，我們宇宙的熵數值在大爆炸時應該是在其最高水平上的。但事實上，熵在宇宙大爆炸時是很低的，表明宇宙在大爆炸之前並沒有發生過無限次數的振盪。事實上，宇宙似乎並不可能發生任何反彈，因爲宇宙大爆炸處於低熵水平的可能性已是 1 對 $10^{10^{123}}$（由 Roger Penrose 計算出。這表示極不可能有反彈）。如果以前發生過一次反彈，宇宙的熵在上次反彈時將是更要低得多（即其發生的可能性將是更小 – 假如這還可想像的話）。

*(See **New Proofs** Chapter One, Section IV.B; and Podcast VI))* *（參閱New Proofs第一課的第四節乙部份，及網站提供的Podcast VI.）*

The above three pieces of evidence show the exceedingly high improbability of an infinitely bouncing universe (including those conceived to occur in higher dimensional space). It is reasonable to conclude from this that if the universe bounced at all, it did not bounce an infinite number of times, and therefore, had a beginning.
以上三項證據均表明一個無限反彈的宇宙（包括那些可能發生於高維空間的）是極不可能發生的。由此可得出的合理結論是，如果宇宙確曾反彈，它的反彈次數並非無限的，因此宇宙是有一個起始的。

VI. Evidence of a beginning of all expanding pre-Big Bang models from space-time geometry

六、 從時空幾何提供的證據，指出所有「前大爆炸膨脹模型」均有其起始

There are three pieces of evidence from space-time geometry that require a beginning of the universe (or multiverse) under certain assumptions. It will be helpful to start with a description of the spacetime field. Recall that space-time is like a field with known properties, conditions, and constants. It is dimensional and orientable; its geometry is compressed and reconfigured through the density of mass-energy in it; it can warp and vibrate; and it can affect the mass energy in it. These characteristics

enable physicists to demonstrate the necessity of a beginning under certain assumptions. All postulated models of a pre-big-bang era fall under these assumptions, and so the following three mutually corroborating pieces of evidence ground the high probability of a beginning of our universe (or multiverse in which it might be situated).

在合乎某些假設下，時空幾何學提供三件證據，指出宇宙（或多重宇宙）必須有其起始。讓我們從時空場開始描述。時空是具有已知特性、條件和常數的場，它是有維度及可定向的。它經在它內的物質能量密度的轉變，可以被壓縮和重整其幾何狀況及格局。它可以扭曲和振動，並能影響在它內的物質能量。這些特點使物理學家能夠證明，時空在某些假設成立下，必須有其起始的。所有提出的「前大爆炸模型」均符合這些假設，所以，以下三個相互引證的證據，充分合理地指明我們的宇宙（或其可能處於的多重宇宙），極有可能有其起始。

The 1993 Borde-Vilenkin Proof

1993年Borde-Vilenkin的證明

Arvin Borde and Alexander Vilenkin gave a proof in 1993 that every inflationary universe meeting five assumptions would have to have a singularity (a beginning of the universe/multiverse in a finite proper time). In 1997 they discovered a possible exception to one of their assumptions (concerning weak energy conditions) which was very, very unlikely within our universe. Physicists (including Alan Guth) did not consider this exception to be very important, meaning that the proof still shows the likelihood of a beginning of time in our universe (or a multiverse in which it might be situated).

Arvin Borde 及 Alexander Vilenkin在1993年提供了證明，任何暴脹的宇宙只要符合5個假設，都必然有一個「奇點」（在有限的原時(proper time)內宇宙或多重宇宙的開始點）。在1997年，他們發現其中一個（有關弱能量條件）假設可能有例外情況，不過這個例外極不可能在我們的宇宙發生。物理學家（包括Alan Guth）不認爲這例外情況有很重大的意義。即是說，Borde及Vilenkin的證明仍然指出我們的宇宙（或其可能處於的多重宇宙），極有可能有其起始。

*(See **New Proofs** Chapter One, Section IV.D; Podcast VII)* *（參閱New Proofs第一課的第四節丁部份，及網站提供的Podcast VII.）*

[**Alexander Vilenkin** is Professor of Physics and Director of the Institute of Cosmology at Tufts University. A theoretical physicist who has been working in the field of cosmology for 25 years, Vilenkin has written more than 150 papers. His work in cosmic strings has been pivotal.]

