香港中文大學天主教研究中心

《天主教研究學報》

〈科學與信仰〉

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主編之序（中譯）

香港中文大學天主教研究中心本年度期刊將致力討論科學與信仰的關係，這亦是一個具爭議且棘手的議題。無容置疑，隨著科技進步，現代世界不斷改變，這議題十分重要。與此同時，不管好壞，宗教經常被新聞報導成爲一個文化及社會上的主要勢力。科學與宗教曾經一度成爲伴侶，現在他們卻被理解爲經常在道德以及意識形態層面上發生衝突的競爭者。

縱貫歷史，有很多科學家都是信徒，例如：孟德爾、哥白尼、開普勒、牛頓、巴士德、愛迪生等。儘管伽利略與教會有磨擦，但是他仍然是一個熱心的信徒，他亦有幾位樞機主教朋友。誠然，科學與信仰的關係從伽利略及達爾文起就變得開始緊張。事實上，兩者的關係在現代有兩個非常重大的割裂：第一個割裂是在理性層面，涉及科學的方法與哲學。當實證方法開始興盛，科學就掙脫了傳統哲學的思辨方法。第二個割裂使理性從信仰中分離，兩者被看成互不相容。筆者於此並不打算闡述隱藏在分裂背後複雜的歷史文化因素。即使有不同的方法去發掘真理，然而天主教仍繼續相信及堅持真理是不能分割的。因此，將真理分爲科學上的真理以及啓示上的真理顯然是一種過於表面的二分法。這見解亦可見於第一次梵蒂岡大公會議的文件、教宗若望•保祿二世的通諭〈信仰與理性〉（Fides et Ratio）及教宗本篤十六世的一些文章中（如在雷根斯堡大學的演辭）。現在，我們應把握良機以其他角度思考科學與信仰兩者的關係。

讀者將會透過本期刊不同的文章瞥見科學及信仰所引起廣博而複雜的議題。在這個寬闊而多元的題目上，雖然文章數量不多，但是已包含了一系列廣博的觀點。文章強調信仰與科學的歷史關係、有關兩者如何互相影響等方法論問題以及信仰或者科學能否有益於對方等思考。有些文章強調兩者的合作，有的則列舉

兩者的衝突與挑戰。有的作者以神學信仰為文章的切入點，然後逐漸延伸到科學的探討；有的則以科學開始，然後嘗試將其與神學建立討論的橋樑。

〈宇宙常數：宇宙的非凡微調的例子〉（The Cosmological Constant: an Example of the Extraordinary Fine-tuning of the Universe）一文，作者提出了一個有趣的理論性的問題：物理學能否證明有創造者存在？作者從科學數據入手，論證一個非凡微調的宇宙是建基在宇宙擴張的物理特徵。非常精準的宇宙學常數指出現時的宇宙只要有些微偏差，就不能存在。同樣，對於生物甚至有智能的生物的存在，這個常數給宇宙提供了精確的參數。這亦是所謂「人擇原理」。宇宙的非凡微調幫助我們推測宇宙存在一個充滿智慧及設計的創造者。

多米尼克•蘭伯特（Dominique Lambert）介紹了喬治•勒梅特（Georges Lemaître）的論文，論文指出靈性與自然對於真理的解釋其實不是兩種無法相容的方法，兩者不會妨礙信徒將其科學上與信仰上的使命同時地實踐出來。至於另一篇文章〈人類在進化宇宙中的地位〉（Humanity's Place in the Evolving Cosmos）對人類的演進以同樣的方法論處理與上述一樣的問題。文章指出信仰與科學是對理解現實的兩種不同方法，前者回答「為甚麼」而後者回答「如何」。與此同時，作者相信在宇宙學的意義以及人類的形成中有一深層的延續性，其中我們對真理、善與美的接納，將揭示真實的最終結構。

〈科學與宗教研究相關的還原論問題〉特別論述科際間有關方法論的問題。作者指出還原是科學成功之關鍵因為還原容許約化原則，這正是不同的科學發展所需要的共同基礎。然而，當還原趨向極端，以及當還原論變成一個意識形態或者成為一個排斥其他方法及學科的操作手法時，這就有危險了。其中的學科如神學，因為既沒有應用科學方法或者不能還原至科學，所以被貶視為不真實或不存在的學科。作者提倡在科際間以一個宏觀的角度思考，這是一個較為弱或者較為適度的還原論形式，其角度較溫

和、較開放、較實際。這個方法避免陷入一些唯物主義（將任何事物還原至物質）或唯心主議（將任何事物還原至靈性）的思考危機。作者特別意識到嘗試將宗教或者信仰經歷透過科學方法還原是困難的，因爲這兩個領域是處於同等的水平系統，因此彼此是不能互相還原。正如作者所言：「這兩個理論系統原本是平等的，甚至可以說是不分高下的，那麼也就無所謂還原了，至少沒有本體論層次上的還原。」對整個學界健康來說，真正需要的是讓我們利用謙遜作良藥，承認各種學科的局限性。

筆者自己的文章〈科學需要倫理嗎？〉分析了在科學中人類活動的價值範圍。這同樣有巨大的挑戰性。一方面，有一信念認爲科學家及科學工程應該免疫於任何外在的批評，這種不健康的高傲最終使科學變爲科技式的帝國主義或者是一個專橫的命令。另一方面，時下對於倫理方法中存在宗教原素仍有一些偏見，偏見認爲這些宗教倫理方法過於偏執或者容易引起分裂。然而，將道德及宗教的貢獻排除在科學的發展中將會是人類將來的一大威脅。

斯坦尼斯拉夫（Stanislav Južnič）的〈耶穌會士劉松齡與北京的科學技術〉一文使我們回想起 17、18 世紀時科學是被用來幫助教士在中國傳播信仰。另外，多米尼克•蘭伯特（Dominique Lambert）一書同樣展示天體物理學家神父喬治•勒梅特（Georges Lemaître）是怎樣相信「一個真實的靈性是可以與科研相容以及一個信徒是怎樣能夠成爲先進科研的參與者而不具窘容。」今天在科學與信仰之中即使出現對立，然而，這情況不會永遠如是，我們希望有一天兩者能再次和平共處。誠如〈信仰與理性〉通諭（Fides et Ratio）指出：「信心與理性就像一雙翼般把人類的精神提升到對真理的沉思；上主已將對真理追求的渴望置於人心之中。換言之，即是了解他們自己。因此，透過了解並愛慕上主，不論男女都可以達到他們對信仰上的滿足。」

Editor's Word

This year's publication by the Centre for Catholic Studies at the Hong Kong Chinese University is dedicated to the thorny question of the relationship between science and faith. One cannot deny the importance of this very current topic, since the modern world is constantly changing as a result of the advances of science and technology. At the same time, for better or for worse, religion frequently appears in the news as a major force in culture and society. While science and religion were one-time partners, they are now perceived as competitors with frequent clashes at the ethical and ideological levels.

Throughout history, many scientists were believers: Mendel, Copernicus, Kepler, Newton, Pasteur, Pascal and Edison to name a few. In spite of his trouble with the Church, Galileo was an ardent believer and friend of several cardinals in his days. Certainly, the relationship between science and faith has turned uneasy since Galileo and Darwin. In fact, two monumental splits occurred during modernity. The first schism occurred at the level of reason, between the methods of science and philosophy. With the rise of the empirical approach, science broke away from the traditional speculative method of philosophy. The second division consisted in reason being divorced from faith, the two being branded as incompatible. The cultural and historical reasons behind these separations are too complex to elucidate here. However, Catholic belief has always held that truth is indivisible, even though there can be many approaches to discover it. Hence, the dichotomy between scientific truths and revealed truths are in fact only apparent. This has been repeated in the documents of the First Vatican Council, the Encyclical *Fides et Ratio* by Pope John Paul II, and the writings of Pope Benedict XVI (e.g. the Regensburg address). Now it is time for us to take another look at this question.

Looking at the articles contained in this journal, readers will get a glimpse of the immensity and complexity of issues confronting science and faith. Though few in number, these articles contain an enormous range of perspectives on a wide variety of subjects. The contributions highlight the historical relationship between faith and science, the methodological questions regarding how these two disciplines interact, and whether faith can say something useful to science and vice versa. Some articles highlight the areas of collaborations while others enumerate the areas of conflict and challenges. Some authors start with theology and strive to reach out to science, while others begin with science and attempt to build a bridge to theology.

The article "The Cosmological Constant: an Example of the Extraordinary Fine-tuning of the Universe" raises an interesting theoretical question of whether physics can or cannot disprove the existence of a Creator. Starting from scientific data, the author presents the evidence of a very fine-tuned universe based on the physical characteristics of the expansion of the universe. The very precision of this "cosmological constant" indicates that the current universe as we know it would not have existed if it were even minutely different. Likewise, this constant provides the universe with exact parameters for not just life but intelligent life to come into existence. Known sometimes as the "anthropic principle," this fine-tuning of the universe can help us to infer the existence of a Creator of the universe with intelligence and design.

Thus, the question of methodology in the interaction between faith and science is inevitable. In his book *The Spiritual Itinerary of Georges Lemaître*, Dominique Lambert introduced Georges Lemaître's thesis of the two ways (spiritual and natural) towards truth as irreconcilable methods, which however, does not preclude the believer to live out his scientific and religious vocations simultaneously. The article "Humanity's Place in the Evolving Cosmos" looks at the same question of methodology when it comes to human evolution. Faith and science are two different approaches to reality, one answers the question "why" while the latter answers the question "how". At the same time, the author believes there is a deep continuity between cosmological meaning and the formation of the human person, where our openness to truth, goodness and beauty in some way reveals the ultimate structure of reality.

The methodological question is addressed specifically by "A Methodological Question on Reductionism in Science and Religious Studies" on reductionism in interdisciplinary studies. The author notes that reduction is the key to success of science because it allows for the generalization of principles which is necessary to provide a common foundation for scientific endeavors. However, there is a danger when reduction becomes extreme, and when reductionism becomes an ideology or *modus operandi* that excludes other methods and disciplines. That is, disciplines such as theology, which does not apply the scientific method or cannot be reduced to science, must be discounted as unreal or non-existent. The author of this article advocates a wider perspective in interdisciplinary studies, which is a weaker or modest form of reductionism that is less extreme, more open and realistic. This approach avoids both the pitfalls of materialism (reducing everything to matter) and spiritualism (reducing everything to the spiritual). The author especially recognizes the difficulties raised in trying to reduce religion and religious experience using the scientific methods because these spheres are equal at the level of system and therefore irreducible to one another. As the author writes, “Since these two theory systems are basically equal, one system is not superior to the other, we cannot speak of reduction, or at least at the level of ontological reduction.” What is needed is a healthy dose of humility to recognize the limits of each discipline.

My own article “Does Science Need Ethics” analyzes the axiological dimension of human actions in science. The challenges here are also immense. On the one hand, there is a belief that scientists and the scientific enterprise should be immune to any external critiques, with an unhealthy exaltation that culminates in a type of technological imperialism or imperative. On the other hand, there is still a strong prejudice against religious input in the ethical methods that is deemed too sectarian and divisive to be of use. However, the exclusion of ethics and religious contribution in the face of scientific progress is a great threat to the future of humanity.

The article “The Great Jesuit Hallerstein and the Science and Technology in Beijing” by Stanislav Južnič recalls the historical past where science was employed to help with the spread of faith in China during the 17th and 18th Century. The book by Dominique Lambert also demonstrated how astrophysicist and priest Georges Lemaître believes that “an authentic spirituality is compatible with scientific research and how a believer, without any embarrassment, can be an actor in advanced scientific research.” Even though there seems to be antagonism between science and faith today, the good news is that this is not necessarily permanent and we hope that one day, they can become friends again. As *Fides et Ratio* indicates, “Faith and reason are like two wings on which the human spirit rises to the contemplation of truth; and God has placed in the human heart a desire to know the truth—in a word, to know himself—so that, by knowing and loving God, men and women may also come to the fullness of truth about themselves.”

科學與信仰

The Cosmological Constant: an Example of the Extraordinary Fine-tuning of the Universe

Alex MOK

宇宙常數：宇宙的非凡微調的例子

莫榮基

[ABSTRACT] This article explores the cosmological constant problem and its anthropic interpretation.

Introduction

The 2011 Nobel Prize in Physics was awarded to three scientists for "the discovery of the accelerating expansion of the Universe through observations of distant supernovae". [1] The discovery of the increasing rate of cosmic expansion is arguably the greatest milestone in observational cosmology since the 1920s, when American astronomer Edwin Hubble first revealed evidence for the expansion of the universe. The most accepted explanation for the

[1] The American astrophysicist Saul Perlmutter received half the prize, with the other half shared between Brian P. Schmidt and Adam G. Riess. "The Nobel Prize in Physics 2011," *Nobelprize.org*, 28 May 2012, <http://www.nobelprize.org/nobel_prizes/physics/laureates/2011/> [2012/05/28].

observed acceleration of cosmic expansion is the non-zero value of the cosmological constant. The idea of the cosmological constant was first proposed by Albert Einstein in 1917, as a modification of his field equations to describe a static universe. Einstein later discarded this idea when it was observed that the universe was actually expanding. However, theoretical predictions for the value of the cosmological constant are substantially larger—by a factor of 10^{120} —than the observed value obtained from measurements by NASA's Wilkinson Microwave Anisotropy Probe (WMAP). In this article, we will investigate this so-called cosmological constant problem and its implications.

We will begin our discussion with the picture of our universe which has emerged from modern observational cosmology. After introducing the basic cosmology ideas of the Big Bang, we will discuss fine-tuning of the universe for the existence of life. Finally, we will examine the value of the cosmological constant and its significance for a habitable universe.

Our Position in the Universe[2]

Our universe is immensely large, and as stated above, it is expanding at an ever-increasing rate. Therefore, vast scales such as the light-year are used to describe astronomical systems and distances. One light-year (ly) is the distance that light travels in empty space in one year,[3] equivalent to 9.461×10^{12} km. On average,

[2] To see illustrations of our position in the universe, the reader may start with "Earth's location in the universe," Wikipedia, 19 May 2012, <http://en.wikipedia.org/wiki/Earth%27s_location_in_the_universe> [2012/05/28].

[3] The speed of light in empty space (c) is 3.00×10^{5} km/s. For example, the average distance between the sun and the earth is about 0.0000158 ly (500 light-seconds or 8.3 light-minutes); the distance between the sun and the farthest planet Neptune is about 0.000475 ly (250 light-minutes or 4.2 light-hours).

our moon is about 1.26 light-seconds (equivalent to 380,000 km) away from the surface of the Earth. The nearest star system, Alpha Centauri, is about 4.3 light-years away from the Sun, which is 100 million times greater than the distance between the Earth and the moon. If the distance between Hong Kong and Shanghai were to represent the distance between the Sun and Alpha Centauri, then the Sun would be the size of a golf ball, providing an example of the truly great amount of space between the stars.

The Solar System is about 27,000 light-years from the centre of our home galaxy, the Milky Way, which contains approximately 200 billion other stars and is likely to contain the same number of planets.[4] The Milky Way is a barred spiral galaxy with a disk diameter of about 100,000 light-years and average thickness of 1,000 light-years. The Milky Way is a member of the Local Group, a gravitationally bound system of more than forty galaxies, including the well-known Andromeda Galaxy at a distance of 2.6 million light-years away from Earth. In turn, the Local Group and about one hundred other galaxy groups and clusters[5] are members of the Local Supercluster,[6] which has a diameter of approximately 110 million light-years. Astronomers estimate that there are millions of superclusters containing more than 200 billion galaxies in the observable universe, which hypothetically is a sphere centred on Earth with a radius of about 46 billion light-years. According to the theory of cosmic inflation, the observable universe represents only a very small region of the entire universe. Cosmologists estimate that

4 A. Cassan, et al.,"One or more bound planets per Milky Way star from microlensing observations" in Nature (London: Nature Publishing Group, Jan. 2012, Vol. 481 Issue 7380), pp. 167–169.

5 Galaxy clusters are larger than galaxy groups, and may contain thousands of galaxies.

6 Superclusters are large groups of smaller galaxy groups and clusters. The Local Supercluster is also known as the Virgo Supercluster.

the entire universe may be at least a hundred trillion billion times larger than the observable universe.[7]

On the large scale of about 300 million light-years, the universe appears to be relatively homogeneous (same at every point) and isotropic (same in all directions). In modern cosmology, the assumption that the universe is homogeneous and isotropic is termed the cosmological principle. This is the ultimate statement of the Copernican principle, or the mediocrity principle, as it implies that the universe has no boundary and no centre. Based on the cosmological principle, the observation of darkness in the night sky infers that our universe is not static and should have a finite age.[8]

Our Time in the Universe

Though our universe is remarkably ancient, it is not infinitely old. In contemporary cosmology, the Big Bang is the standard cosmological model[9] that describes the evolution of the cosmos from its early history to the present observable universe. In the Big Bang model, the universe began about 13.7 billion years ago[10] with a gargantuan explosion, from which all matter, energy, space and time came into being. In this scenario, the universe has been expanding and its temperature has been falling ever since that extremely hot

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[7] Alan H. Guth, *The Inflationary Universe: the Quest for a New Theory of Cosmic Origins* (New York: Perseus Publishing Group, 1997), p. 186.

[8] If the universe were homogenous, isotropic, infinite and unchanging, then everywhere in the universe would be as luminous as the surface of a star, so the whole night sky should be bright. This is called the Olbers' paradox.

[9] The 2006 Nobel Prize in Physics was awarded jointly to two American scientists, John C. Mather and George F. Smoot, for their work that offered increased support for the Big Bang theory of the universe.

[10] The best current estimation of the age of the universe is 13.75 ± 0.11 billion years, based on the WMAP project's seven-year data release in 2010.

primordial explosion.[11] One of the consequences of this cooling process was the formation of matter out of the hot radiation. Some of this matter later assembled into galaxies, stars, planets, and even life and consciousness which we observe today, in compliance with the laws of nature.[12] Modern cosmology shows that our own existence is intimately linked to the history of the cosmos as well as the underlying physical laws and physical constants governing all of the interactions in the universe.

Throughout history, humanity has looked to the sky with awe and sought to understand our lives within the context of the universe. Modern astronomical discoveries constantly reinforce this fact, as new findings have profound existential significance. If we condense the entire history of the universe into just 24 hours, then the Big Bang occurred at 00:00. The first galaxies and stars were born at 00:20.[13] Our solar system was formed out of the solar nebula at 16:00.[14] The most primitive life on earth appeared at 17:30[15] and later evolved into the diversity of life that we observe today.[16] Dinosaurs came on to the evolutionary stage at 23:36 and became

[11] Modern cosmology can only describe the evolution of the universe from 10^{-43} s after the beginning, when the temperature of the universe was 10^{32} ºC.

[12] For a more comprehensive description of modern cosmology and the anthropic principle, see Robert John Russell, Nancey Murphy, and C. J. Isham (editors), *Quantum Cosmology and the Laws of Physics* (Vatican City State: Vatican Observatory, 1996) and John D. Barrow and Frank J. Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986).

[13] The first galaxies and stars formed about 200 million years after the Big Bang. “First galaxies were born much earlier than expected,” *Science Daily*, 12 April 2011, <http://www.sciencedaily.com/releases/2011/04/110412101330.htm> [2012/05/28].

[14] The solar system formed approximately 4.6 billion years ago; Earth was born about the same time.

[15] The earliest living organisms were prokaryotes which appeared about 3.8 billion years ago.

[16] Discoveries from paleontology indicate that more than 99% of all species which developed have become extinct during evolutionary history.

extinct at 23:53.[17] *Homo sapiens* were latecomers, and appeared only one second ago at 23:59:59,[18] following *Homo erectus* which originated in Africa at 23:59:47.[19] Molecular biology and fossil discoveries have demonstrated that human beings and modern African apes share approximately 99% of their DNA, indicating that both species are descended from common ancestors[20] who existed before 23:59:15. Early human civilizations began at 23:59:59.9 and the industrial revolution occurred at 23:59:59.998. Although human beings appeared only a blink of an eye ago on the cosmic stage, we are indisputably part of nature and, more significantly, have a long cosmic and biological evolutionary history.[21]

The Big Bang Cosmology

The Big Bang is the most comprehensive and accurate explanation[22] for multifarious modern astronomical discoveries, including the red-shift of distant galaxies, background microwave radiation and the abundance of the elements. According to the Big Bang theory, the universe was originally in an extremely hot and dense state that expanded at great speed against the force of gravity. This expansion caused the universe to cool and resulted in the

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17 Dinosaurs first appeared on Earth 230 million years ago and died out due to an asteroid impact which caused a mass extinction 65 million years ago.

18 Modern humans appeared about 200,000 years ago.

19 *Homo erectus* originated about two million years ago.

20 For example, the chimpanzee-human last common ancestor (CHLCA) lived more than 7 million years ago.

21 For a chronology of human evolution, see "Timeline of human evolution," *Wikipedia*, 25 May 2012, <http://en.wikipedia.org/wiki/Timeline_of_human_evolution> [2012/05/28].

22 It should be emphasized that scientists can never observe the Big Bang itself. It is only a scientific model for explaining what we can observe today. In the philosophy of science, it is called an inference to the best explanation, also known as abduction.

present diluted state which continues to expand, though at a lower speed due to the effect of gravity. By assuming that the universe is homogeneous and isotropic, the dynamics of the entire universe can be described by Einstein's theory of general relativity, in which gravity can be expressed as a geometrical property of space and time. The theory of general relativity can be summarized by the famous quote of John Wheeler[23] who stated that "matter tells spacetime how to curve, and curved spacetime tells matter how to move."

The spacetime geometry of a homogeneous and isotropic universe[24] is described by the Friedmann-Lemaître-Robertson-Walker (FLRW) metric,[25] which can be written in terms of the spherical coordinate system (r, θ, φ) as:[26]

$$c^2 d\tau^2 = c^2 dt^2 - R^2(t)\left[\frac{dr^2}{1-kr^2} + r^2 d\theta^2 + r^2 \sin^2\theta\, d\varphi^2\right] \qquad (1)$$

where c is the speed of light in empty space and $d\tau$ is the proper time.[27] The time-dependent function $R(t)$ is the cosmic scale factor, which represents the relative expansion of the universe. The

23 John Archibald Wheeler (9 July, 1911–13 April, 2008) was an American theoretical physicist who made significant contributions to general relativity, as well as quantum mechanics.

24 The FLRW cosmological model is the standard model of modern cosmology. For a basic introduction to general relativity with application to cosmology, see Edwin F. Taylor and John A. Wheeler, *Exploring Black Holes: Introduction to General Relativity* (San Francisco: Addison Wesley Longman, 2000).

25 A metric is a mathematical function that defines the separation between two events in 4-dimensional spacetime (curved spaces). It is similar to the famous Pythagorean formula (also called the Euclidean metric), which gives the distance between two points in 2-dimensional or 3-dimensional (flat) space.

26 The reader can simply skip the equations if he/she is not familiar with mathematical expressions.

27 Proper time is the time interval between two events as measured by a clock passing through both events.

constant k in Equation (1) can only have the values $+1, 0, -1,$ giving three different kinds of spatial curvatures corresponding to a closed, flat or open universe. Einstein's field equations relate the evolution of the scale factor $R(t)$ to the pressure and energy of the matter in the universe. From Einstein's field equations, we can obtain two independent equations for the FLRW metric:

$$\left(\frac{\dot{R}}{R}\right)^2 = \frac{8\pi G}{3}\rho - \frac{kc^2}{R^2} \tag{2}$$

and

$$\frac{\ddot{R}}{R} = -\frac{4\pi G}{3}\left(\rho + \frac{3p}{c^2}\right) \tag{3}$$

where a dot (·) indicates a time derivative and G is the gravitational constant. In the derivation of these equations, it is assumed that the matter of the universe is in the form of a perfect fluid of mass-energy density ρ and pressure p. As the density and pressure of the perfect fluid are always positive, Equation (3) implies that the second time derivative of the scale factor, $\ddot{R}(t)$, is negative. This means that the universe must be either expanding or contracting, and the expansion rate of the universe must be decreasing[28] because of the mutual gravitational attraction of matter in the universe. In other words, Einstein's field equations actually predict that the universe cannot be static. Equations (2) and (3) are usually called the Friedmann equations.[29] They describe the expansion of a

28 If the universe is contracting, its contraction rate must be increasing.

29 The Friedmann equations were first derived by the Russian cosmologist Alexander

homogenous and isotropic universe and are the most important equations in cosmology.[30]

In physical cosmology, the Hubble parameter is defined as:

$$H(t) \equiv \frac{\dot{R}}{R} \qquad (4)$$

At the present time t_0, $H_0 = H(t = t_0)$ is called the Hubble constant, which is related to the age of the universe. With the measured value of $H_0 = 73.8 \pm 2.4$ (km/s)/Mpc derived by the Hubble space telescope in 2011, the age of the universe[31] is given approximately by:

$$t_0 \approx 1/H_0 = 13.3 \pm 0.5 \text{ billion years.} \qquad (5)$$

Putting Equation (4) into Equation (2) and setting $k = 0$ give:

$$\rho(k=0) = \rho_c = \frac{3H^2}{8\pi G} \qquad (6)$$

In Equation (6), ρ_c is known as the critical density which differentiates a universe that expands forever from one that re-collapses. For $H = H_0$,

$$\rho_c = 9.3 \times 10^{-27} \text{ kg/m}^3 \qquad (7)$$

This value seems very small for the critical density, and corresponds to about five hydrogen atoms in every thousand litres of space.

Friedmann in 1922.

[30] We will include the cosmological constant in these equations when we discuss the acceleration of cosmic expansion in the later sections.

[31] See Footnote 10.

However, if we express ρ_c in terms of the solar mass $\mathrm{M_{Sun}}$ and megaparsecs[32] (Mpc), we obtain:

$$\rho_c \approx 10^{11}\ \mathrm{M_{Sun}}/(\mathrm{Mpc})^3 \qquad (8)$$

Now ρ_c does not look so small. In fact, $10^{11}\ \mathrm{M_{Sun}}$ is about the mass of a typical galaxy and a megaparsec is roughly the typical separation between galaxies. Therefore, our universe should not be far away from the critical density.

Let us define the ratio of the actual density of the universe to the critical density using:

$$\Omega \equiv \frac{\rho}{\rho_c} \qquad (9)$$

This is known as the cosmic density parameter. Using Equations (6) and (9), the Friedmann equation in Equation (2) can be written as:

$$\Omega - 1 = \frac{kc^2}{R^2 H^2} \ . \qquad (10)$$

This equation is particularly useful. It implies that if $\Omega = 1$, then $k = 0$; therefore $\Omega = 1$ for all time, even though both R and H are functions of time. However, if $\Omega \neq 1$ (and thus $k \neq 0$), then Equation (10) tells us how the density of the universe has evolved. Moreover, Equation (10) clearly connects the matter and energy density (Ω) of the universe with the geometry (k) of the universe, as described by general relativity. There are three possible cases:

(1) If the matter and energy density in the universe is greater than the critical energy, i.e. $\Omega > 1$, the average curvature must be positive ($k = +1$). The universe is closed; therefore it will eventually collapse into a point (the big crunch).

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[32] One megaparsec (Mpc) is approximately 3,262,000 light-years. Astronomers commonly measure the distances between galaxies in megaparsecs.

(2) If $\Omega < 1$, the average curvature must be negative ($k = -1$). The universe is open and it will expand forever.

(3) If the matter and energy density in the universe is equal to the critical density, i.e. $\Omega = 1$, the geometry of the universe is flat ($k = 0$). The universe will also expand forever but will approach a zero expansion speed.

That is to say, the geometry (and hence the fate) of the universe is determined by the cosmic density. It should be noted that Ω cannot be much greater than 1, otherwise the universe would have collapsed before stars had time to evolve. Conversely, Ω cannot be much smaller than 1, as the universe would have expanded so quickly that matter would not have condensed into stars and galaxies. This is actually an example of the anthropic principle, which will be discussed in more detail in the next section. Current estimations of Ω from the WMAP project, combined with other astronomical observations, give $0.99 < \Omega < 1.01$. This suggests that the matter and energy density in the universe is almost equal to the critical energy, and we in fact live in a flat universe, or a nearly flat one.

From Equations (2) and (10), we obtain:

$$(\Omega^{-1} - 1)\rho R^2 = -\frac{3kc^2}{8\pi G}. \qquad (11)$$

The right side of Equation (11) is a constant. Assuming that matter is non-relativistic, [33] we have $\rho \propto R^{-3}$ and therefore $\rho R^2 \propto R^{-1}$. Equation (11) then yields $(\Omega^{-1} - 1) \propto R$. This means that $(\Omega^{-1} - 1)$

[33] For radiation and relativistic matter, we then have $\rho \propto R^{-4}$.

increases rapidly with R and also with time; hence, Ω must be extremely close to 1 at the beginning.

Fine-tuning of the Universe

Living in the age of science, we are often reminded of the fine balance required for life to exist on our planet—the perfect blending of chemical elements and energy necessary to produce and maintain life as we know it. Yet, the requirements for the existence of life extend far beyond our atmosphere, and even our solar system. As revealed by modern cosmology, our presence is intimately linked to the fundamental parameters and laws of nature.

The more scientists discover about the conditions necessary for life to emerge, the more we see how narrow this window is. Any slight change in the laws of nature or to the values of the fundamental physical constants[34] would result in an absence of life in the universe. For example, if the gravitational constant were slightly larger, stars would burn up quickly and unevenly, thereby making the evolution of life on planets impossible; if it were smaller, no nuclear fusion could occur in stars and heavy elements would not be produced. In fact, the observed value of the gravitational constant is 'just right' for the occurrence of life. This fact, along with many other similar phenomena, has led to the promulgation of the so-called anthropic principle[35] : the view that the likelihood of the emergence

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[34] There are about a dozen physical constants whose values have to be determined from experiments. For example, the gravitational constant (G) is equal to $6.67384(80)\times10^{-11}\,\mathrm{m^3kg^{-1}s^{-2}}$.

[35] As stated by Barrow and Tipler (Footnote 12), there are three primary versions of the anthropic principle: (1) Weak Anthropic Principle (WAP): "The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirements that the Universe be old enough for it to have already

of intelligent life hinges on the delicate balance of the natural laws and constants.

The discovery of the accelerating universe in 1998 immediately became a strong example of the anthropic principle, sparking much discussion among scientists and theologians. The widely accepted scientific explanation for the increasing speed of cosmic expansion is the presence of dark energy, which accounts for 73% of the total mass-energy of the universe,[36] based on feedback from the WMAP project. Dark energy is often defined as the negative equation-of-state energy that gives rise to a repulsive force of gravity. The simplest form of dark energy is the cosmological constant, which describes the constant energy density in empty space. According to the energy-time uncertainty principle in quantum mechanics, an empty space, or vacuum, is filled with virtual particles that can contribute some background energy in space, even when space is devoid of matter and radiation.[37] This quantum vacuum energy can give rise to a negative pressure that drives the accelerating universe.

The Value of the Cosmological Constant

Historically, the cosmological constant was first proposed by Albert Einstein, as a modification of his field equations to describe a

done so." (2) Strong Anthropic Principle (SAP): "The Universe must have those properties which allow life to develop within it at some stage in its history." (3) Final Anthropic Principle (FAP): "Intelligent information-processing must come into existence in the Universe, and, once it comes into existence, it will never die out." Barrow and Tipler, *The Anthropic Cosmological Principle*, pp. 15–23.

[36] 73% of the mass-energy content of the universe is proposed to be dark energy, 23% is dark matter and only 4% is the ordinary matter that we can observe with our telescopes.

[37] The effects of vacuum energy have been observed in different experiments such as the Casimir effect and the Lamb shift.

static universe. As mentioned in the previous section, the Friedmann equations entail a changing universe. This result conflicted with the conviction of scientists in the early 20th century, including Einstein, who thought that our universe should be unchanging.[38] Therefore Einstein introduced the cosmological constant Λ in his field equations, so that their solutions might correspond to a static universe.[39] As a result, the Friedmann equations could be modified by adding a new constant term on the right-hand side as follows:

$$\left(\frac{\dot{R}}{R}\right)^2 = \frac{8\pi G}{3}\rho - \frac{kc^2}{R^2} + \frac{\Lambda c^2}{3} \tag{12}$$

and

$$\frac{\ddot{R}}{R} = -\frac{4\pi G}{3}\left(\rho + \frac{3p}{c^2}\right) + \frac{\Lambda c^2}{3}. \tag{13}$$

In light of Equations (12) and (13), we can define the vacuum-energy density ρ_Λ and vacuum-energy pressure p_Λ as:

$$\rho_\Lambda = \frac{\Lambda c^2}{8\pi G} > 0 \tag{14}$$

and

$$p_\Lambda = -\rho_\Lambda c^2 < 0. \tag{15}$$

It should be noted that the vacuum-energy density ρ_Λ is a positive constant; therefore, the total vacuum energy increases as the universe expands. Moreover, the corresponding vacuum-energy pressure ρ_Λ is negative, thus giving rise to gravitational repulsion.

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38 In fact, there was no scientific evidence for a static universe at that time.

39 For a static universe, the scale factor would be a constant, i.e. $\dot{R}(t) = \ddot{R}(t) = 0$.

After Edwin Hubble discovered that the universe was actually expanding by measuring the red-shifts and the distances of the remote galaxies in the later 1920s, Einstein completely abandoned the idea of the cosmological constant. In an academic discussion with George Gamow,[40] Einstein remarked that the addition of the cosmological constant to his equations was the biggest blunder in his life. In fact, the static universe solution to the modified Friedmann equations is not stable. If the universe expands slightly, it will gain vacuum energy that causes it to expand further. Similarly, if the universe contracts a little, it will continue to contract until it collapses.[41]

Since the remarkable and unexpected discovery of the increasing rate of cosmic expansion, the idea of the cosmological constant has been revived with much attention.[42] In physical cosmology, the value of the cosmological constant is often expressed in terms of the ratio between the vacuum-energy density ρ_Λ and the cosmic critical density ρ_c as:

$$\Omega_\Lambda \equiv \frac{\rho_\Lambda}{\rho_c}. \qquad (16)$$

It should be noted that ρ_c actually changes with cosmological time, whereas ρ_Λ is a real constant independent of the age of the

[40] George Gamow (4 March 1904–19 August 1968) was a famous Russian-born physicist.

[41] In addition, the gravitational attractive force between matters will decrease as the universe expands and increase as the universe contracts. In physics terminology, the static universe is in an unstable equilibrium.

[42] Before 1998, cosmologists simply took the value of the cosmological constant to be exactly zero.

universe. Based on measurements from WMAP as well as other supporting evidence,[43] we have:

$$(\Omega_\Lambda)_{\text{observed}} = 0.73 \qquad (17)$$

for the present time.[44] In the flat universe ($\Omega = 1$), the present ratio of the matter density[45] to the critical density is then:

$$\Omega_M = 0.27\,. \qquad (18)$$

The fact that Ω_Λ and Ω_M are of the same order of magnitude in the present epoch is an unsolved problem in cosmology,[46] which is usually termed the cosmic coincidence problem.

If we assume that dark energy is caused by the quantum vacuum energy fluctuation, we may roughly estimate the vacuum-energy density ρ_Λ using Planck units, which are based only on the properties of free space. By definition,

$$\rho_\Lambda = \frac{M_P}{l_P^3} \qquad (19)$$

where M_P is the Planck mass and l_P is the Planck length,[47] which leads to $\rho_\Lambda = 5.2 \times 10^{96}\ \text{kg/m}^3$. Hence, using Equation (7), we obtain:

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43 John D. Barrow and Douglas J. Shaw, "The Value of the Cosmological Constant," in *General Relativity and Gravitation* (Berlin, Heidelberg: Springer, Oct. 2011, Vol. 43 Issue 10), pp. 2555–2560.

44 The corresponding value of the cosmological constant (Λ) is $1.3\times10^{-52}\text{m}^{-2}$ (in SI units).

45 The matter density includes both dark (non-baryonic) matter and ordinary (baryonic) matter.

46 Note that $\Omega_\Lambda + \Omega_M = \Omega$. In the past $\Omega_M >> \Omega_\Lambda$, but in the future $\Omega_\Lambda >> \Omega_M$. Presently we have $\Omega_\Lambda \approx \Omega_M$.

47 In Planck units, $M_P = \sqrt{\hbar c / G} = 2.18\times10^{-8}\text{kg}$ and

$$(\Omega_\Lambda)_{\text{theory}} \approx 10^{122} \qquad (20)$$

Our rough estimation for Ω_Λ is 122 orders of magnitude[48] greater than the observed value. A more sophisticated calculation,[49] based on quantum field theory, still gives $(\Omega_\Lambda)_{\text{theory}} \approx 10^{120}$. This astoundingly large deviation from the measured value of the cosmological constant is "probably the worst theoretical prediction in the history of physics."[50]

The Anthropic Explanation

The great discrepancy between the predicted and observed values of the cosmological constant is the ultimate example of fine-tuning in the universe. This paradox is known as the cosmological constant problem. Steven Weinberg[51] noted that the anthropic principle actually provided an upper bound for the value of the cosmological constant: if it were only a few times (less than one order of magnitude) greater than the observed value, our universe would have expanded so rapidly that there could be no formation of galaxies and stars.[52] Without stars, there would be no stellar

$l_P = \sqrt{\hbar G / c^3} = 1.62 \times 10^{-35}\,\text{m}$, where $\hbar = 1.055 \times 10^{-34}\,\text{Js}$, which is called the reduced Planck constant.