〔Alexander Vilenkin 是 Tuffs University 的物理學教授和宇宙學研究所所長。他是一名理論物理學家，研究宇宙論共 25 年，寫了 150 多份學術論文。他有關宇宙弦的作品甚具影響力。

Alan Guth's 1999 analysis of expanding pre-big-bang models

Alan Guth 在1999年對膨漲的前大爆炸模型的分析

Guth concluded his study as follows: "In my own opinion, it looks like eternally inflating models necessarily have a beginning. I believe this for two reasons. The first is the fact that, as hard as physicists have worked to try to construct an alternative, so far all the models that we construct have a beginning; they are eternal into the future, but not into the past. The second reason is that the technical assumption questioned in the 1997 Borde-Vilenkin paper does not seem important enough to me to change the

conclusion."
Guth 的研究結論如下：「在我個人認爲，永久暴漲宇宙模型看來一定要有一個開始。我相信這有兩個原因。首先，事實上物理學家一直在努力嘗試構建另一個可能的模型，但迄今所有構想出來的宇宙（前大爆炸）模型，都具有起始，這些宇宙的模型可以有無盡的未來，但其過去卻是有限的（不是無窮盡的）。第二個原因是， Borde-Vilenkin 在 1997 年提出的技術假設的質疑，在我看來並不重要，也沒有改變我的結論。」

*(See **New Proofs** Chapter One, Section IV.D; Podcast VII)* ***（參閱New Proofs第一課的第四節丁部份，及網站提供的Podcast VII.）***

[Alan Harvey Guth is a theoretical physicist and cosmologist. Guth has researched elementary particle theory (and how particle theory is applicable to the early universe). Currently serving as Victor Weisskopf Professor of Physics at the Massachusetts Institute of Technology, he is the originator of the inflationary universe theory.]
〔**Alan Harvey Guth** 是一位理論物理學家和宇宙學家。他曾經研究基本粒子理論（及粒子理論如何應用於早期宇宙）。他目前擔任麻省理工學院的 Victor Weisskopf 物理學教授，他是暴漲宇宙理論的鼻祖。〕

The 2003 Borde-Vilenkin-Guth Theorem (the BVG Theorem)
2003年BVG理論（由Borde-Vilenkin-Guth共同合作的理論）

Borde, Vilenkin, and Guth joined together to formulate an elegant and applicable demonstration of a beginning of expanding universes in a famous article in *Physical Review Letters*. Alexander Vilenkin explained it as follows:
Borde、Vilenkin 及 Guth 在物理報導期刊中聯合發表了一篇著名的文章，提出了一個優雅而可應用的證明，論述暴漲宇宙必然有其起始。Vilenkin 有如下解釋：

> *Suppose, for example, that [a] space traveler has just zoomed by the earth at the speed of 100,000 kilometers per second and is now headed toward a distant galaxy, about a billion light years away. That galaxy is moving away from us at a speed of 20,000 kilometers per second, so when the space traveler catches up with it, the observers there will see him moving at 80,000 kilometers per second.*
>
> *If the velocity of the space traveler relative to the spectators gets smaller and smaller into the future, then it follows that his velocity should get larger and larger as we follow his history into the past. In the limit, his velocity should get arbitrarily close to the speed of light.*
> 假設，例如，有一太空旅行者以每秒十萬公里的速度剛剛飛越地球，駛向一個大約距離地球十億光年的遙遠星系。這個星系正在以每秒二萬公里的速度遠離我們，所以，當太空旅行者趕上這星系時，在星系的觀察員也將看到太空旅行者是以每秒八萬公里衝向他們的。
>
> 如果在將來，太空旅行者與那星系觀察員的相對速度漸漸減少的話，那麼相反過來把時間推回過去，觀眾員將發現太空旅行者的速度在過去會越來越快，如果繼續向過去推，旅行者的速度會很接近光速的極限。