48 That is to say, $(\Omega_\Lambda)_{\text{theory}}$ is greater than $(\Omega_\Lambda)_{\text{observed}}$ by one hundred trillion trillion trillion trillion trillion trillion trillion trillion trillion trillion times!

49 Ta-Pei Cheng, *Relativity, Gravitation and Cosmology: A Basic Introduction* (New York: Oxford University Press, 2010), pp. 272–273.

50 M. P. Hobson, G. P. Efstathiou and A. N. Lasenby, *General Relativity: An Introduction for Physicists* (New York: Cambridge University Press, 2006), p. 187.

51 Steven Weinberg received the Nobel Prize in Physics in 1979 for his pioneering work on the unification of the electromagnetic interaction and the weak interaction.

52 Steven Weinberg, *Dreams of a Final Theory: The Scientific Search for the Ultimate*

nucleosynthesis to produce heavy elements[53] such as carbon and oxygen, and without heavy elements, life and consciousness would not have been possible.

While anthropic phenomena such as the cosmological constant problem have been viewed as evidence of purposeful design by a cosmic creator, many scientific minds continue to explore alternative explanations. The hypothesis of multiple universes, otherwise known as the multiverse, is the most discussed scientific explanation for the many remarkable coincidences which have led to the evolution of intelligent life. In the multiverse scenario, many universes, each with different natural laws and physical constants, could exist simultaneously or successively. Cosmologists estimate that an unimaginably large number of at least $10^{10^{10000000}}$ universes could exist in the multiverse.[54] Most of these universes would be uninhabitable; however, a few might harbour life under the right conditions. Our own universe, with its very special laws and physical constants, fortuitously succeeds in producing and sustaining life in the midst of the many universes that are incapable of doing so. The odds are extremely small, but like a winner in a sweepstakes, our universe has been given the prize of intelligent observers.

Popularized in science fiction and fantasy, the multiverse idea is now echoed in some modern physical theories such as string theory and loop quantum gravity. Some think that the multiverse idea satisfactorily explains the fine-tuning of our universe; however, opponents dispute that this hypothesis is highly speculative and lacks

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Laws of Nature (New York: Vintage Books, 1994), p. 228.

53 In physical cosmology, no chemical elements heavier than beryllium could be formed in the early universe.

54 Andrei Linde and Vitaly Vanchurin, "How Many Universes are in the Multiverse?" in *Physical Review D* (College Park, Maryland: American Physical Society, Apr. 2010, Vol. 81 Issue 8), 083525.

supporting scientific evidence.[55] The primary problem is that other universes are, in principle, unobservable; therefore, the hypothesis is not verifiable. Moreover, the existence of the multiverse itself may require further explanation, and in fact, the multiverse and cosmic creator may not be mutually exclusive ideas.

It is evident that the very small (but not zero) value of the cosmological constant, which allows the existence of life as it is presently understood, demands some explanation—whether by a cosmic creator or by the multiverse. While the idea of alternate universes is disputable, modern cosmology has clearly demonstrated that our universe is not only orderly, but also intelligible and awe-inspiring. Reflecting on the place of intelligence in the universe, Einstein remarked, "What I see in Nature is a magnificent structure that we can comprehend only very imperfectly, and that must fill a thinking person with a feeling of 'humility'. This is a genuinely religious feeling..."[56] This anthropic reasoning is, in fact, a good starting point for the dynamic and imperative dialogues between science and religion, as it provides profound insight into the nature of humanity as part of the evolving cosmos. We certainly need further exploration of our relationship with the known universe. Perhaps, like the apostle Thomas, who did not believe in the witness of his fellows to the risen Jesus and demanded more empirical evidence by examining the nail-marks in Jesus' hands,[57] our search for the reality of the anthropic universe is also a journey of faith.

[摘要] 本文章探討宇宙常數問題及其人擇釋義。

55 John Leslie, *Universes* (New York: Routledge, 1989), pp. 66–68.

56 Helen Dukas and Banesh Hoffman (editors), *Albert Einstein, The Human Side: New Glimpses from His Archives* (Princeton, New Jersey: Princeton University Press, 1979), p. 39.

57 John 20: 24–25.

Humanity's Place in the Evolving Cosmos

Jan Van der VEKEN

人類在進化宇宙中的地位

Jan Van der VEKEN

[ABSTRACT] The search for the place of the human person in the evolving universe is a contemporary instance of the traditional problem concerning the relationship between faith and reason. If we say that in the human person the creative advance into novelty shows its utmost possibilities (until now), we move into the direction of a religious outlook at reality. Then, in fact, we see that the human and the universe are truly related. When we see the emergence of the human as the result of mere "chance and necessity" (as Jacques Monod would have it), then an atheistic outlook at reality seems unavoidable. Then there would be in fact no "alliance" (or reasonable relation) between man and the universe.

Introduction

The question that increasingly comes up in all discussions about religion and science is this: what is humanity's place in the developing universe? For some, life is little more than a bit of fungus on a lost planet and humanity means nothing in view of the entire cosmos reality. For others, humanity is the "crowning work" of creation. It looks as if we can look at the same reality (our being there in the cosmos) in two different ways. And that is indeed the case. We have to do here with a special case of "seeing as". Wittgenstein has developed the concept of "seeing as" towards the end of his *Philosophical Investigations*. What we see depends upon the way we interpret. He gives the example of the famous duck-rabbit picture (Jastrow). I think that this example can be very well applied to our situation in the cosmos. You can look at it in two totally different ways: either you "see" that the human person is nothing else than an evolved animal; or you can "see" that the coming to be of a being capable to being aware of its own being there is the most significant event in the whole cosmic evolution. We surmise that looking at "humanity's place" in the cosmos is very different, before and after Galileo and before and after Darwin, in the same way as you can see in the same picture either a rabbit or a duck. Note that there is no "true" way to see and interpret such an ambiguous picture. The two interpretations are indeed possible, and to a certain extent justified.

Everyone is in agreement: along the line of biological evolution the human is a late arrival. And yet the question remains: Is the human nothing more than a coincidental branch on the tree of life or is the human's being the "most significant event" in all of evolution?

Faith and Science: Two Different Ways of Looking at Reality

There are different ways to look at the relationship between science and meaning. And one has discovered this very gradually. In just about all pre-scientific cultures (i.e. before the 16th and 17th centuries) meaning is almost automatically religious. Faith and faith in the ultimate purpose of life fall practically together. Only gradually does a healthy differentiation arise between “faith” and “science.” This must not necessarily lead to an unhealthy separation as though the one had nothing to do with the other.

In the Middle Ages and long afterwards (up to Galileo) people looked to nature and to the Bible for answers to the same questions. Saint Bonaventure happily used the metaphor of the “two books”: the will of God can be discovered in the Bible, but also in nature. Galileo, however, pointed out that the Bible and natural science were concerned with two different questions: “how the heavens go” and “how to go to heaven.” This is an insightful distinction (that Galileo borrowed from his friend Baronnius). Unhappily enough, this has not always been understood properly. As a result of the enormous impact of the theory of evolution since the nineteenth century, faith and science have come to be seen as “enemies.” (cf. Andrew D. White, *A History of the Warfare of Science with Theology*, D. Appleton and Co, 1896).

Today the relationship between natural science and faith is no longer viewed as antithetical. Faith has certainly not disappeared because of the advances in the positive sciences. Each has something to say to the other. Indeed it involves “interplay.” Today we see much better that faith and science are two very different approaches to reality. And so we see that someone like Stephen Jay Gould can speak of NOMA (non-overlapping magisteria). Faith and science have no reason to fear each other just because they seek an answer to different questions. The natural sciences (cosmology and biology) offer us information about how of the concrete coming to be of the universe (or better, of this "cosmic epoch") and the beginning of life and humanity in this greater spatial reality. In the religious search for meaning in reality, one looks for the why of this immense ("marvelous") event. This standpoint is not so different from Galileo's position. The question remains, however: how are the two approaches related?

In what follows I will argue for the "continuity thesis." By that I mean the deep continuity between the grounding and structure of the cosmos and the emergence of life that culminates in a being with a complex brain structure. So, on the one hand I think that there is a deep connivance between the very structure of the universe and life; and on the other hand, given the good circumstances and enough time, more intricate (or complex) forms of life are probable. A very complex brain structure is a necessary requisite for reflective consciousness and what A. N. Whitehead calls: "the finer experiences of mankind"—the human openness to "the true, the good and the beautiful."

Questions of Fact and Questions of Meaning

Thanks to contemporary science, we today can get in touch with the history of (this) cosmos. Anthropology, paleontology, biological-genesis and cosmological-genesis take us back farther and farther.

From a scientific standpoint (the how of the process that eventually resulted in humans) the beginning and the development of life is, according to scientists like Christian de Duve,[1] essentially a chemical event (i.e. the development of life is regulated by what we call natural laws). In this understanding there is no exceptional divine intervention necessary. There is no need to point to an improbable Coincidence or Chance either. That actually would mean that one would have to accept what Iris Fry refers to as a "lay miracle".[2] Coincidences or Chance undoubtedly play some role in concrete evolution but occurs within a "Spielraum" that made possible and even probable the arrival of highly complex structures. In other words, it lies, given the nature of the Universe, in the line of what would be reasonably expected. That is the "objective" of the scientific side of the account of our being human.

The Question of Meaning

The manner in which we "see" the phenomenon of life on this planet—thanks to the positive sciences (cosmology, biology, paleontology)—determines the way in which we can speak today meaningfully about being human. Actually the fundamental question comes to this: What is the relationship between humanity and this fantastic evolutionary event; and what is its deep meaning, its significance? From the fact that the arrival of the human in this cosmos is not actually necessary (and in part can be due to chance occurrences) cannot mislead one into holding that human-being is without meaning (as Jacques Monod argues.) Quite the contrary.

[1] Christian de Duve, *Life Evolving. Molecules, Mind, and Meaning* (Oxford, New York : Oxford University Press, 2002).

[2] Iris Fry, *The Emergence of Life on Earth*: A Historical and Scientific Overview (London: Free Association Books, 2000).

That a being is capable of self-reflection about its own being, that a human can strive after truth, goodness, and beauty reveals something about the deep foundation of reality itself. The be-ing of the human, with its various capabilities, is the most "significant" occurrence in all of evolution. The believer expresses this by saying "the human is made in the image and likeness of God." In other words, what is revealed in the human person (the openness to truth, goodness and beauty) reveals as well the ultimate structure of "reality" itself. So there are today two totally distinct ways to "see" the place of the human person in the Universe: either you surmise that the human is nothing else than an evolved animal, and a pure product of chance and utterly meaningless, and then your overall view of Reality will be scientific materialism. Religion in such a context will not be something else than product of evolution, which allows a species which has developed it to be more successful, in the struggle for life. That is according to my understanding the contemporary face of atheism, broadly spread today by authors as R. Dawkins, D. Dennett and other "new atheists". If you "see", however, that what appears in the human being is significant to understand the Whole of Reality—as permeated by Logos and Consciousness—than the human is truly understood as made according to the image of the divine. In such a context a contemporary understanding of the divine can be elaborated. It goes without saying that even then very different ways to conceive of God remain open. How to conceive of God cannot be decided upon scientific grounds. Some "independent evidence" (Whitehead) is required.

In any case, the relationship between "God" and "world-and-humanity" ought not to be thought of as a relationship between Maker and the made but rather as a "Covenant" (*Une Nouvelle Alliance* as in the title of the book by Ilya Prigogine and

Isabelle Stengers La Nouvelle Alliance, Métamorphose de la science, Paris 1979).

"Covenant" is a typical biblical word and opens the way to a completely different manner of "seeing" the relationship between "God and world" than traditional creationist thought that is so marked by the image of the relationship between Maker and what is made (in fact a Deist understanding).

The Big Difference in Evolution since the Arrival of the Human is that the Human Takes Part in the Evolutionary Event

From this point on it is not just a natural process but also a cultural event. This implies that the human carries an enormous responsibility for the further existence of its own ecological "niche". A very great problem is the "conflict of time frames:" Biological evolution takes into account millions of years. Within a few thousand years, the human being can bring about an irreversible destruction of our planet. All indicators point to the arrival of humans in this world as the most significant event in all of evolution; and it is in all likelihood the event that has the greatest impact on evolution. This places on human shoulders an enormous ethical responsibility. (See for instance: www.worldmeters.info/nl/)

In a recent book,[3] Christian de Duve speaks about the "original sin" of evolution. There are apparently evolutionary mechanisms that make humans a very successful sort so that humanity expands in explosive fashion. Apparently however evolution has not promoted

[3] Christian de Duve, *Génétique du péché originel. Le poids du passé sur l'avenir de la vie* (Paris: Odile Jacob, 2009).

wisdom. We need to fundamentally change our position over nature and the entire evolutionary process. Nature must be seen as much more than a source of goods and energy. The delicate (im)balance of nature is a task for which we ourselves are responsible. Maintaining "civilized life on earth" is a task that connects with all of our involvements with nature. Being-human is more than maintaining a relationship based on production and consumption. There must be space as well for wonder and respect.

All of our dealings with reality, also at the technological and commercials levels, must follow, on one hand, their own logic (and their own language); but, on the other hand, must remain open for the "finer experiences of humankind": our openness to the true, the good and the beautiful. Those are the real fruits of the spirit.

A New Turn in the Road for the Relationship between Faith and Science: the Unfortunate Opposition between Chance and Design

The opposition between faith and science has pretty much subsided in the university landscape. Unfortunately there still are some remnants of this opposition in what is called "creationism" (i.e., in a too literal reading of the biblical creation narrative). Especially in the United States is this viewpoint especially strongly represented in groups of "evangelicals" (evangelical Protestants). A modern form of creationism is the thesis of "intelligent design."

As John Cobb, Jr. observed: "we are confronted with two very bad choices": chance and design are not opposites. Logically or structurally they are related to each other. Iris Fry says (correctly) that Chance is a kind of "lay miracle." "Chance" (with capital C) and design mean implicitly that there is something from outside that "intervenes" to make the coming of life and of humanity possible, or that the coming of life and of humanity a very high level chance event is that in no way lies within the line of expectations. This goes completely against the (here defended) continuity thesis. The two horns of the dilemma therefore are: On one side Chance or Design; and on the other side the arrival of life as the result of a complex interplay of physico-chemical events that comply with the intrinsic laws of nature.

The difficulty is that every way of speaking comes from a position of power. So often the acceptance of an evolving world image (in the lines of Darwin) is seen as writing-off religious meaning. So among people for example as J. Monod, Stephen Weinberg, and Richard Dawkins. A response to this "*discours*" from the religious side pointing to the insufficiencies of scientific explanations is yet another form of "power-talk": evolution is then "seen" as a mistake and a deception. We need something more than science (which is correct except not when it comes to solving scientific problems). According to our understanding there is no longer an opposition between faith and science. There is tension between the faith perspective that has endured the confrontation with the insights of the positive sciences and the Enlightenment and the faith understanding that discards that tension and says it is correct to oppose scientific insights. This is all part of the posture that some people take against "modernity" (in which of course the positive sciences play an important role). As A.N. Whitehead says, the future of the planet will depend on the way in which various cultures handle the relationship between faith and science.

In conclusion, I would like to offer two quotations that interpret the tension between questions of fact and questions of meaning:

(1). "Whenever I listen to music, whenever I wander through an art gallery, whenever I let my eyes wander along the clear lines of a Gothic cathedral, whenever I read a poem or a scientific article, whenever I observe my grandchildren or whenever I simply reflect on the fact that I can do all of this, with the understanding of course that I can reflect on these things, then it is impossible for me to state that the universe, of which I am a part, were not obliged to be, by its very nature able somewhere and at some time, perhaps at various times and in various places, to bring forth beings that would be capable of accounting for the beauty of the universe, who would be capable of experiencing love, seeking truth and wondering at mystery. That being said, I belong to the category of the romanticists. So be it."[4]

Why do you have to be a romanticist to hold that position? Romanticists, indeed, in reaction to the scientific materialism of their time, hold that there is a profound connivance between Nature and the human person

Another fine quotation that friends passed on to me some time ago, comes from Rabbi Bunan (as quoted by M. Buber):

(2). "A man should carry two stones in his pocket, One should be inscribed 'I am but dust and ashes!' On the other, 'For my sake was the world created,' and he should use each stone as he needs it (as quoted by Rabbi Bunan)." This citation shows so clearly that a scientific approach and a religious approach are very different. They don't have to discount each other. But people do have to know—with wisdom—which language best fits which context.

[4] Christian de Duve, "La vie est inscrite dans l'univers. Le savant s'interroge…et prend position," in *La libre Belgique*, October 12, 1990.

[摘要] 即使當代，我們仍有一些傳統上遺留下來的問題需要處理，其一就是尋求人類在進化宇宙中的地位。這個例子涉及信仰與理性的關係。若然我們說在人類身上的創進的歷程成為更新是展示人類至今為止的無窮可能性，那末我們就會進入宗教的角度看現世。我們亦因而覺察人類與宇宙是確切地有聯繫。然而，當我們認為人類的出現只不過是因為「機會與需要」（如 Jacques Monod 認為）時，似乎不能避免以一個無神論觀點看現世。這樣，人類跟宇宙將不會有任何合理的關係，更談不上可以成為「聯盟」。

科學與宗教研究相關的還原論問題[1]

傅曉

A Methodological Question on Reductionism in Science and Religious Studies

Xiao FU

[摘要] 本文在對「還原」與「還原論」進行初步介紹的基礎上，首先簡要討論了它們在宗教研究這個學術研究領域應被如何看待的問題，進而著重討論在進行諸如科學與宗教間交叉學科研究的過程中，應如何處理還原論。筆者認爲，溫和的尤其是方法論上的還原論是幾乎所有學術研究都應秉持的基本態度，本體論上的還原論則總是需要盡力避免的。前者無疑是科學得以迅速發展最有利的工具之一，但後者則容易在跨學科研究或交流過程中導致不平衡（例如可能抬高某學科自身、同時貶低其他學科的價值），甚至導致對話難以進行。另外，在進行交叉學科研究時，宏觀上的整體論與局部在方法論上的還原是有益的，引進溝通雙方相關概念的橋樑對於交叉學科的比較研究尤其重要。

[1] 本論文的初稿曾於 2011 年 5 月 27–29 日北京師範大學之第五屆科學與信仰學術年會上口頭發表。

前言

還原（Reduction）與還原論（Reductionism）是科學研究或者宗教研究都不可避免的話題，若進行科學與宗教對話，這個問題應會顯得更加複雜。還原作爲一種科學研究的程序／方法幾乎是各種科學研究都不可或缺的，甚至連聲稱不能被還原的宗教現象學研究本身都不例外。還原論作爲一個哲學命題，是值得包括科學哲學、宗教哲學以及各學科的學者在內所深思的問題。據筆者的理解，還原和還原論是在自然科學領域的哲學討論中爲主；宗教研究作爲一個相對較新的現代學術領域，盡管不可避免面對還原及還原論的問題，相關的討論仍較前者爲少；而在科學與宗教間跨學科的研究領域裡，相關的討論更是少見。本文擬對宗教研究、科學與宗教的交叉學科研究中的還原論問題進行探討，目的主要是希望能爲學者進行相關的交叉學科研究提供必要的方法論和研究立場上的參考和借鑒作用。

簡要介紹還原與還原論

「大事化小，小事化了」在生活哲理上是種解除煩惱的有效方法；若與科學的研究方法相比，它倒頗似還原的原理。忽略現實中錯綜復雜的諸多「干擾」因素，而僅在意及去把握其最基本的部份或意義。

還原，又可被稱爲化約、約化。Ernest Nagel 對還原的理解較爲經典，即一個較高的理論能被還原到一個較低的理論，較高理論的概念與較低的理論中的相關，並能從中衍生出來。[2] 它到底有多長的歷史？Manfred Stoeckler 認爲還原（To Reduce）的方法僅被應用了幾個世紀，[3] 黃欣榮則認爲還原的思想和應用可以

[2] Ernest Nagel, *The Structure of Science; Problems in the Logic of Scientific Explanation* (London: Routledge & Paul, 1961), Chapt. 11.

[3] Manfred Stoeckler, "A Short History of Emergence and Reductionism" in *The*

追溯到古文明時期，如中醫之五行或亞里斯多德的四因說等等。[4] 無論如何，還原——這種將複雜問題簡單化的方法的出現，遠早於還原論的出現（二十世紀中期）。

「還原論」的歷史則僅有幾十年而已。它作爲一個詞雖然至少在 1942 年就曾出現過，[5] 但被更廣泛重視的討論還原論的學者是 Willard Van Orman Quine。還原論是他在 1951 年的一篇文章中提到經驗主義的兩個教條中的一個，[6] 其後還原論的內涵和應用都得到了擴展。

還原與還原論的差別，用 Evandro Agazzi 的話來說：還原是具體的，還原論是抽像的：前者是一個科學程序或方法（Scientific Procedure），後者則是一個哲學學說（Philosophical Doctrine），或者也可以簡單說是一個哲學信條（Tenet）或主張（Claim）。[7] 還原論由於是種人爲提出的哲學主張，那麼本身就應該是會面臨質疑和挑戰的；而還原由於是種既已存在的具體科學程序，最主要是需要被描述、解釋、理解和准確定義，以及被批判性地分析，包括認識其局限性等，而非真的要被挑戰。[8] 爲了更好地了解還

Problem of Reductionism in Science, Vol. 18, ed. Evandro Agazzi (Dordrecht; Boston: Kluwer Academic Publishers, 1991), p. 72.

[4] 「在中國文化中，把對象分解爲它的組成部分去研究的做法古已有之，莊子贊揚的庖丁解牛，中醫講的五臟六腑，就是例證。在西方文化中，還原的信念更是源遠流長，古希臘的先哲們大部分都有這樣的思想，例如，泰勒斯的水，赫拉克裡特的火，德謨克裡特的原子與虛空，亞裡士多德的四因說等等，都試圖把自然現象的複雜性認識歸結到尋求一種或幾種本源。但無論古中國，還是古希臘等其他古代民族，都沒有形成系統的分析方法，更談不上形成現代還原論這種完整的方法論。」引自：黃欣榮，〈科學還原論及其歷史功過〉，《江西財經大學學報》，2008 年第 4 期，頁 74。
http://d.wanfangdata.com.cn/Periodical_jxcjdxxb200804016.aspx.

[5] A. Campbell Garnett, "Scientific Method and the Concept of Emergence," in *The Journal of Philosophy* 39, no. 18 (August 1942), pp. 477–486.

[6] "The other dogma is reductionism: the belief that each meaningful statement is equivalent to some logical construct upon terms which refer to immediate experience." W. V. O. Quine, "Main Trends in Recent Philosophy: Two Dogmas of Empiricism," in the *Philosophical Review 60*, no. 1 (January 1951), p. 20.

[7] Agazzi, The Problem of Reductionism in Science, p. VII.

[8] Ibid., p. VII.

原論，也許通過與反還原論對比會有所幫助。還原論會將追求統一、簡化、更原始或基本的規律、知識的系統關係等作爲認識世界的方法論原則；而反還原論則突顯現實中多樣性的存在，以及發現和理解複雜性的能力。[9] 還原論的本體伙伴是原子論（Atomism），反還原論則對應整體論（Holism）。[10] 至此，應能基本了解它們所選擇的迴異立場了。

還原的局限性主要在於缺乏合成（Synthesis），無論整個世界還是人類的知識都是成系統的，而並非由獨立的單位簡單聚合而成；於是，合併兩個或者更多理論、甚至整個研究領域，通常比將一個理論還原成另一個理論更爲必要。[11] 不過近代科學的迅猛發展已經顯示出將整體分解開來研究，將一定程度上的還原作爲一種科學研究程序或方法來應用是相當高效的。因此，本文的重點會放在對還原論的討論上，這有利於準研究的立場；其次才是放在還原身上，尤其去了解這種方法在交叉學科的研究上應該如何被較好地應用，同時又不至於落入不當的還原論立場上去。

還原論可以包含多個層面的內涵，如本體論的（Ontological）、認識論的（Epistemological）及理論的等。本體論層面的還原論，簡而言之是對世界構成的一種認識或者信念，認爲較高層次的事物或者成份都是由較低層次的基本成份所組成的，是種相信世界的本體乃是「同一」的信念。認識論層面的還原論是針對人類的知識體系而言，希望通過將事物分解到較低層次去研究、分析，從而能了解到較高層次的現象等。而理論還原論，即基於理論間的還原，通常是認爲較高層次的、或被認爲較不成熟的理論能從較基礎的、或較成熟的理論中派生出來。

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[9] Agazzi, The Problem of Reductionism in Science, pp. IX–X.

[10] Maria Bunge, “The Power and Limits of Reduction” in ibid., p. 32. 該文中還提到反還原論已經成爲近年來後現代主義者「反對」科學和理性的口號了，不過這是後話。

[11] Ibid., p. 33.

在對交叉學科研究的還原論問題進行討論前，尚有必要先借用 Maria Bung 對各層次系統的介紹來理清整個認識系統的脈絡。鑒於同時有宏觀或微觀層次的差別，與本體論或認識論間的差別，總共有如下八種不同關係：[12]

1，微–微（MICRO–MICRO，mm），（a）本體論的，如原子碰撞，愛的紐帶（The Love Bond），（b）認識論的，如原子的量子理論，人際關係的心理學理論：

2，微–宏（MICRO–MACRO，mM），（a）本體論的，如電子與原子間作爲一個整體的相互作用，由一個小的大氣擾動導致的山崩，由一位有魅力的領袖觸發的社會運動，（b）認識論的，如統計力學，天體物理學，由諸如微量的光子擊打到視網膜上這樣的微刺激觸發的動物行爲方式的理論：

3，宏–微（MACRO–MICRO，Mm），（a）本體論的，如洪水或地震對一個動物的影響，政府對個人的影響，（b）認識論的，如一個微觀物理實體的侵入性測量理論（A Theory of an Intrusive Measurement of a Microphysical Entity）；洋流中船舶漂流路線的模型：

4，宏–宏（MACRO–MACRO，MM），（a）本體論的，如太陽與地球的相互作用，動物群體間（如家庭間）的競爭，（b）認識論的，如行星天文學，板塊結構學理論，國際關係模式。

還原論者與反還原論者分別看重其中那些關係呢？還原論者認爲微–微、微–宏關係有解釋力，而反還原論者則認爲宏–微、宏–宏關係有能力解釋。[13] 亦即前者重視從微觀角度來解釋，而後者重視宏觀角度。

[12] Ibid., pp. 39–40.

[13] Maria Bunge, “The Power and Limits of Reduction”, p. 40.

所謂的宏觀與微觀自然應是相對的（Relative），所謂的各學科也應是相對的。當今的學科分類由於各種歷史和現實的原因變得越來越細，一個學科內的問題，在學科分家後可能變成學科間的問題（例如各式各樣的物理學）。不過，由於宗教與自然科學「分家」很早，本文將要討論的宗教與科學間的研究，應毋庸置疑地被視爲學科間、即交叉學科的問題。

此外，強弱還原論的概念對本文的討論也較爲重要。黃欣榮認同還原論的強弱是基於理論間能還原的程度不同而言的。[14] 劉勁揚則相信，強還原論是極端的還原主義，將對象完全視爲基本單位的簡單堆砌，認爲爲數不多的基本規律就能滿足解釋世界的需要：弱還原論雖然也承認世界可以靠基本規律來解釋，也將整體分解來研究，但並不認爲整體是基本單位的簡單聚集，因爲它重視整體性，故分解還原的方法是不得已而爲之的。[15] 強還原論的論調常帶有些典型的表達方式，如「nothing but」，諸如愛僅是種化學反應而已，抑或思維無外乎是腦細胞放電的作用，等等。筆者認爲，無論是僅從理論間還原的角度，還是從整體的還原論角度來講，強還原論確實是種極端的、尙不現實的、理想化的信念而已，通常缺乏足夠的科學實證所支持：弱還原論則是更開放的、更現實的、尤其對於交叉學科的對話更具可操作性。

Elena Klevakina 討論了在認識論的概念中，還原價値成份（Value-Components）的不同方式，Klevakina 將其稱爲激進的（Radical）還原與溫和的（Modest）還原。所謂的激進還原，她所舉的例子是極端唯物主義者，如 L. Buechner，K. Vogt，J.

[14] 「依據理論間還原的強弱程度不同，還原論又分爲強還原論與弱還原論。強還原論體現的是一種無條件的、絕對的、完全的還原觀念。它指一個理論的全部術語、規律還原爲另一理論的術語、規律而不借助於任何附加條件和原理。與此對應，弱還原論則是一種有條件的、相對的、部分的還原觀念。它指兩理論間還原之實現須依賴於一定的附加條件與原理 (即橋接原理) 。就實際情況而論，弱還原論則更接近於科學理論還原的實際狀況。引自：黃欣榮，〈科學還原論及其歷史功過〉，頁 76。

[15] 劉勁楊，〈還原論的兩種形相及其思維實質〉，《自然辯證法通訊》29，第 6 期，2007 年，頁 29–30。

Moleschott 等等，他們將物質範疇視爲是最根本的，而非物質的精神範疇則被簡單地去除掉，抑或在某種意義上還原到物質範疇中去了。[16] 其實不僅極端唯物主義者屬於激進的還原論者，唯心主義者同樣可以被扣上這樣的帽子，因爲他們將所有的存在都還原到精神或意識範疇。[17]

我們應能看到強還原論者的做法是有價值取向在內的，且甚爲排他，非常堅持自己的價值取向，而忽略他人的、自己通常並不接受的價值取向。如何解決這個問題，Klevakina 認爲將命題降到經驗層面會更容易去除價值成份的影響，例如亞里斯多德關於 Natural Good 的理論 “An Object (a state of affairs) is a Natural Good if all Persons Desire it”，如此，價值就與經驗性的現實聯繫起來了，多少降低了價值層面的影響。[18] 當然，其可操作性到底如何，尙需另文討論。

宗教研究（作為一個學術學科）中的還原論問題

經過反復斟酌及修改後，Arvind Sharma 對宗教研究領域中的還原論給予了下列定義：“Reductionism is a mode of explanation or interpretation in the study of religion or a religion which attempts to grasp religious phenomena other than on a plane of reference which is regarded as religious by the subjects of such study.”[19] 他很清楚宗教研究的還原與反還原間的論戰背景，因此希望這樣一種

[16] Elena Klevakina, “The Problem of Reducing Value-components” in Agazzi, *The Problem of Reductionism in Science*, p. 201.

[17] Arvind Sharma, “What is Reductionism” in *Religion and Reductionism :Essays on Eliade, Segal, and the Challenge of the Social Sciences for the Study of Religion*, *Vol. 62*, eds. Thomas A. Idinopulos and Edward A (Leiden; New York: E.J. Brill, 1994), p. 130.

[18] Klevakina, “The Problem of Reducing Value-components”, p. 202.

[19] Sharma, “What is Reductionism”, p. 142.

在概念上對還原論的澄清能讓雙方互利，並讓他們從自以爲是的煙幕後走出來。[20]

在〈宗教學的方法論探索：以「約化論」與「反約化論」的爭辯爲例〉一文中，[21] 黎志添也非常清楚地提到這兩派間的爭辯與學科的建立及其獨特的學科方法之建立背景（如芝加哥學派與非芝加哥學派間的紛爭）密不可分。以 Mircea Eliade 等爲代表的芝加哥學派致力於建立一獨立的宗教研究方法。他們堅持宗教研究不能還原宗教信仰者的經驗，而是要從信仰者的角度出發，同情地理解他們的宗教經驗。用 Eliade 的話來說，「嘗試以心理學、社會學、經濟學、語言學、文學或其他研究來獲取宗教的本質是錯誤的；這樣作會失去宗教現像內所蘊含獨有、不可被約化的元素——神聖元素。」[22] 且，他也聲稱了自己並非是要否認從其他視角來研究宗教現像的效用。[23]

約化論者則相信：若宗教研究是科學的，那其研究對象與其他學科一樣不應有特殊待遇，即宗教經驗的內容不能輕易從字面去接受和理解，而是需要依靠人類的其他經驗來參照、理解和解釋；另外，要求研究者從信仰者角度去理解、尊重甚至接受其邏輯和意義，這對學者來說幾乎是不可能的；[24] Eliade 甚至被認爲有將其自身所認爲的具有普遍性的宗教意識強加到所有宗教信仰者身上的情況。[25]

更重要的是黎教授清晰地指出了雙方的局限性，如：一方面，儘管約化論（還原論）者表示宗教現像學者擔心宗教的本體

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[20] Ibid.

[21] 黎志添，〈宗教學的方法論探索：以「約化論」與「反約化論」的爭辯爲例〉，《輔仁宗教研究》，第 5 期，2002 年，頁 87–109.

[22] 黎志添，《宗教研究與詮釋學：宗教學建立的思考》(香港：中文大學出版社，2003)，頁 26。

[23] Mircea Eliade, *Pattern in Comparative Religion,* trans. By Rosemary Sheed (New York: Sheed & Ward, Inc., 1963), p. xiii. Cf. ibid., p. 27.

[24] Ibid.

[25] 黎志添，《宗教研究與詮釋學：宗教學建立的思考》，頁 28–29。

性被還原掉是多餘的，但作者認爲理論性的還原與本體性的還原之差別（說來容易）其實是模糊的，如 Robert Segal 的立場本身就是不接受宗教信仰者的超越性理解，即便說是理論性還原，其實也包含著強烈的本體論層面的還原；另一方面，作者雖然並沒有直接去反駁 Mircea Eliade 作爲反還原論者本身也在使用還原的方法，但指出了宗教研究者「不能再有伊利亞德 [Eliade] 那般的信心，在著作裡宣告宗教信仰者是如此的想、如此的意識、以及如此的相信」。[26] 藉此，筆者認爲 Eliade 已不僅僅是在認識論上使用了還原的方法，而是（如同上述的唯心主義者的還原傾向）在信念上注入了自己本體論的理解，這種還原如果過頭了，是比認識論層面上的還原要「激進」些的。即便其他學者也有能「理解」Eliade 的做法，即相信他僅僅是爲了保留獨特的學科方法，及研究者個人最爲熟悉和慣用的專有學術用語，簡而言之是爲了學科而絕非某種宗教的神學承諾，[27] 筆者還是認爲是否應該有 Eliade 的那般「自信」確實是應該謹慎的，至少在學術性的宗教研究領域。

那麼，如何才是相對客觀的宗教研究態度呢？筆者個人覺得，黎教授的建議是很值得學習和借鑒的：「任何宗教研究與解釋都不是以追求和解釋在宗教經驗世界裡的普遍性意義和結構，而是謙虛地承認我們研究出來的成果只是屬於研究者本身對宗教經驗、結構及意義的某種理解。」[28] 筆者認爲，這絕不單單是謙虛和自信程度的問題，而是一種開放的胸襟，是保證不墮入自負的極端還原論信念的必要條件。

[26] 黎志添，〈宗教學的方法論探索：以「約化論」與「反約化論」的爭辯爲例〉，頁 104–105。.

[27] George Weckman, “Reductionism in the Classroom” in *Religion and Reductionism :Essays on Eliade, Segal, and the Challenge of the Social Sciences for the Study of Religion*, pp. 214, 218.

[28] 黎志添，〈宗教學的方法論探索：以「約化論」與「反約化論」的爭辯爲例〉，頁 105。.

交叉學科的還原論問題

在 Hans Primas 看來，並不存在一個科學的、有根據的、重要的交叉學科上理論還原的例子，至少就 Hempel，Oppenheim，Nagel Sneed 或者 Stegmueller 而言；因此對於一個當代理論學家而言，還原論已經死了。[29] 老的還原論「死」了，絕不表示當代就不再關心還原論的問題了。各種理論間的關係顯然仍是現代科學所感興趣的，但傳統的理論還原對各種科學理論間結構的看法過於簡單了；實際上，不同層次的理論間的關係非常復雜，遠遠超過單純主張還原論或者反還原論的預想。[30] 就現代科學發展至今的情況而言，傳統的舊的還原論已無法解決問題，從下面的生物學例子就應能清晰顯現出來現代科學理論間的還原之困難。

以生物學爲例,將它還原到化學甚至物理學到底有無充分根據？的確，生物學的新進展推出了 DNA[31] 分子這樣的概念，爲還原論者從微觀視角來解釋宏觀現像提供了一個有力證據，甚至似乎爲將生物學直接還原到化學甚至物理學提供了重要支持。不過，反還原論也很容易舉出甚多反駁點，如 DNA 的生物學特性（如參與合成蛋白質、自我復制等等）是無法從化學或者物理的角度來解釋的。借用 Bunge 的例子，如同一個飛行員在家裡是無法表現其飛的能力的，一個 DNA 分子若在細胞外也無法表現其獨特的生物學功能。[32] 此外，學科間的專業概念間無法直接轉換或者關聯的問題，也是導致無法簡單還原的重要原因，如遺傳學的基因、染色體、細胞等就根本無法被翻譯爲電荷、共價鍵、基本粒子等概念，因此遺傳學在邏輯上是難以被還原爲量子力學等物理學的。[33]

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29 Hans Primas, “Palaver Without Precedent” in ibid., p. 169.