This point constitutes a boundary to past time in any expanding universe or multiverse. This boundary to past time could indicate an absolute beginning of the universe or a pre-Big Bang era with a completely different physics. If the latter, then the pre-Big Bang period would also have to have had a boundary to its past time (because it

would be expanding). Eventually, one will reach an absolute beginning when there are no more pre-pre-Big Bang eras. What does this mean? **It means that there must be an absolute beginning of any expanding universe or multiverse** (even if it has multiple pre-Big Bang eras).
這一點構成了的結論是，膨脹的宇宙或多重宇宙中，時間在過去是有界限的。時間在過去的邊界可顯示宇宙有絕對的起始，或宇宙大爆炸以前有完全不同的物理學的時期。如果是後者，則前宇宙大爆炸時期也必須有一個過去的時間邊界，（因爲它是向外膨漲的）。最終，宇宙將達到起始的開端，在那之前再沒有更前的前大爆炸時代。這是什麼意思？這意味著任何膨脹的宇宙或多重宇宙（即使它有多個前大爆炸時期），必須有一個絕對的開始。

This demonstration is applicable to just about any model universe or multiverse that could be connected with our universe. It applies also to oscillating universe conjectures where the average Hubble expansion is greater than zero. Exceptions to this theorem are very difficult to formulate and are quite tenuous because they require either a universe with an average Hubble expansion less than or equal to zero (which is difficult to connect to our expanding universe) or a deconstruction of time (which is physically unrealistic). For this reason all attempts to get around the BVG Theorem to date have been unsuccessful. Even if physicists in the future are able to formulate a hypothetical model which could get around the BVG Theorem, it would not mean that this hypothetical model is true for our universe. It is likely to be only a testimony to human ingenuity. Therefore, it is quite likely that our universe (or any multiverse in which it might be situated) had an absolute beginning. This implies a creation of the universe by a Power transcending our universe.
這個證明適用於任何可連繫我們宇宙的宇宙模型或多重宇宙模型。它也適用於平均「哈勃膨脹值」大於零的振盪宇宙推說。這個定理的例外情況極難制定，且相當脆弱，因爲它們要求哈勃膨脹值平均小於或等於零（這很難與我們的膨脹宇宙連繫起來），或要時間解構（這不合符物理現實）。因此，所有試圖繞過 BVG 定理的模型迄今都未獲成功。即使在未來的物理學家能夠制定一個假想模型，可以繞過 BVG 定理，這並不代表這假想模型就是我們宇宙的真實情況。這很可能只證明人類有極高的創作力。因此，我們的宇宙（或我們處身於的任何多重宇宙）很有可能有絕對的起始。這意味著我們的宇宙是由一個超越宇宙的大能所創造的。

*(See **New Proofs** Chapter One, Sections IV.D – IV.E and Section V; Podcast VIII)* ***(參閱New Proofs第一課的第四節丁至戊部份，及網站提供的Podcast VIII.)***

The above three mutually corroborating pieces of evidence (the 1993 Borde-Vilenkin singularity proof; Guth's analysis showing that every constructed expanding cosmology has a beginning; and the 2003 BVG theorem showing that every expanding cosmology has a boundary to past time) show the high probability of a beginning of our universe (or any hypothetical multiverse in which it might be situated) from the vantage point of space-time geometry.
以上三個相互引證的證據，（即1993年Borde-Vilenkin「奇點」的證明；Guth對於任何可建立的膨漲宇宙學均有起始的分析；及2003年BVG定理證明膨漲的宇宙學在過去的時間有邊界），由時空幾何的角度分析，充分合理地指明我們的宇宙（或其處於的假想多重宇宙），極有可能有其起始。

VII. Evidence of supernatural design from our low entropy universe and anthropic values of our cosmological [physical] constants