30 Ibid.

31 DNA 即脫氧核糖核酸，是生物體內重要的遺傳單位。

32 Bunge, “The Power and Limits of Reduction”, p. 43.

33 F. J. Ayala, “Biology as an Autonomous Science, ” in *American Scientist* 56, no. 3 (1968), p.　207.

簡而言之，無論將細胞還是生物機體視作一個系統，微觀視角下的 DNA 分子要能充分起作用，就無法脫離系統來研究；或者說，用還原的方法來研究微觀的對象，得出其部份結論在科學方法論上是可行的，但徹底放棄系統存在的事實而持較強的還原論，來堅持被還原的部份能說明和衍生出更高的系統層面上的現象和規律，就成了一種片面、錯誤的哲學信條了。不但這種完全不同的學科間的還原是如此，一個大學科下面的分支學科間的還原也是需要慎重的。如微觀生態學家與宏觀生態學家間存在的理解鴻溝，又如神經生理學家與精神學家間有時幾乎難以跨越的溝通障礙，都是客觀存在的事實。正如 Frank E. Budenholzer 所相信的，其實各種不同層次（如從原子、分子到細胞、組織、個體等層面下）的知識結構並不存在孰高孰低。[34]

那麼，若我們在求知和探索的道路上仍期望繼續走下去的話，尤其是在跨學科或者交叉學科的處境下，應該如何妥善地處理學科間、各理論間的還原問題呢？一個基本理論（A Universally Valid Basic Theory）的所有次級理論（Subtheories）與其假定的第一原則之間，首先是種和平共處的關系；Primas 認爲，若要讓它們能夠從初級理論中衍生出來，必須引入新的關鍵的結構元素。[35] 要在兩個理論或者系統間建立關聯，也是 Nagel 對還原的理解下必須完成的一個任務，沒有建立可靠的關聯性，還原必然僅是空想或者一個單純的信念而已。與基本理論相比，所有較高層次的理論都是處境相關的；較高層次的理論確實擁有一定程度自主性，若不考慮用來觀察較高層次現像的模式認識裝置（Pattern Recognition Devices），就不能由基本原則（Universally Valid First

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[34] Frank E. Budenholzer, "Some Comments on the Problem of Reductionism in Contemporary Physical Science," in *Zygon: Journal of Religion and Science* 38, no. 1 (2003), p. 61.

[35] "Furthermore, all subtheories of a universally valid basic theory are in a state of peaceful co-existence with the postulated first principles, but they cannot be deduced from them without introducing crucial new structural elements." Cf. Primas, "Palaver Without Precedent", p. 170.

Principles）所推導出來。[36] Primas 相信，互相獨立互補的對自然的描述（理論）不僅是允許的，也是具有平等資格的、必然的；即，科學必然是多元的。[37] 事實也的確如此，如果說宗教缺乏可驗證性是比較容易被理解的，那麼很多科學理論的有效性和局限性也是需要被正視的，即便當今科學對整個人類社會的影響力看似遠遠大於宗教信仰，但在認知層面上仍難以作任何無懈可擊的類似宣稱：孰高孰低、孰真孰假。

（廣義的）科學是多元的，這也是筆者所持的基本態度。回到科學與宗教對話的論題上，科學與宗教在未來的發展即便我們將其極度理想化，暫時幻想一下它們最後的整體相融，但現實卻一定遠非如此。受到人類認知程度等因素所局限，不同學科間的相互對應是偶然的，而無法對應卻是必然的，故，要求所有理論都能在更基礎層次的理論中得到對應是不可能的；換言之，Nagel 的還原僅能在局部意義上成立。[38] 科學與宗教的研究自然也不例外，從整體角度不能全然還原是必然的，但局部還原還是可能的。

科學（或者某種自然科學學科）與宗教（或者某種宗教）之間的關係，按照 Bunge 的分類來看，應該是屬於 MM，即宏–宏的關係，看起來似乎更是反還原論者的視角。的確如此，如果我們並不站在極端的唯物主義或者唯心主義等角度上，這兩個理論系統原本是平等的，甚至可以說是不分高下的，那麼也就無所謂還原了，至少沒有本體論層次上的還原。如果真的有還原的因素在內的話，要麼是方法論或認識論上的還原，要麼是受較為偏執或強硬的意識形態的主導——導致本體論上的某種還原（無論是將宗教理念還原到某自然科學學科的理論中去，還是將自然科學學科的解釋系統還原到宗教義理中去）。

[36] Ibid.

[37] Ibid.

[38] 張華夏，〈兼容與超越還原論的研究綱領——理清近年來有關還原論的哲學爭論〉，《哲學研究》，第七期，2005 年，頁 118。

筆者認為，本體層面的還原論確實是相對更容易引起爭議的。用 Ian Barbour 的話說，這即是相信較高層次事件是被較低層次組分（Components）的性能（Behavior）所決定的。[39] 如果說 Richard Dawkins 所謂的自私的基因（The Selfish Gene）中的「自私」還應被視為一種比喻的用法，[40] 那麼孔憲鐸所相信的人性的惡是由自私的基因所決定的，[41] 便顯然是種本體層面的還原論。這樣的論斷無疑最容易引起較大的爭議，其合法性無疑值得進一步討論。持類似觀點的學者其實不在少數，其中尚包括 DNA 雙螺旋結構發現者之一、諾貝爾獎獲得者 Francis Crick，他相信人類的快樂、痛苦、記憶以及自由意志等都無外乎神經細胞及與之相關聯的那些分子綜合作用的結果。[42] 與此不同，科學哲學家 Nancy Cartwright 認為，不少物理學家之所以認定意識並非神秘的，而是可以完全用科學來解釋的（筆者注：儘管當今的科學離這一步還很遠很遠），這實際上是種存在於整個科學以及科學哲學的基本偏見，是種對還原性解釋的鍾愛。[43] Stephen Kaplan 在對不二論[44] 與神經科學進行對話的嘗試中，相信在進行神經科學與宗教交叉學科分析的過程中，不必再糾纏於本體論的問題，這將有利於對話而非衝突。[45] Francisca Cho 與 Richard K. Squier 亦

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[39] Ian Barbour, “Theology and Physics Forty Years Later,” in *Zygon* 40, no. 2 (2005), p. 509.

[40] 他將人類的各種特性視為進化的產物，而進化過程中的關鍵乃是基因，即諸如人類的道德感之類的人性特徵也都是這種分子級的遺傳物質在進化過程中，經過自然選擇、適者生存所發展來的。參見：Richard Dawkins, The Selfish Gene, 30th anniversary ed. (Oxford; New York: Oxford University Press, 2006).

[41] 參見：孔憲鐸、王登峰，基因與人性 (北京：北京大學出版社，2009).

[42] Francis Crick, The Astonishing Hypothesis : The Scientific Search for the Soul (New York: Scribner, 1994), p. 5. Cf. Kirsten Birkett, “Conscious Objections: God and the Consciousness Debates,” in *Zygon* 41, no. 2 (2006), pp. 249–250. .

[43] Birkett, “Conscious Objections: God and the Consciousness Debates,” p. 63.

[44] 印度哲學中吠檀多派的一個主要分支，佛教哲學中也有著非常類似但不盡相同的思想。

[45] Stephen Kaplan, “Grasping at Ontological Straws: Overcoming Reductionism in the Advaita Vedanta—Neuroscience Dialogue,” in *Journal of the American Academy of Religion* 77, no. 2 (Jun 2009), p. 265.

明確地提出了，爲了有益地將認知科學運用到宗教研究中去，毫無必要固守諸如唯物主義哲學堅持的還原論。[46]

如若說科學主義者會毫不猶豫地將宗教還原到社會學或者心理學甚至神經心理學等等各種可能的其他學科中去；同樣，有著濃厚神學氣質的宗教研究學者也有可能將自然科學還原到宗教教義中去，那裡，無論哪種宗教，大概都不難找出能供科學「落腳」的地方，無論是基於對上帝萬能的信念，還是業感緣起理論的應用，自然神學便是較典型的例子。但這種還原是我們所追求的麼？Stuart Kauffman 在對還原論進行了否認之後，仍相當堅持對「God」一詞的使用以及強調神聖感對當代的重要性。[47] 雖然他所謂的上帝和神聖感並非出自很狹義的基督教角度，而是更面向一個全球倫理這樣的視角，他的這種堅持到底是否是種另類的（即神學傾向很重的）還原論、以及是否值得借鑒，倒仍值得（尤其宗教研究）學者深思。

結語

還原論如同世間萬物，雖然有其存在的意義但並不完美。正如 Sharma 評價 Webster's 字典中對還原論的定義，既點出了其目的又顯出了其危險：爲了使複雜的現像顯得有意義於是將其還原成簡單的，但危險正是過於簡單化。[48] 在 Bunge 看來，還原論者和反還原論者都是半對半錯，原因很簡單，（微觀與宏觀的）四種關係都是存在的；激進的還原論者與激進的反還原論者都有問

[46] Francisca Cho and Richard K. Squier, “Reductionism: Be Afraid, be very Afraid,” in *Journal of the American Academy of Religion* 76, no. 2 (1st June 2008), p. 412.

[47] S. Kauffman, “Beyond Reductionism: Reinventing the Sacred,” in *Zygon* 42, no. 4 (2007), p. 903.

[48] 該字典中對還原論的定義：“A procedure or theory of reducing complex data or phenomena to simple terms; ESP: oversimplification. . . ” Philip Babcock Gove, *Webster's Third New International Dictionary of the English Language*, ed. Philip Babcock Gove (Springfield, Mass.: G&C Merriam Company, 1959), p. 1905. Cf. Sharma, “What is Reductionism”, p. 128.

題，只有接受系統的策略，涵蓋所有四個關係（甚至有需要時涵蓋更多關系）才對。[49] 還原（作為科學程序/方法）是值得應用的，但應該意識到其局限性；溫和的（弱）還原論不但是種比激進的（強）還原論更現實的研究策略，也比反還原論更有力。[50]

基於本文至此的討論，筆者認同溫和的（弱）還原論不但是自然科學研究應該秉持的態度，也是宗教研究的良好態度。如黎教授所建議的「謙虛」，正是堅持盡可能不將個人的價值觀有意無意融入學術研究中去的做法，因此不至於成為「自以為是」的強還原論者；又絕不放棄對複雜的宗教現像等的研究與理解，同時也不必對其他學者不同的研究進路和方法論進行抵觸，也因此在保留了學科獨特的方法論的同時並不排斥方法論層面的還原，又不必成為強烈反對其他學者的激進反還原論者。

至於科學與宗教的交叉學科中的還原論問題，筆者以為即便是學術研究，客觀中立也是相對的，偏見的存在則是絕對的，例如先入為主的意識形態（無論是唯物主義的，還是宗教信仰的）對學者的影響是潛移默化的。如研究認知科學的學者如果已經默認宗教是錯的，即靈魂並不存在，那麼他們所構建的便是個無需靈魂存在的認知理論。[51] 唯物主義的哲學思想（作為不同意識形態之一）絕非現代科學的產物，而是必須要追溯到公元前 5 世紀的古希臘的哲學家去，如作為原子論的代表人物 Leucippus（留基伯）和 Democritus（德謨克利特）；[52] Socrates（蘇格拉底）與他們的辯論甚至與現代關於意識（唯物主義與不死的靈魂等之間）的辯論甚為雷同。[53] 故此，即便唯物主義的意識形態在當今仍佔據著主流，學者在進行跨學科研究的過程中，仍應該盡量避免本體論層面的還原。

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[49] Bunge, “The Power and Limits of Reduction”, p. 40.

[50] Ibid., p. 48

[51] Birkett, *Conscious Objections: God and the Consciousness Debates*, p. 252.

[52] Ibid., 251.

[53] Ibid.

從宏觀上看，整體論也許更加契合跨學科研究的背景，作爲認識世界的不同理論系統，它們正是科學多元性的表現所在。但在局部的層面，通過引入溝通雙方術語和觀念的橋樑對於交叉學科研究是非常關鍵的，不過具體如何操作極其必然將面對的困難是不容忽視的。如果有可能，應該說方法論層面的還原應該總是有幫助的；但在本體論層面，則應盡可能保持「中立」，盡可能不帶有過重的價值成份、意識形態，亦即不在本體論層面進行任何強還原（將某個系統完全還原到另一個系統的嘗試）。筆者在〈佛學與科學對話的不同立場〉一文中也表達了類似的看法，即不做價值或意識形態的比較和聲稱，以及平等、謙虛、開放的態度對於跨學科研究的重要性。[54] 相信只有通過這般努力，不同學科共同健康地來進行各自或互相廣泛關聯的跨學科研究才能真正成爲可能。

[54] 傅曉，〈佛學與科學對話的不同立場，《佛學與科學》，第一期，2011 年，頁 20–32。

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[ABSTRACT] Based on the brief introduction of reduction and reductionism, this essay first demonstrated how they should be treated in the academic field of religious studies. I have then focused on how we shall apply reductionism or reduction in interdisciplinary research such as religion and science. From my point of view, modest reduction should be used in most of the academic research areas, whereas ontological reductionism has to be avoided all the time. Holism in the macro scope and methodological reduction used locally are beneficial in interdisciplinary research, and providing effective communication between the relevant conceptions on the two sides is of great importance for interdisciplinary comparative research.

Does Science Need Ethics?

Joseph Tham, LC

科學需要倫理嗎?

譚傑志

[ABSTRACT] This paper addresses two main challenges of the place of ethics in science. The first deals with the problems associated with a postmodern attitude toward science. In spite of the vertiginous advances of science and technology in our globalized world, there is a sense of unease in our relationship to them. We will examine the causes behind this unease by looking at the historical and philosophical roots of scientism, technological will to power, transhumanism and moral relativism. Scientism and nihilism which negates the needs of ethics as an independent audit of the scientific enterprise can pose a great threat to humanity. The second challenge concerns what kind of ethics should guide science. Here, the debates revolve around whether there are any universally accepted ethical approaches to science, and the role of religion in these methods. Postmodernity negates the possibility of a contribution from a religious ethics since they claim it is not empirical and therefore irrelevant. As a response, a critique is offered from the natural law perspective and recent writings of Pope Benedict XVI on the proper relationship between science and ethics, faith and reason.

Introduction

At first, it seems like an odd question to ask if science needs ethics. It is evident that science and scientists need to be ethical in their research and endeavors. One only needs to recall the haunting images of the atomic explosions over Japan and those of Nazi doctors experimenting on their prisoners in concentration camps to think otherwise. However, there are frequent conflicts between the claims of science and that of ethics. This paper will address two of the claims that science should be an independent discipline, and that ethical limits does not apply to science because that would slow down its progress.

The first claim comes from a belief that science and technology alone can resolve all human questions and problems without any outside help. This paper will trace the historical and philosophical roots of this movement called scientism which exalts science to such an extent that any critiques aimed at it or limits placed upon it would be considered untenable. This ideology is supported by the increasing role of technology in our society, where objective truth becomes subjugated to the whims of those who have the power to impose their desires on reality. This was already predicted by philosopher Nietzsche as nihilism, which he characterized with "the will to power," the creation of supermen and moral relativism. While science and technology can certainly offer many important advantages to improve our lives, if it ignores ethical implications it could also become a tyrant.

The second claim concerns what kind of ethics should guide science. Here, the debates revolve around whether there are any universally accepted ethical approaches to science, and the role of religion in these methods. Both the aforementioned scientism and nihilism negate the possibility of a contribution from a religious ethics since they claim it is not empirical and therefore irrelevant for our postmodern needs. This paper will look at the question of the conflicts between reason and faith, and in particular the tension between rationalistic philosophical-based ethics and religious faith-inspired ethics.

As a response to these challenges, we will look at the Catholic approach to ethics based on the natural law perspective and some recent writings of Pope Benedict XVI on the proper relationship between science and ethics, faith and reason.

Science and Reason Alone Can Solve all Ills

Certain currents of thought today question the need of ethics in science. The first of this is termed scientism, also known as scientific or logical positivism. This is the product of the Enlightenment that enthrones science and reason to be a new goddess. First conceived of by the philosopher Auguste Comte (1798–1857), he envisioned three stages of progress in human knowledge: theological, metaphysics, and positivist. The theological stage is marked by medieval beliefs in the forces of the gods and spirits. This was replaced by metaphysics during the scientific revolution which attempted to explain causes in terms of invisible forces. In the positive stage, the purest form of human knowledge is attained by measurable and verifiable data of science. The most evolved stage of scientific positivism manifestly makes the claim: “Only that which is observable is true.” Accordingly, metaphysical and religious truths are dubious since they cannot be scientifically demonstrated. Comte sees this evolution of knowledge in science and in society based on evolutionary theories in vogue at the time. Scientific positivism is reductive by nature, presuming a romantic but unproven view of history as unidirectional and progressive. Its corollary in science is the belief that all scientific and technological advances and discoveries are necessarily positive and constructive.[1]

According to this view, only science can save humanity from misery. Therefore, society should not put any limits or prohibitions on scientific endeavors, including ethical ones. Thus, it is not uncommon to hear some scientists decrying government or churches when they voice concern on types of research. This has sometimes been coined as the scientific or technological imperative, where science trumps all other concerns. Recently, when some scientists discovered a way to create a deadly flu virus that could kill millions, the US government asked the journal not to publish the details of how this is done to protect against potential terrorism. Yet, some scientists felt that this was an infringement on scientific freedom and in the end, the publication went ahead.[2] A recent article on the questions of ethics in science wonders whether the public should have any say on the work of scientists. If anything, this confirms the general attitude that scientists should have absolute independence and not much accountability towards society.[3]

Scientists sometimes impose their desire by manipulating the message in such a way that their wishes are granted. For instance, most serious scientists know that embryonic stem cell research will not yield likely cures to diseases like Alzheimer's. Yet, there is so

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1 See "Scientific Progress", Stanford Encyclopedia of Philosophy (October 1, 2002), in <http://plato.stanford.edu/entries/scientific-progress/>

2 Alexandra Velcelean, "Dutch Researcher Created A Super-Influenza Virus With The Potential To Kill Millions," in Medical News, (November 28, 2011) <http://www.doctortipster.com/6952-dutch-researcher-created-a-super-influenza-virus-with-the-potential-to-kill-millions.html>

3 Janet D. Stemwedel, "Who matters (or should) when scientists engage in ethical decision-making?" in Scientific American, (April 23, 2012) <http://blogs.scientificamerican.com/doing-good-science/2012/04/23/who-matters-or-should-when-scientists-engage-in-ethical-decision-making/>

much hype in the media that is not corrected by the scientific community that one wonders if they allow this misinformation on purpose in order to have a free hand in their research.[4] Sociologist John Evans has shown how scientists have influenced secular ethicists by forming an implicit alliance with those who in turn give the official nod to their undertakings. Citing a study of the history of the debates over the public control of science in the first thirty years of the Human Genetic Engineering debate, he concludes:

> "During this period in which the democratic approach to decision-making appeared to be gaining acceptance and impact, the political challenge it represented was successfully contained [by scientists], to such an extent that the technocratic approach—and the process of decision-making by elites that lies behind it—was never seriously threatened."[5]

If it is true that the only sure source of knowledge comes from what is empirically proven, then what cannot be thus demonstrated does not exist. Hence, any consideration that includes the existence of God, souls, human nature, and even such experiences as love, friendship, or courage will be eliminated in this equation. The ethical questions are therefore either irrelevant, or must be under the domain of science. That is, scientists can arrive at ethical decisions by using scientific methods like surveys. This is logically inconsistent as some philosophers have demonstrated. G.E. Moore calls this the *naturalistic fallacy* and David Hume calls this the *is-ought* problem. In essence, they complain that it is not valid to derive normative

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[4] Sherif Girgis, "Stem Cells: The Scientists Knew They were Lying?" in *Public Discourse*, (April 13, 2011) <http://www.thepublicdiscourse.com/2011/04/2490>

[5] John H. Evans, *Playing God*, *Human Genetic Engineering and the Rationalization of Public Bioethical Debat*e, (Chicago University of Chicago Press, 2002), 82, citing D. Dickson, *The New Politics of Science* (New York: Pantheon Books, 1984), p. 220.

ethical statements (what *ought* to be) from descriptive empirical facts (about what *is*). Science can tell us what is, not what we ought to do. As *Donum Vitae* insists, "What is technically possible is not for that very reason morally admissible."[6] Pope Benedict XVI in his Regensburg address critiqued this position:

> "This gives rise to two principles which are crucial for the issue we have raised. First, only the kind of certainty resulting from the interplay of mathematical and empirical elements can be considered scientific. Anything that would claim to be science must be measured against this criterion. Hence the human sciences, such as history, psychology, sociology and philosophy, attempt to conform themselves to this canon of scientificity. A second point, which is important for our reflections, is that by its very nature this method excludes the question of God, making it appear an unscientific or pre-scientific question. Consequently, we are faced with a reduction of the radius of science and reason, one which needs to be questioned."[7]

The Technological Revolution

The ideology of scientism has taken hold because technology has taken tremendous strides since the industrial revolution, resulting in many positive improvements for humanity. We live longer,

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[6] Congregation for the Doctrine of the Faith, *Donum Vitae—Instruction on respect for human life in its origin and on the dignity of procreation*, 1987, 4.

[7] Benedict XVI, *Address at University of Regensburg*, (September 12, 2006), <http://www.zenit.org/article-16955?l=english>

healthier, and more comfortable lives than our ancestors. Medicine has undergone a breathtaking transformation in the recent past. The end of the 19th century saw the beginning of anesthesia, antiseptic practices and X-Rays. We tend to forget that scientists discovered the first effective antibiotics only during the Second World War. After that, medical science exploded with an armamentarium of life-saving procedures—blood grouping, open heart surgery, mechanical ventilation, dialysis, organ transplants, and chemotherapy, to name a handful. Throughout most of human history, death came at an early age—typically one lived only 25–35 years. Over the past century, however, life expectancy has risen to around 77 years—tripling the life span of our ancestors.

Science and technology has indeed eliminated many miseries and discomforts. Thanks to technical advances, we have higher standard of living, travel with relative ease, and can communicate with family or friends on the other side of the globe instantly. Most of us cannot live without these modern comforts—just imagine living without electricity or hot showers. At the same time, we are plagued by the fact that technology can sometimes harm us. There is a sense that technology can also harm us.

This ambivalent attitude towards technology is evident in many areas today. Industrialization has undoubtedly improved the quality of life, but we are just beginning to recognize many ecological disasters that came with it. The nightmare of Chernobyl, acid rain from electric plants, air pollution from automobiles, oil spillage and water pollution, ozone depletion, animal extinction, the problem with waste disposal and climate change are just some examples.[8] While genetically modified foods promise to alleviate world hunger, there

[8] See Paul Haffner, *Towards a Theology of the Environment* (Leominster: Gracewing, 2008).

are those who are worried of "Frankenfood" and the seeds that will destroy the natural food chain.[9] Information technology has changed the way we relate to each other in the spheres of social relationships, education and research, commerce and politics, religion and culture. At the same time, the negative impact of cybernetics is just around the corner—online gambling, pornography and even child porn, plagiarism and illegal trading, invasion of privacy, spam and virus attacks are prominent examples.[10] One must not forget that many innovations, including internet, GPS and innovative surgical techniques were ironically spin-offs from military technology. The ambivalent attitude toward technology is most acute in medicine because it affects us more deeply than other advances, promising cures and extending lives. Lifesaving techniques make it possible to resuscitate biological life, but at the expense of unconscious existence sustained by inhuman machines. Unprecedented choices have fostered false hopes that medicine can do the impossible, not only radically reduce human suffering, but enhance human performance and make allowance for new and better lifestyles.[11]

Yet, we feel helpless without technology, and there seem to be no turning back to an age without cell phones, internet or organ transplants. Will science and technology save or destroy humanity?

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[9] See for example, F. William Engdahl, *Seeds of Destruction: The Hidden Agenda of Genetic Manipulation* (Montreal: Global Research, 2007).

[10] See for example, the recent UK report on the problem of pornography for the underage in *Independent Parliamentary inquiry into online child protection: findings and recommendations*, (April 2012) <http://www.claireperry.org.uk/downloads/independent-parliamentary-inquiry-into-online-child-protection.pdf>

[11] See Daniel Callahan, *Setting Limits: Medical Goals in Aging Society* (Washington DC: Georgetown University Press, 1987); Id., *False hopes: Overcoming the Obstacles to a Sustainable, Affordable Medicine* (New Brunswick, NJ: Rutgers University Press, 1999).

We see this ambivalence toward technology from this passage of John Paul II in *Redemptor Hominis*:

> "The man of today seems ever to be under threat from what he produces, that is to say from the result of the work of his hands and, even more so, of the work of his intellect and the tendencies of his will. . . Man therefore lives increasingly in fear. He is afraid that what he produces—not all of it, of course, or even most of it, but part of it and precisely that part that contains a special share of his genius and initiative—can radically turn against himself; he is afraid that it can become the means and instrument for an unimaginable self-destruction, compared with which all the cataclysms and catastrophes of history known to us seem to fade away."[12]

Where does ethics fit into all this? To answer this question, we need to examine the history of technology and our troubled relationship with it. During modernity and the industrial revolution, there was a buoyant optimism that a new humanity could finally triumph over nature by means of science. Francis Bacon's dictum "Knowledge is power" became the banner of the insatiable search for improvement. This positivistic vision makes the question of direction—what are our goals, why we want to go there, and what is the best way to get there—irrelevant or impossible. Later on, evolutionary theories applied this concept of malleable nature to humans themselves. The next few centuries saw a vertigo-inducing metamorphosis of the world. These advances allow modern man to program the future with technical precision in almost every aspect of

[12] John Paul II, Encyclical *Redemptor Hominis* (March 4, 1979), n. 15.

his economic, political and aesthetical life. Even health, sickness and death become organized. This new technological culture receives a quasi-religious significance, providing a sense of security that replaces the traditional need for a providential God. Technologized societies must operate according to values such as efficiency, programming and power. However, organization and planning cannot fill the place of ethics.[13]

At the same time, modern man is in anguish because it is not able to find any firm point of reference. When modernity denies traditional forms authority, everything including power is up for grabs. The technical culture of constant movement and renewal cannot satisfy the human spirit. Since nature has become an unknown, chaotic and uncertain force, humans are now engaged in a game of power struggle—imposing force on culture, nature and on each other—in order to survive. Risky behaviors are a part of this gamble, since technology has made the world impersonal and cold. In this scenario, where individuals can exercise power without personal responsibilities, the tragic consequences of the World War II ensued.[14] The atom bomb, "an invention to end all inventions," has gravely shaken our confidence in the saving powers of science and reason.

It is as if technology has taken on a life of its own, something we can no longer dominate but has the potential to destroy everything we hold dear. The catastrophic events of World War II greatly influenced the philosopher Hans Jonas, who called for responsible ethics in this era of high technology. Traditional ethics is no longer

[13] See Romano Guardini, *Power and Responsibility: a Course of Action for the New Age* (Chicago: Henry Regnery Co., 1961).

[14] See Romano Guardini, *The End of the Modern World* (London: *SHEED & WARD*, 1957).

sufficient. We need to consider the accumulative effects of human impact on the world. Jonas proposes an "imaginative heuristic of fear" as the guiding principle which anticipates the issues in balance and their attendant perils. This precautionary ethical approach to foresee all possible ill-effects on future generations and humanity is urgent since the velocity of technological advances makes it difficult to exercise restraint. Against the temptation of "Promethean immodesty," Jonas calls for a "power over power" by seeking political and structural responsibility to safeguard the future of humanity.[15]

Another German philosopher, Martin Heidegger, offers a contrasting reflection. Even though his philosophy is not an easy read, his *Question Concerning Technology* provides a thought-provoking analysis to this postmodern dilemma.[16] *Techne* in its original etymological sense is related to *poiesis* because they are both productive. The latter arises from an instinctive awe with nature producing or bringing forth the arts and poetry. Originally, *techne* conceals and reveals to humanity something about Being, nature and truth. Modern technology, however, has changed this relationship with nature. We no longer cooperate with or learn from nature but challenge, assault and exploit it for our own benefit. Nevertheless, technology still has the ability to reveal and bring forth the truths of nature and our destiny. This is more difficult since our contact with nature is no longer immediate but mediated by many unknown steps when we tap into its powers. Thus, the technology of our age is ambiguous: it could be either "supreme danger" or "saving power."

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[15] See Hans Jonas, *The Imperative of Responsibility. In Search of Ethics for the Technological Age* (Chicago / London: Chicago University Press, 1984).

[16] See Martin Heidegger, "The Question Concerning Technology," in *Basic Writings*, ed. David Krell (New York: HarperCollins, 1993).

Heidegger uses the German word *Gestell*, which literally means "en-framing," to describe our present-day predicament. By this, he wishes to convey the disquieting reality that this all-encompassing framework traps the postmodern society—technology is no longer a means to an end but a mode of human existence: "Thus we shall never experience our relationship to the essence of technology so long as we merely conceive and push forward the technological, put up with it, or evade it. Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it." [17] Technology has become absolute. While we may still live with the illusion that they are only instruments, we are in fact their slaves. It is no longer neutral but invades every aspect of our globalized world. In this *Gestell*, every solution we seek to resolve problems created by technology is itself technological. This serves only to reaffirm the prison we are in.

Perhaps the difference in approach between these two contemporary authors Jonas and Heidegger is indicative of the postmodern uncertainty regarding the role of technology. Hiroshima and Auschwitz make the need for ethical responsibility ever more urgent. Jonas approached the urgency with a proposal of increased awareness and collective duty. Heidegger, however, is silent on this subject, probably because he sees no solution in this *Gestell* since ethics implies the ability to free oneself of this technological prison in order to choose the right course of action from an outsider perspective. His existential and individualistic philosophy would not permit him such a project. Heidegger, realizing the impossibility of such a task, hinted with a note of irony that only a "god" could provide us with such an external perspective.

[17] See Martin Heidegger, "The Question Concerning Technology", p. 287.

From the Will to Power to Transhumanism

Today's dilemma concerning technology is also caused by an increased awareness of human freedom. Since the time of the Enlightenment, freedom has taken on greater significance in society, but with a heavy emphasis on individual choices and rights. Autonomy, privacy and self-determination are the hallmarks of modern liberal societies. As technology joins forces with liberty, it is not difficult to understand why the public accepts the latest novelties from the high-tech market.

Friedrich Wilhelm Nietzsche (1844–1900) coined the famous dictum "the will to power" (*der Wille zur Macht*) commonly understood to mean that the new man must continually strive to achieve perfection. Since evolution and transformation are the principles of reality, the modern man must never be fixed on anything alleged to be true. Instead, he should move on to a higher plane. Will to power means that truth is the result of the will, deriving its power from superior forces and even violence. Certainly, the ideology of "might makes right" is found in political regimes as well as in religious fundamentalism. Less well known is its presence in scientific pursuits that seek to silence all dissensions. Carlo Caffarra summarizes this ideology in the case of reproductive technology, "the belief that subjective rights coincide with the desire of psycho-physical well-being: I have the right to what I desire. This identification of 'desire-right' is tied to the belief that 'what is technically possible must be allowed.'"[18]

[18] "La convinzione secondo la quale il diritto in senso soggettivo coincide col desiderio del bene-essere psico-fisico: ciò che io desidero ho diritto ad avere. Questa identificazione "desiderio-diritto" si sposa ad un'altra convinzione, quella secondo la quale "ciò che è tecnicamente possibile deve essere consentito." Carlo Caffarra, "La procreazione artificiale: aspetti etici ed aspetti politici," Verona (8 February, 2003) <http://www.caffarra.it/verona03.php>

As we have noted already, technology and science allows us to explore the nature outside us, and the human nature within us. The news that we can clone animals made news in 1998, and attempts have since been made to clone humans, to create animal-human hybrids, and to proceed with synthetic biological life. Recent advances in the areas of genetic engineering, neuroscience, nanotechnology, and artificial intelligence are also on the horizon as means to cure diseases, prolong lifespan, and enhance the human race. Manipulation of nature, especially human nature at the beginning of life, the end of life, and the processes of human reproduction is the major concern of biomedical ethics. For instance, if an infertile couple "wills" to have a child and, if medical science unleashes this "power," then it seems reasonable for them to employ the latest reproductive know-how. Artificial reproductive technology has precisely moved along this logic from contraception to *in vitro* fertilization to eugenic measures through genetic screening and enhancement. Eugenics in its original sense means the promotion of good genes—now this can be done by screening either at the prenatal level (before the child is born) of at the preimplantational level (testing the genetic makeup embryos with PGD)—by eliminating the less than perfect embryos and implanting the desired ones. In these techniques, the scope is the same—creating an offspring with the best if not perfect genetic material. While prenatal diagnosis or PGD can eliminate the supposed "burden" of unhealthy offspring, they open the way to manufacture of "designer babies" and gender discrimination, a slippery slope toward the genetic discrimination of GATTACA.[19]

[19] See for instance, Gilbert C. Meilaender, *Body, Soul, and Bioethics*, (Notre Dame: University of Notre Dame Press, 1995): 61–88; Leon R. Kass, "Making Babies: The New Biology and the "Old' Morality", in Id., *Toward a More Natural Science: Biology and Human Affairs*, (New York: The Free Press, 1985), 43–79.

The science fiction film GATTACA portrays a futuristic struggle with biotechnology. The initial letters of the four DNA bases (Adenine, Cytosine, Guanine, and Thymine) forms the title of this cinematographic drama. In this society driven by liberal eugenics, there is a lot of pressure for parents to use preimplantation genetic diagnosis (PGD) to create children selectively with the best hereditary traits. In this way, society differentiated its members according to their genetic makeup which predicts their personality traits, physical prowess, disease risks and lifespan. Only those who have superior genomes and enhanced traits qualified for the best jobs, whereas the disease-prone and mentally inferior members were consigned to menial labor. The plot of this movie revolves around one of these inferiors who manages to beat the system by his ingenuity, hard work, sacrifice, courage, and indomitable spirit that are ironically missing in his genetically superior counterparts. The last scene is evocatively religious. The genetically defective protagonist manages to reach the heavens in a space shuttle. As the fire of the rocket blasted, the scene shifts to the fire of the furnace where his genetically perfect alias incinerates himself for failing to live up to his genetic destiny. Interestingly, afteranalyzing hundreds of films, NASA recently named this "the most plausible science fiction movie ever made."[20]

Leon Kass wonders aloud if we have purchased technical progress with the high price of our humanity:

> "[As] Aldous Huxley prophetically warned us, in his dystopian novel *Brave New World*, the unbridled yet well-meaning pursuit of the mastery of

[20] See Jarett Wieselman, "NASA picks the best & worst sci-fi movies," in *New York Post*, (January 06, 2011) http://www.nypost.com/p/blogs/popwrap/nasa_OI2DH3V3G5dBOdxlXj3MiI

> human nature and human troubles through technology can issue in a world peopled by creatures of human shape but of shrunken humanity—engaged in trivial pursuits; lacking science, art, religion, and self-government; missing love, friendship, or any true human attachments; and getting their jollies from high-tech amusements and a bottle of soma."[21]

In fact, this coupling of liberty (will) with technology (power) echoes the famous dictum "will to power" Nietzsche predicted would characterize our postmodern world. When liberty becomes absolute and technology unchecked, he predicted that a new human race of supermen (ÜBERMENSCH*)* would be the logical outcome. In science, we see the realization of this in transhumanism, where certain scientists and philosophers advocate the enhancement of the human species—both in mind and body—by employing any means at our disposal.

Transhumanism is the climax of this will to power as it proposes to overcome our present limitations and take control of our evolutionary future with the latest biotech innovations. Joseph Fletcher, one of the fathers of bioethics, was ahead of his time when, in the 1950s, he advocated the right to contraception and artificial insemination.[22] For the sake of perfecting the human race, he denied the personhood of defective infants and mentally handicapped, which he derogatorily considered as "idiots."[23] Following this logic, killing

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[21] Leon Kass, "Defending Human Dignity," in *Human Dignity and Bioethics*, Vv.Aa., (Washington DC: President's Council on Bioethics, 2008), 303; Aldous Huxley, *Brave new world* (New York Perennial Classic, 1998).

[22] See Joseph Fletcher, *Morals and Medicine* (Princeton: Princeton University Press, 1954).

[23] "Idiots. . . are not, never were, and never will be in any degree responsible. Idiots, that is to say, are not human. The problem they pose is not lack of sufficient mind, but of any mind at all. No matter how euphoric their behavior might be, they are outside

"idiots," as in the case of mentally of physically disabled neonates, is justified as "postnatal abortion." [24] The unrepentant Fletcher encourages quality control by genetic selection for intelligence and weaning out carriers of undesirable traits.[25] At one point, he echoes the Nazi's eugenics program by encouraging annihilation of genetically defective children by forced abortion: "It would be right either voluntarily or coercively to limit procreation by prevention either before or after conception—if and when specified genetic diseases or defects are predictable or at risk." [26] Fletcher is unhampered by any fixed notion of human nature, and would not be abashed at the possibility of reconstructing males so that they may give birth, or creating hybrids through coitus between humans and apes.[27] His utilitarian leanings led him to such outrageous proposals as reproductive cloning to produce an army of soldiers or workers, and creating transhumans:

> "If the greatest good of the greatest number (i.e. the social good) were served by it, it would be justifiable not only to specialize the capacities of people by cloning or by constructive genetic engineering, but also to bio-engineer or bio-design para-humans or "modified men" —as chimeras (part animal) or cyborg-androids (part prostheses). I would vote for cloning top-grade soldiers and scientists, or

the pale of human integrity. Indeed, sustained and "plateau" euphoria is itself *prima facie* clinical evidence of mindlessness." Joseph Fletcher, *Humanhood: Essays in Biomedical Ethics* (Buffalo, NY: Prometheus Books, 1979), p. 22.