七．從低熵宇宙及物理常數的人擇數值提供超自然設計的證據

There are several conditions of our universe necessary for the emergence of any complex life form. Many of these conditions are so exceedingly improbable that it is not reasonable to expect that they could have occurred by pure chance (these highly improbable but necessary conditions for life are termed "anthropic coincidences"). For this reason many physicists attribute their occurrence to supernatural design. Some other physicists prefer to believe instead in trillions upon trillions of "other universes" (which are unobserved and likely unobservable) to lower the improbability of these conditions. Therefore, these anthropic coincidences can only be explained by belief – either belief in a superintellect that designed them or belief in trillions upon trillions of unobserved universes. Current multiple universe (multiverse) theories have shaky assumptions and require as much fine-tuning as the conditions they are meant to explain. Therefore, belief in a transcendent superintellect has considerable probative force.

我們的宇宙要容許任何複雜生命的形成，必須具備幾個條件。這些條件中，有許多是極不可能發生的，所以我們沒有理由相信他們的發生是純屬巧合（這些極不可能自然發生，但對生命來說是必要的條件，通稱爲「人擇巧合」）。因此，許多物理學家把這些條件的發生歸因於超自然的設計。其他一些物理學家卻相信，世上存在數以萬億計的「其它宇宙」（可是這信念既無實際觀測支持，也可能根本無法觀察），以減低這些條件之所以發生的不可能性。所以，這些人擇巧合，只能用信念去解釋 -- 即相信有一超智慧設計一切，或是相信世上存在數以萬億計觀察不到的宇宙。現今多宇宙（多重宇宙）理論的假設甚爲薄弱，用這些理論來解釋人擇條件，其本身亦需作許多精密調整。因此，相信有一個超越宇宙的超智慧更具說服力。

*(See **New Proofs** Chapter Two, Section III; and Podcast IX)* ***（參閱New Proofs第二課的第三節，及網站提供的Podcast IX.）***

The high improbability of a pure chance occurrence of our low-entropy universe
我們的低熵宇宙由純粹偶然產生的機會微乎其微

A low-entropy universe is necessary for the emergence, development, and complexification of life forms because a high entropy universe would be too run down to allow for such development. Roger Penrose has calculated the exceedingly low probability of a pure chance occurrence of our low-entropy universe as one in $10^{10^{123}}$. Absent a natural explanation of this phenomenon, one is left with two choices to explain the initial conditions of our universe: either they were selected by a super-intellectual creator or they occurred naturally in one universe amidst trillions upon trillions upon trillions of other unobserved universes. Penrose himself concludes, **"In order to produce a universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of the phase space of possible universes—about $1/10^{10^{123}}$ of the entire volume, for the situation under consideration."**

生命形態的出現、發展及達至如此複雜，必然要在一個低熵宇宙才能發生，因爲耗竭的高熵宇宙無法配合生命形態的發展。Roger Penrose已計算過，低熵宇宙純粹由偶然產生的機會極微，只有$10^{10^{123}}$分之一機會。這現象既沒有合乎自然規律的解釋，我們宇宙初始條件的出現，只有兩個解釋可給人們選擇：要不是有一個超智的創造者所訂立，就是因爲我們的宇宙只是數以萬億計無從觀察得到的宇宙之中，一個純粹偶爾的巧合。Penrose的結論是：「爲了產生一個類似我們生活在其中的宇宙，造物主就必須瞄準一個眾多可能存在的宇宙中極細小的相空間，大約是整個空間的 $1/10^{10^{123}}$，並製造這些合適條件。」

*(See **New Proofs** Chapter Two, Section II; and Podcast X)* *(參閱New Proofs第二課的第二節，及網站提供的Podcast X.)*

The high improbability of five other anthropic conditions (based on cosmological [physical] constants)
另外5個人擇條件的極低機率(基於一些物理常數)

A cosmological [physical] constant is a number that controls the equations of physics; the equations of physics, in turn, describe the laws of nature. Therefore, these numbers control the laws of nature (and whether these laws of nature will be hospitable or hostile to any life form). Some examples of constants are: the speed of light constant (c= 300,000 km per second), the reduced Planck constant ($h = 6.6 \times 10^{-34}$ joule seconds), the gravitational constant ($G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2})), the strong coupling constant ($g_s \sim 1$), the weak coupling constant ($g_w(m_w) = 0.653$), the mass of the proton ($m_p = 1.67 \times 10^{-27}$ kg), the mass of the electron ($m_e = 9.11 \times 10^{-31}$ kg), and the charge of the electron ($e = 1.6 \times 10^{-19}$ coulombs). There are several other constants, but these pertain to the following anthropic coincidences (highly improbable conditions required for life).
一個物理常數是一個數值，控制物理方程式;而物理方程式接而描述自然定律。因此，這些數字就是控制著自然定律(不論這些自然定律是任何生命形態的朋友或是敵人)。常數的一些例子有：光速常數（c= 300,000 km s^{-1}），約化普朗克常數（$h = 6.6 \times 10^{-34}$ J s），引力常數（$G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2})），強作用力偶合常數（$g_s \sim 1$），弱作用力偶合常數（$g_w(m_w) = 0.653$），質子質量（$m_p = 1.67 \times 10^{-27}$kg），電子質量（$m_e = 9.11 \times 10^{-31}$kg），電子電荷（$e = 1.6 \times 10^{-19}$C）。還有其他一些常數，但以上的常數與人擇巧合（極不可能發生而又是生命必要的條件）有密切關係。

A. If the gravitational constant (G) or weak coupling constant (g_w) varied from their values by an exceedingly small fraction (higher or lower) – one part in 10^{50} (.00000000000000000000000000000000000000000000000001) then either the universe would have suffered a catastrophic collapse or would have exploded throughout its expansion, both of which options would have prevented the emergence and development of any life form. This cannot be reasonably explained by pure chance.
甲、 如果引力常數（G）或弱作用力偶合常數（g_w）從他們的數值作一個極小的變化（稍高或稍低）— 10^{50}分之一（0.00000000000000000000000000000000000000000000000001），那麼宇宙就會遭受災難性的崩塌或者整個宇宙會在膨脹過程爆破，這兩種情況均會阻礙任何生命形態的形成與發展。這不用純屬巧合能夠解釋的。

B. If the strong coupling constant were higher than its value (~1) by only 2%, there would be no hydrogen in the universe (and therefore no nuclear fuel or water – this would have prohibited life). If, on the other hand, the strong nuclear force constant had been 2% lower than its value then no element heavier than hydrogen could have emerged in the universe (helium, carbon, etc). This would have been equally detrimental to the development of life. This anthropic coincidence also seems to lie beyond the boundaries of pure chance.
乙、 如果強作用力偶合常數高於其值（~1）只有 2%，宇宙就不會有氫的存在（那就沒有核燃料或水--生命亦不能出現）。如果，另一方面，強作用力偶合常數值降低 2%，任何比氫重的元素就不可以在宇宙中出現（氦，碳等）。這將是同樣無助生命的發展。這種人擇巧合似乎也超越純屬偶然的界線。

C. If the gravitational constant relative to the electromagnetic fine structure constant or the proton mass relative to the electron mass varied from their values by only a tiny fraction (higher or lower), then all stars would be either blue giants or red dwarfs. These kinds of stars would not emit the proper kind of heat and light for a long enough period to allow for the emergence, development, and complexification of life forms. Again, these anthropic coincidences are beyond pure chance occurrence.
丙、 如果引力常數相對於電磁精細結構常數、或質子質量相對於電子質量等常數值稍有不同，即使只是極小轉變（稍高或稍低），所有恆星將變成(極光亮的)「藍巨星」或（暗淡的）「紅矮星」。這兩種恆星不會長時期排放適當的光和熱，讓生命形態得以出現、發展和複雜化。同樣，這種人擇巧合也超越純屬偶然的界線。

D. If the weak coupling constant had been slightly smaller or larger than its value, then supernovae explosions would never have occurred. If these explosions had not occurred, there would be no carbon, iron, or earth-like planets.
丁、 如果弱作用力偶合常數值稍爲提高或減少，那麼超新星爆炸就不會發生。如果這些爆炸沒有發生，就不會產生碳、鐵、或類似地球的行星。