[24] See Joseph Fletcher, *Humanhood*, p. 140–148.

[25] See Joseph Fletcher, *The Ethics of Genetic Control: Ending Reproductive Roulette* (New York: Doubleday 1974).

[26] Joseph Fletcher, *Humanhood*, p. 119.

[27] See Wesley J. Smith, *Culture of Death: The Assault on Medical Ethics in America* (San Francisco Encounter Books, 2000), pp. 225–226.

> for supplying them through other genetic means, if they were needed to offset an elitist or tyrannical power plot by other cloners—a truly science-fiction situation, but imaginable. I suspect I would favor making and using man-machine hybrids rather than genetically designed people for dull, unrewarding or dangerous roles needed nonetheless for the community's welfare—perhaps the testing of suspected pollution areas or the investigation of threatening volcanoes or snow-slides."[28]

He is so optimistic in technological advances that no restriction must ever be placed on scientific research, none whatsoever! In this scheme of things, even the last liberal hurdle of individual autonomy and choice must be vaulted for the good of the society: "Testes and ovaries are social by nature and it would appear ethically that they should be controlled in the social interest."[29]

Apparently, when Fletcher wrote in the 1970s, his predictions about technology were imprecise. Modern day transhumanists are more sophisticated and advocate employing the latest gizmos to reengineer the human race. In some way, this is the logical conclusion to the train of thought developed above. *In vitro* fertilization provides the "raw material" of a large quantity of human embryos for commercialization, experimentation and selection. Stem cells and cloning jumped on to this bandwagon of regenerative medicine, which together with nanotechnology, cybernetics, and genetic engineering promise to cure the incurable and indefinitely prolong life. James Hughes, director of the World Transhumanist

[28] J. Fletcher, *Humanhood*, p. 85.
[29] J. Fletcher, *Humanhood*, p. 118.

Association, argues that these technologies will radically enhance human lives and expand the boundaries of humanness. As an inevitable coda to evolution and scientific progress, modern democracies must make these technologies available to everyone.[30] In the words of Gregory Stock, "The next frontier is our own selves."[31] In the same vein, geneticist Lee Silver writes:

> "Why not seize this power? Why not control what has been left to chance in the past? Indeed, we control all other aspects of our children's lives and identities through powerful social and environmental influences and, in some cases, with the use of powerful drugs like Ritalin and Prozac. On what basis can we reject positive genetic influences on a person's essence when we accept the rights of parents to benefit their children in every other way?" [32]

Indeed, the biotech gamble has raised the stakes since it allows us to transform human nature itself. The transhumanist proposal to seize the power and take control of our evolutionary future can leave us either with Nietzsche's superman or the *Abolition of Man* predicted by C.S. Lewis. [33] The indiscriminant use of biotechnological powers has alarmed not only religious groups but also a number of secularists who worry about unchecked

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[30] See James H. Hughes, *Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future* (Cambridge, MA: Westview Press, 2004); Id., "Embracing Change with All Four Arms: A Post-Humanist Defense of Genetic Engineering", *Eubios Journal of Asian and International Bioethics* 6.4 (1996): pp. 94–101.

[31] See Gregory Stock, *Redesigning Humans: Choosing our Genes, Changing ourFuture* (Boston: Houghton Mifflin, 2003).

[32] Lee Silver, *Remaking Eden. Cloning and Beyond in a Brave New World* (New York: Avon, 1998), p. 277.

[33] See Friedrich Nietzsche, *Thus Spake Zarathustra: A Book for All and None*, (1891); C. S. Lewis, *The Abolition of Man*, 6th ed. (Glasgow: HarperCollins, 1986).

profit-driven interests, the effect of an unknown post-human future, and generational inequalities that would undermine the foundation of liberal democracies.[34]

Moral Relativism and the Denial of Universal Truth

As a sequel to the logic of the will to power which proposes the making of a superman in the transhumanist agenda, Nietzsche advances his belief that there is no objective truth found in nature, including human nature. Thus, moral relativism is inevitable. He states in *The Twilight of the Idols*:

> "One knows my demand upon the philosopher that they place themselves *beyond* good and evil—that they have the illusion of moral judgment *beneath* them. This demand follows from an insight first formulated by me: *that there are no moral facts whatever*. Moral judgement has this in common with religious judgement that it believes in realities which do not exist. Morality is merely an interpretation of certain phenomena, more precisely, a misinterpretation. Moral judgment belongs, as does religious judgement, to a level of ignorance at which the concept of the real, the distinction between the real and imaginary, is lacking: so that at such a level "truth" denotes nothing but things we today call "imaginings". To this extent moral judgments are therefore never to be taken

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[34] See Jeremy Rifkin, *The Biotech Century,* (London: Penguin, 1998); Francis Fukuyama, *Our Posthuman future: Consequences of the Biotechnology Revolution* (New York: Picador, 2002); Jürgen Habermas, *The Future of Human Nature* (Cambridge: Polity, 2003).

literally: as such it never contains anything but nonsense."[35]

For moral relativists, no universal standard exists by which the truth of an ethical proposition's can be assessed, but they are instead relative to social, cultural, historical or personal circumstances. According to Tristram Engelhardt, in the field of ethics, moral skepticism and relativism is rampant. Even though one might not agree with his understanding of the role of reason and natural law, he is prophetic in foretelling the moral skepticism of the day which denies or doubts the possibility of ascertaining moral knowledge or ethical truth.[36]

One form of moral skepticism is the neo-positive school of non-cognitivism and emotivism which holds that ethical statements (for example, 'Do not kill innocent persons') are not assertive propositions—that is, they do not express factual claims or beliefs and therefore are neither true nor false (i.e., they are not *truth-apt*)—but express only emotions (e.g., Killing is yucky). While non-cognitivists and emotivists do not negate the existence of moral truths, they maintain that it is not the function of ethical discourse to refer to such values. The real function of moral discourse is to express *feelings* of approval or disapproval, and to recommend similar *emotions* to other.[37] MacIntyre declares emotivism to be the unprofessed moral

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35 Friedrich Nietzsche, *Twilight of the Idols* in Philip Novak (ed.), *The Vision of Nietzsche*, (Rockport, MA: Element Books, 1996 [1889]), p. 72.

36 See H. Tristram Engelhardt, Jr., *Bioethics and Secular Humanism: the Search for a Common Morality* (London–Philadelphia: SCM Press—Trinity Press International, 1991), pp. 110–111.

37 See Hans Reichenbach, *The Rise of Scientific Philosophy* (Berkeley University of California Press, 1951).

theory accepted today. It is very much "embodied in our culture" and is more common than we think.[38]

Moral skepticism, emotivism and relativism are cognates, all feeding into Nietzschean nihilism which is the philosophy asserting that right and wrong, good and evil do not exist. The average man on the street is not a philosopher who speculates on these matters. But in public behavior and lifestyle, many hold similar attitudes in a pragmatic rather than abstract way. In place of moral truths that are objective and obligatory for everyone, the current mentality seems to exalt personal choices and freedom. Freedom without truth means that what I desire and want becomes the measure of "my" truth and "my" morality. This is the common slogan of the pro-choice advocates and those who see no problems with same-sex marriages, transgender operations, etc, as long as the person wants it and is comfortable with his or her decision. Benedict XVI summarizes this disconcerting mindset in the Regensburg address:

> The subject then decides, on the basis of his experiences, what he considers tenable in matters of religion, and the subjective "conscience" becomes the sole arbiter of what is ethical. In this way, though, ethics and religion lose their power to create a community and become a completely personal matter. This is a dangerous state of affairs for humanity, as we see from the disturbing pathologies of religion and reason which necessarily erupt when reason is so reduced that questions of religion and ethics no longer concern it. Attempts to construct an ethic from the

38 See Alasdair C. MacIntyre, *After Virtue* (London: Duckworth, 1984), p. 22.

> rules of evolution or from psychology and sociology, end up being simply inadequate.[39]

We have just taken a very look at the sociological and philosophical background as to why science has been put on a pedestal and is now almost immune to any external critiques. As a result, most people on the street have high regards for scientists and do not usually question their endeavors. This new clout gained by the scientific community makes it very difficult to question the motives and ethnicity of scientific research and development. To add to this, financial interests and political leverage makes it even harder to criticize them. Critics, religious or not are often labeled as luddites who are considered retrogrades, doomsayers and against the progress of humanity.

Which Ethics for Science?

We are also faced with the second challenge of finding an adequate ethic of science. Heated debates exist among ethicists about the existence of a common or universal ethics. There are some who outright reject the existence of a global ethics, while others accept it on a pragmatic level and yet there are those who enthusiastically embrace it. These positions will be briefly evaluated, leading to an examination of natural reason espoused by the Catholic tradition.

While modern philosophers launched the project of rationalism as the criterion of truth with heavy reliance on the scientific method, postmodernists are skeptical that truth is accessible by reason. Modern philosophers in a way dug their own grave when they limited their scope of truth to the realm of empirically verifiable data.

39 Benedict XVI, *Address at University of Regensburg*.

Empiricism shed great doubts on our ability to know realities beyond our senses, thereby challenging the metaphysical concepts of nature, causality and substance. German idealism delivered the *coup de grâce* because it further limited reason's grasp of reality outside of the self. This eventually provoked the final phase of postmodernism nihilism which rejects any truth-claims, any reference to objective values within reach of reason or faith.

In the field of medical ethics, there was a dire need in the 1970s to seriously address a number of critical issues brought on by technology and human experimentation. The *Belmont Report* (1978) emerged from an examination of principles and their application to guidelines for informed consent, risk-benefit assessment and selections of subjects. This was eventually proposed as a universally acceptable method available to all cultures and backgrounds. The four principles of biomedical ethics, autonomy, beneficence, non-maleficence, and justice, provided a theoretical framework for practical decision making. None was *a priori;* all were viewed as *prima facie* in application. In its latest edition, Beauchamp and Childress further elaborate a defense of this methodology which is founded on *prima facie* or self-evident principles. Beauchamp reiterates the case on the basis of a common morality that is binding on all humanity, irrespective of race and culture.[40] This is not to say that principlism in itself, rooted in secular liberal philosophy, is unproblematic from a Christian and natural law perspective. Above all, it tends to absolutize individual choices at the expense of other values, and falls into the emotivism that MacIntyre complains about.

[40] See Tom Beauchamp and James Childress, *Principles of Biomedical Ethics*, OUP, New York 1979; Tom Beauchamp, "Comparative Studies: Japan and America," in *Japanese and Western Bioethics: Studies in Moral Diversity*, ed. Kazumasa Hoshino (Dordrecht 7 Boston/ London: Kluwer Academic Publishers, 1997), 25–48.

Another pragmatic candidate to global ethics is the “overlapping consensus” of John Rawls. It can serve as the basis of common morality among different visions of the good in a society, by picking the lowest common denominator. Rawls recognizes the lack of broad agreement about what constitutes the good in modern democratic societies. A plurality of doctrines—religious, political or philosophical—raises the interrogative as to how society could reconcile these differences. He reformulates the possibility of “overlapping consensus” in public debates based on a political conception of justice. Overlapping consensus provides a core of moral standards that all reasonable individuals in a pluralistic society with different comprehensive conceptions of the good would support since it is largely uncontroversial. Overlapping consensus is the area of agreement, shared by all reasonable participants in this social contract.[41]

Another frequent appeal to global ethics is found in the language of human rights. After the tragic experience of the Second World War and the Nuremburg trials, many nations felt the need for a safeguard against future abuses and inhuman acts. Thus, in 1948 the United Nations signed the *Universal Declaration of Human Rights*. Its preamble says: “All human beings are born free and equal in dignity and rights.” These rights are deemed basic to all humans and transcend all cultures and nationality. Since then, many other national and international documents have recourse to the language of human rights in the areas of politics, work, education, healthcare, and the environment.

A few years ago, some Asian leaders complained that human rights were a Western invention that were imposed on the rest of the

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[41] See John Rawls, *Political Liberalism, The John Dewey Essays in Philosophy 4*, Columbia University Press, New York 1993.

world. There were other complaints that these declarations never explicitly define the meaning, content, and foundations of human rights. Mary Ann Glendon traces the development of the 1948 *Declaration* and shows that the signing nations looked for a political consensus rather than a moral or philosophical treatise on human nature.[42] In spite of this deficiency, nations affirmed human rights and dignity because man's inhumanity to man was fresh in their minds—the Holocaust, slavery, genocide, ethnic cleansings, political murders of dissidents in totalitarian regimes, religious coercion, human trafficking, torture and degradation of prisoners. It was through this *via negativa* that they affirmed the existence of universal human rights.[43] Even though many people uphold that some moral propositions such as "slavery is always wrong" can be universally held, they are unable to agree upon the rationale behind this. Can natural law rationality supply the missing foundation of human rights based on human dignity and natural rights? Before turning to this question, we will now address the question of religious input in general ethics.

There was a time when religious input was essential in any ethical consideration. However, with the rise of modernity and secular humanism, religion was considered sectarian and detrimental to the good of humanity. Since the times of the Enlightenment, traditional control of religion in vital spheres of the social order began to crumble under the secular challenge in the areas of politics, culture, science, economy, judiciary, philosophy, and education. Ethics and theology were probably the last strongholds until they

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[42] See Mary Ann Glendon, "Foundations of Human Rights: The Unfinished Business," *American Journal of Jurisprudence* 1 (1999): 1–14.

[43] See Joseph Tham, "Challenges to Human Dignity in the Ecology Movement," *Linacre Quarterly* 77, no. 1 (2010), 53–62.

eventually succumbed as well under the influence of the now secularized academia.

This is most evident in the budding field of bioethics which began in the 1960s due to a peculiar set of circumstances in the USA. Biomedical technology was developing at an unprecedented pace, and there was a need to make decisions on a slew of difficult issues. It was a time of cultural upheaval, when traditional ethical theories seemed inadequate. Bioethics was born as a response to address these complex issues, with an interdisciplinary approach involving philosophers, theologians, lawyers, doctors and policymakers. Obviously, medical ethics traces its origin to the Hippocratic Oath, with significant Christian input from moral theology and manuals as well as the code of ethics. However, even though a majority of the forerunners in bioethics had theological training, in the next few decades, a process of secularization took place.[44]

As a result, the religious voice has been marginalized and deemed inappropriate in the public debate on ethics and bioethics. This somewhat provocative (or humorous, depending on how seriously one takes it) posting on the internet is indicative of a general antagonism toward religious "intrusion" into ethical issues:

> "This blind acceptance of mixing ethics and medical science with religion is unacceptable, and has to stop. For centuries, societies have known better than to let religious influences interfere with democracy, due process, reason and scientific inquiry. The inalienable domains of biology and procreation should be regarded no differently than the social and

[44] See Joseph Tham, "The Secularization of Bioethics," *National Catholic Bioethics Quarterly* 8, no. 3 (2008): pp. 443–453; John Evans, *Playing God*?

> political arenas. Religious bioethics is full of inherent problems and inconsistencies. It's time to dismiss it and acknowledge the efficacy and validity of real and accountable secular bioethics. In biology as in politics, citizens have the right to be free from the pressures of organized religion."[45]

Other examples of discrimination against religious voices in public debates can be observed in the media treatment of cloning, stem cell research and end of life issues. In California, supporters of Proposition 71 avert that opposition to embryonic stem cell research "rests on religion attempting to block science and amounts to imposing religious views on public policy."[46] *Washington Monthly* accuses the religious right of promoting pseudo-science by its own experts.[47]

After the 9-11 tragedy, there were posters with this slogan: "Science will fly you to the moon. . . Religion will fly you into a building." Lately, there has been constant reminder in the media by different writers such as Richard Dawkins and Christopher Hutchins that science and religion, reason and faith are incompatible. Thus, the question of whether science needs ethics is complicated with the question of whether an ethics of science can be open to religious input. The question is increasingly urgent as the technological imperative becomes widespread. Stanley Jaki adverts:

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45 G. Dvorsky, "Canada: The Separation of Church and Bioethics: Our Physical Bodies should be as Free from Religious Interference as Our Political Bodies", in <http://www.sentientdevelopments.com/2006/03/separation-of-church-and-bioethics.html>

46 Anonymous, "Stem-cell dispute not *reason versus ignorance*, theologian says", *Catholic News Service* (Oct. 19, 2004). <www.catholicnews.com/data/stories/cns/0405767.htm>

47 See Chris Mooney, "Research and Destroy: How the Religious Right Promotes Its Own *Experts* to Combat Mainstream Science", *Washington Monthly* 36 (2004): 34. <http://www.washingtonmonthly.com/features/2004/0410.mooney.html>

> "No longer is it enough. . . 'to wave the flag of Galileo.' That flag is being waved by all those molecular biologists who hold what Chargaff called the Devil's Principle: 'Whatever can be done, must be done.' That principle had already been obeyed when scientists went ahead with the construction of the atomic bomb on the ground that it was merely superb physics and that after all it was, to quote Oppenheimer's defense of it, a technically sweet project."[48]

What then is the proper role of religion in the ethics for science? To answer this, we will primarily explore the traditional Catholic approach of natural law which sees a harmony between reason and faith. Rationality is the common basis and the starting point of ethical reasoning, but it is not the only font of knowledge since it is open to transcendental truth and revelation.[49] The 2008 International Theological Commission (ITC) document *The Search for Universal Ethics: A New Look at Natural Law* is an outstanding update of this approach to common ethics.[50] The first numbers of this document highlight the need and awareness of a global solidarity which calls for the "search for common ethical values" amid current challenges. The ITC document recognizes the far-reaching applicability of natural law in the global context of bioethics and human rights. However, without a firm acknowledgement of human nature, human

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[48] Stanley L. Jaki, "Consistent bioethics and Christian consistency", *Linacre Quarterly* 3 (1994), 8280.

[49] See John Paul II, Encyclical *Fides et Ratio: on the Relationship between Faith and Reason*, 1998.

[50] The original document in Italian can be downloaded from <http://www.vatican.va/roman_curia/congregations/cfaith/cti_documents/rc_con_cfaith_doc_20090520_legge-naturale_it.htm>l The observations and quotations is taken from an unofficial English translation downloaded from <http://www.pathsoflove.com/universal-ethics-natural-law.html>

rights in the absence of duty and limits can be abusive.[51] On the contrary, it protects individual conscience in face of unjust laws:

> "Facing the menace of the abuse of power, and even of totalitarianism, which juridical positivism conceals and which certain ideologies propagate, the Church recalls that civil laws do not bind in conscience when they contradict natural law, and asks for the acknowledgment of the right to conscientious objection, as also the duty of obedience in the name of obedience to a higher law."[52]

Confronting relativistic individualism—in which every subject decides for himself what is good and right—and cautious about democratization of ethics based on consensus, natural law proposes objective moral truths knowable by human reason. As a matter of fact, the most recent encyclical by Benedict XVI emphasizes the indivisible characteristic of human ethics—ecology, bioethics, social ethics and business ethics all form a single book.[53] Natural reason can engage secular positions in public debate by presenting non-sectarian arguments, which are also directed towards individual and common good.[54]

Grounded on our natural capacity to reason, it can concurrently counteract the claims of cultural relativism while permitting intercultural and interreligious dialogue. In fact, Pope John Paul II spoke of a "grammar," "a *moral logic* which is built into human life

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[51] See *The Search for Universal Ethics*, no. 18–35.