E. Fred Hoyle and William Fowler discovered the exceedingly high improbability of oxygen and carbon having the precise resonance levels to allow for carbon abundance (necessary for life). This anthropic coincidence was so striking that it caused Hoyle to abandon his previous atheism and declare: "A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question."
戊、 Fred Hoyle及William Fowler發現氧和碳極不可能地具有精確的共振能級，以至出現如此大量的碳原子（生命所必須的元素）。這種人擇的巧合是如此驚人，使Fred Hoyle放棄他以前的無神論想法，並宣布： "只要運用常理去理解這些事實，便會顯示出，物理、化學和生物學是如何被一個超級智慧所掌管，而且，自然界並沒有所謂的偶然力量。人們透過這些論證所得出的數據，是如此壓倒性地令人信服，這個結論幾乎是毫無疑問的。

[**Sir Fred Hoyle** was an English astronomer who started his career as an atheist. Later studies convinced him that sheer force of numbers dictates the existence of a Creator. The odds of life emerging otherwise are far too difficult to explain. Hoyle compared the random emergence of even the simplest cell to the likelihood that "a tornado sweeping through a junk-yard might assemble a Boeing 747 from the materials therein." Hoyle also compared the chance of obtaining even a single functioning protein by chance combination of amino acids to a solar system full of blind men solving Rubik's Cube simultaneously.]
〔Fred Hoyle 爵士是英國天文學家，他原本是一個無神論者。他後來的研究使他改變了，從數字上絕對地肯定了造物主的存在，否則難以解釋生命存在的機率。他作了一個比較，即使是最簡單的細胞，在隨機情況下形成的機率，相似龍捲風席捲一個垃圾場卻意外地從廢物當中組裝出一架波音 747 客機一樣。另外，他計算出氨基酸偶然的組成且成爲一個可運作的蛋白質的機率，與太陽系充滿盲人卻同時成功完成紐計骰的機率相約。〕

(For all five anthropic coincidences, refer to ***New Proofs*** *Chapter Two, Section II; and Podcast X)(所有關於人擇原理的5個巧合，可參閱New Proofs第二課第二部份及網站提供的 Podcast X)*

Conclusion
結語

We began this fact sheet by elucidating the horizons and limits of scientific methodology in its description and explanation of the universe and its limits. Scientific theories and conclusions are subject to modification because of the possibility of new discoveries. Nevertheless, certain theories and conclusions are considered well grounded and highly probable because they rest on multiple, distinct, bases of evidence which mutually corroborate one another. The evidence for an absolute beginning and extraordinary fine-tuning of the universe is grounded in three distinct bases:

1. Three pieces of evidence from the law of entropy;
2. Three pieces of evidence from space-time geometry; and
3. The fine-tuning intrinsic to multiple anthropic coincidences.

本文闡明了科學方法對有關描述和解釋宇宙的範疇與局限。科學理論和結論都會因應新的發現，而可能作出修改。然而，某些理論和結論被認爲是非常合理及有充分根據的，因爲它們是由多個並獨立而相互印證的實據構建而成的。下列三個充分合理的證據，指出宇宙有其絕對的起始，並且它是極爲巧妙地得以微調的：

1. 從熵定律得出三項證據；
2. 從時空幾何得出三項證據；及
3. 多樣人擇巧合中的精確調控。

As such, the current physical evidence supports a reasonable likelihood of the creation of our universe by a highly intelligent transcendent power. We invite you to visit the website of Magis Center of Reason and Faith at www.magisreasonfaith.org to learn more and join the discussion.

因此，我們的宇宙甚有可能是由一個高度智慧的超然力量所創造的想法，是獲現今物理學上的證據所支持的。我們邀請您來參觀Magis Center of Reason and Faith的網站，了解詳情並參與討論(www.magisreasonfaith.org)。

The Magis Center of Reason and Faith is a private, non-profit organization dedicated to explaining the consistency between science and spirituality in contemporary physics.

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