[52] *The Search for Universal Ethics*, no. 35; see also John Paul II, Encyclical *Evangelium Vitae: on the Value and Inviolability of Human Life*, 1995, no. 73–74.

[53] See Benedict XVI, *Caritas in Veritate: on Integral Human Development in Charity and Truth*, 2009, no. 51.

[54] See *The Search for Universal Ethics*, no. 35.

and which makes possible dialogue between individuals and peoples."[55] Joseph Ratzinger, in a famous interchange with German philosopher Jürgen Habermas, points out the fact that secularization which marginalizes the place of religion in society and politics in the West is in fact an anomaly compared to the rest of the world. He believes that secular rationality without any limits and is not comprehensible to all humanity. In this dialogue, he emphasized that faith and reason needs one another, to purify one another from possible excesses.

"We have seen that there exist pathologies in religion that are extremely dangerous and that make it necessary to see the divine light of reason as a 'controlling organ'. Religion must continually allow itself to be purified and structured by reason. . . There are also pathologies of reason, although mankind in general is not as conscious of this fact today. There is a hubris of reason that is no less dangerous. This is why reason, too, must be warned to keep within its proper limits, and it must learn a willingness to listen to the great religious traditions of mankind. If it cuts itself completely adrift and rejects this willingness to learn, this relatedness, reason becomes destructive."[56]

The then-cardinal continues that global ethics derived in this manner "remains an abstraction." This hubris of reason is dangerous and threatens humanity, as the atomic bomb and the treating of humans as products have shown. Instead, a healthy tension between faith and reason, avoiding the extremes of fideism and rationalism,

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[55] John Paul II, Address to the Fifteenth General Assembly of the United Nations Organization, 5 October, 1995. http://www.vatican.va/holy_father/john_paul_ii/speeches/1995/october/documents/hf_jp-ii_spe_05101995_address-to-uno_en.html

[56] See Joseph Ratzinger and Jürgen Habermas, *The Dialectic of Secularization: On Reason and Religion* (San Francisco: Ignatius Press, 2007), 76.

can take on an intercultural dimension. In fact, for Christians, Christ being the *Logos* Incarnate means that faith itself cannot be *illogical*. Even though natural law finds its fulfillment in the new commandment of charity of Christ, it does not exclude dialogue with other groups on a common basis that is above cultural and religious differences.[57]

Conclusion

This paper has addressed two challenges of the place of ethics in science. The first deals with the problem of scientism and nihilism which in effect negates the needs of ethics as an independent audit of the scientific enterprise. The second challenge relates to the question of finding an ethical system for science, which for historical reasons has rejected natural reasoning and religious input. As a response to these challenges, some comments deriving particularly from Catholic sources would follow.

First, there is a need to reappraise the role of technological prowess by accepting our frail human condition with humility. Against the hubris of a technological imperative to create a Brave New World, many secular writers are sending signals of caution against the indiscriminant use of these powers. Jewish ethicist Leon Kass cautions about such possibility:

> "At long last, mankind has succeeded in eliminating disease, aggression, war, anxiety, suffering, guilt, envy, and grief. But this victory comes at the heavy price of homogenization,

57 See *The Search for Universal Ethics*, pp. 103–116.

mediocrity, trivial pursuits, shallow attachments, debased tastes, spurious contentment, and souls without loves or longings. The Brave New World has achieved prosperity, community, stability, and nigh-universal contentment, only to be peopled by creatures of human shape but stunted humanity. . . Brave New Man is so dehumanized that he does not even recognize what has been lost."[58]

The self-sufficient and self-centered technocratic society is ultimately unsatisfying and miserable. As Pope John Paul II in *Veritatis Splendor* emphasizes repeatedly, true freedom means responsibility. Perhaps what is needed is greater humility to see and accept our human condition in the face of technological modernity. It also means accepting our contingency and fallibility when events may escape our efficient programming. This might require fortitude and courage to make amends while trusting in providence.[59]

In place of an unrealistic reliance on technology, we need to recognize that our ultimate hope cannot be based on the flimsy nature of created matter. Heidegger was ambiguous about the dilemma of technology. In an interview on the same question before his death, the German philosopher uttered the now famous refrain, "Only a God can save us." [60] Since Heidegger was an agnostic, he probably meant to remind us of the need to recover a sense of wonder and admiration toward nature, rather than callously exploiting it. There are elements

58 Leon Kass, "Preventing A Brave New World," in *The New Republic Online* (June 21, 2001) <www.csus.edu/indiv/g/gaskilld/ethics/BanCloning.doc>

59 See John Paul II, Encyclical *Veritatis Splendor: Regarding Certain Fundamental Questions of the Church's Moral Teaching*, 1994; Romano Guardini, Power and Responsibility**.**

60 See Martin Heidegger, "Only a God Can Save Us," in *The Heidegger Controversy*, ed. Richard Wolin, (Cambridge: MIT Press, 1992), 91–116.

of truth in Heidegger's intuition that we cannot escape the *Gestell* which has become the very structure of our relations. The ambiguity of technology is all the more frightening because of the sense of impersonality and irresponsibility that came with it. Technology seems to offer hope to a suffering humanity, but technology itself can be a cause of harm.

The two recent encyclicals by Pope Benedict XVI offer other examples of theological critiques of the modern culture. *Caritas in Veritate* recalls the fact that true human development is not just technical, but primarily and integrally, human.[61] *Spe Salvi* states that the question of technology is ultimately a question of hope for a better future. The pontiff's discourse points to the vanity of this enterprise without God:

> "Francis Bacon and those who followed in the intellectual current of modernity that he inspired were wrong to believe that man would be redeemed through science. Such an expectation asks too much of science; this kind of hope is deceptive. Science can contribute greatly to making the world and mankind more human. Yet it can also destroy mankind and the world unless it is steered by forces that lie outside it."[62]

Second, against a pessimistic view that everything is relativistic and that ethical truth is too idealistic, we nonetheless need to make an effort to strive for this ideal. As a result of secularization, the current culture has turned its back on the search for universal ethics which it considers too authoritarian. The fragmented moral tradition prefers now the language of diversity and tolerance. This poses a great

[61] See Benedict XVI, Caritats in Veritate, pp. 68–77.

[62] Benedict XVI, *Spe Salvi,* pp. 24–25.

challenge to Christianity which is universal in its doctrine, scope and ethical demands. The Christian faith does not extinguish cultural diversity, but is capable of purifying some of these elements.

This engagement is possible when reason is open to faith, while faith-based assumptions are also open to the critique of reason, thus faith and reason purify each other from possible excesses. Natural reason can thereby appeal to the conscience of all individuals to discover the good and avoid evil. Above all, derivations of the first principle of natural law are apparent—slavery, torture, racism and terrorism are to be censured. For this reason, the human rights and human dignity language can be useful in the international setting with certain legal force, on the condition that it restrains itself from excessive liberal extensions of rights; reconsider its link to natural rights; and avoiding an *a priori* exclusion of religion from discussions. In a recent homily, Pope Benedict commented on the meaning of the light of the Easter candle:

> "The darkness that poses a real threat to mankind, after all, is the fact that he can see and investigate tangible material things, but cannot see where the world is going or whence it comes, where our own life is going, what is good and what is evil. The darkness enshrouding God and obscuring values is the real threat to our existence and to the world in general. If God and moral values, the difference between good and evil, remain in darkness, then all other "lights", that put such incredible technical feats within our reach, are not only progress but also dangers that put us and the world at risk. Today we can illuminate our cities so brightly that the stars of the sky are no longer visible. Is this not an image of

> the problems caused by our version of enlightenment? With regard to material things, our knowledge and our technical accomplishments are legion, but what reaches beyond, the things of God and the question of good, we can no longer identify. Faith, then, which reveals God’s light to us, is the true enlightenment, enabling God’s light to break into our world, opening our eyes to the true light.”[63]

As we step into this new millennium, we can hope that scientists and ethicists will discover this light and see that science does need ethics, and such ethics need not be closed to religious input or reference to the transcendent.

[摘要] 本文主要討論兩個與倫理在科學中之地位有關的難題。第一個挑戰將處理與後現代科學觀相關的一些問題；縱然在全球化下的世界，科技急速多變發展，我們與科技之間仍有一種不安感。我們將會透過以下三個角度分析形成這種不安感背後的原因：一、從歷史及哲學角度探討科學主義的根源；二、探求科技上衝創意志的根源；三、超人類主義以及道德相對主義的根源。科學主義以及虛無主義均否認倫理的需要，特別是當倫理作爲一個獨立的科學事業審計，將會爲人類帶來威脅。第二個難題關於科學應該受甚麼類型的倫理指導。爭辯常圍繞科學中是否亦有普世接受的倫理標準以及宗教在這些倫理方法中的角色。後現代主義否定宗教倫理學的貢獻的可能性，持論者認爲宗教倫理學並不能以經驗爲依據而視之爲不重要。基於上述的背景，本文以自然律的角度回應。早前教宗本篤 16 世亦撰文論述科學與倫理以及信仰與理性的正確關係。

[63] Benedict XVI, “Pope’s Holy Saturday Homily” in *Zenit News Agency*, (April 8, 2012) <www.zenit.org/article-34598?l=english>

耶穌會士劉松齡與北京的科學技術[1]

斯坦尼斯拉夫著，周萍萍譯述

"The Great Jesuit Hallerstein and the Science and Technology in Beijing"

Stanislav JUŽNIČ, translated and narrated by Ping Ping ZHOU

譯者按：耶穌會士劉松齡（Auguštin Hallerstein，1703—1774 年）出生於歐洲中部，生活于哈布斯堡王朝時期，屬於享有特權的貴族階層。1738 年，他來到中國，並以宮廷天文學家和數學家的身份奉旨進京，在欽天監任職達三十餘年。任職期間，他與歐洲科學院、天文臺開展合作，把當時歐洲較爲先進的科學知識如星曆表、日心說等傳入中國，反之亦然，那個時代歐洲最重要的科學期刊刊登了其在中國進行的多種觀測結果，如蝕象觀測記錄、天體間的距離等。劉松齡堪爲中西文化交流的使者。

[1] 本文譯自出生於斯洛文尼亞、現工作於美國奧克拉荷馬大學的斯坦尼斯拉夫（Stanislav Južnič）教授的著述《劉松齡——耶穌會在京最後一位偉大的天文學家》（Hallerstein, *The Last Great Jesuit Astronomer at Beijing*, Ljubljana: Tehniška Založba, 2003）中的第六章"北京的科學技術"中的第 2、3 節。

日球和月球

劉松齡第一次聽到關於蝕象的正確解釋是在他的堂兄埃伯格（Janez Benjamin Erberg，1699—1759 年）的論文答辯中。1716 年，受業於斯坦納（Sebastijan Stainer，1679—1748 年）教授的埃伯格在盧布爾雅那（Ljubljana）耶穌會大學參加了學生考試論文答辯。正確預測日蝕對於耶穌會士而言顯得特別重要，因爲這可以爲他們在所傳教的國家尤其是在中國帶來敬重。劉松齡掌管的欽天監不得不提前預測一年中所有的蝕象以及大自然的各種異象，然後每個月把預測結果發往將發生這種現象的省份。欽天監官員在每次預測的蝕象裏增加了與王公貴族以及皇帝氣數相關的占星術解釋，因此這種預測是國家機密。[2]

1768 年，劉松齡在 1717 年 9 月 21 日至 1744 年 10 月 21 日間所作的蝕象觀測記錄出版了，其中一些已經發表于 1747 年戴進賢（Ignatius Kögler，1680–1746 年）的《蝕象科學》中。[3]

日蝕

乾隆對官方預測的 1760 年 6 月 13 日將發生日蝕有點懷疑。但是劉松齡準確地預測了湖南省和山東省日蝕的程度，他知道人們在極度黑暗的那一刻會害怕死亡。[4]

劉松齡的手下準確預測了 1762 年 10 月 17 日的日蝕，但是文員在抄寫時出了一些差錯。由於人們沒有注意到這些差錯，所以關於日蝕預測的錯誤資料被發往各省總督，供他們向轄境內的百姓宣讀。日蝕在意想不到的時間發生了，乾隆遂傳訊一百多名欽天監官員。劉松齡解釋說，這是抄寫員的錯誤，而不是科學的

[2] Shi Yunli（石雲裏）, Eclipse Observations Made by Jesuit Astronomers in China: A Reconsideration, in *JHA,* 2000, 31: 145; Matteo Ricci, "China in the Sixteenth Century," in *The Journals of Matteo Ricci* (New York: Random House, 1953), p. 32.

[3] Hallerstein, review 1774, p. 156.

[4] Andreas Rodrigues, "Observationes Astronomicae Habitae ab Andrea Rodrigues," in *Memorias de Mathematica e Phisica da Academia Real das Sciencias de Lisboa*, 1799, 2:31.

誤算。他請求皇帝的寬宥。乾隆沒有像前幾次那樣將這些天文學家革職。[5] 1725 年之後，他們對忽視或者錯誤預測天文現象時間的欽天監官員責罰六十大板。[6]

劉松齡向赫爾（Maximilian Hell，1720–1792 年）彙報了 1746 年 3 月 22 日、[7] 1770 年 5 月 25 日早晨七點、[8] 1773 年 3 月 23 日北京發生的日蝕現象。[9] 1770 年 5 月 25 日，劉松齡測量了太陽的相對直徑是 31' 40" 和 32' 10"，這和現在大家所認可的 1,900" 幾乎完全一樣。[10] 這次觀測從 7 點 30 分 44 秒開始直至 9 點 9 分 44 秒結束，共持續了 1 小時 39 分。月球中心和太陽中心的最小表觀距離是 9' 48"，在日蝕的所有階段平均距離是 10' 18"。在那次日蝕中，劉松齡用自己的新方法計算了太陽和月球之間的最小表觀距離。他把這些結果與 1760 年 6 月 13 日、1715 年以及 1706 年 5 月 12 日的日蝕進行了比較。拉•伊爾（De la Hire，1640–1718 年）和凱西尼（Giovani Domenico Cassini，1625–1712 年）的學生——里昂聖三一學院的邏輯學和數學教授、耶穌會士費伯（Faber）一起觀測了後兩次日蝕。1719 年，教廷使者不允許傅聖澤 （Jean- François Foucquet，1663–1741 年）[11] 以及其他在京耶穌會士使用 1702 年出版的拉•伊爾的哥白尼學派星表。後來，劉松齡能夠使用這些星表。18 世紀 50 年代，B.F. 埃伯格（B.F.

[5] Godefridus Laimbeckhoven, *Der Bishof von Nanking und saine Briefe aus China mit Faximile seinem Reisenbeschreibung* (Sankt Augustin: Institut Monumenta Serica, 2000),
p. 158; Shi Yunli, 2000, pp. 140–141.

[6] Pietro Corradini, "The Chinese Imperial Astronomical Office and the Jesuit Missionaries," in *Rivista degli Studi Oriental,* 1994, 68: 349.

[7] Hallerstein, *Ephemerides Astronomicae,* 1776, 20: 19.

[8] Hallerstein, 1776, 20: 20; Hallerstein, *Ephemerides Astronomicae,* 1772, 6: 248.

[9] Hallerstein, *Ephemerides Astronomicae,* Anni 1774, Vien-nae 1773, Appendix, 18: 157; Hallerstein, 1776, 20: 18.

[10] Eli Maor, *Venus in Transi,*. Princeton University Press, 2000, p. 169.

[11] 傅聖澤，1663 年 3 月 12 日出生於法國勃艮第；1681 年 9 月 17 日在巴黎進入初修院；1741 年 3 月 4 日在羅馬去世（John Witek, *Controversial Ideas in China and in Europe: A Biography of Jean-François Foucquet S.J. (1665–1741)* (Roma: Institutum Historicum S.J., 1982), p. 74）。

Erberg）爲盧布爾雅那的耶穌會修院購買了拉・伊爾星表的德文本。

劉松齡採納了勒莫尼埃（Le Monnier，1715–1799 年）對這次觀測的建議。赫爾肯定地宣稱，這次日蝕結束的精確時間比其開始的時間更難以測算，因爲特別要考慮光的大氣折射造成的天空曲率。

1770 年，劉松齡把這些結果匯總在五欄表格中。第一欄列出了從開始觀測直至 8 點 22 分 22 秒全食時的 18 次觀測，這時在 18'28"的視角可見月球覆蓋了太陽表面的一部分。那是太陽直徑整個視角的 58%，估計在 31' 40"。第二欄是太陽逐漸變黑過程中落在測微計上的光的部分。第三欄列出了 18 次他們所觀測到的複圓與食甚時同樣的光度。第四欄列出了恰在日蝕結束前的 17 次觀測，這樣，劉松齡計算出用視角測算的日心和月心之間的最小距離。在報告的結尾，最後兩欄再次以列表的形式展示。劉松齡重複了第一張表格中的一些資料，共計十六行。赫爾在兩年中兩次出版了載有劉松齡測算結果的相同表格，但文本解釋一點沒變。[12] 在第一版中，赫爾僅僅提到劉松齡在日蝕時用來計算日心和月心之間最小距離的幾何和分析新方法。

1772 年，赫爾神父採納高慎思（José de Espinha，1722–1788 年）神父在北京聖若瑟駐所同時進行觀測的記錄，補全了劉松齡 1770 年 5 月 25 日的日蝕觀測記錄。高慎思使用了和劉松齡一樣的望遠鏡，鏡頭近 8 英尺長，孔徑直徑爲 7.34 '英寸或接近 20 釐米。他測量的太陽最大直徑比劉松齡小 4"16'"。高慎思用符號來表示弧秒的六十分之一。高慎思比劉松齡早 3.5 分鐘開始測量太陽直徑、晚 1.5 分鐘結束測量。赫爾把高慎思的測量列成六欄，把劉松齡的列爲五欄。[13]

[12] Hallerstein, 1774, 18: 157, 161.

[13] Hallerstein, 1772, 16: 249.

齊類思（Luigi Cipolla，1736–1805 年之後）神父稍後公佈了對這次日蝕稍有不同的測量結果。根據他的報告，日蝕於 7 點 31 分 7 秒開始，於 9 點 19 分 52 秒結束。因此，他開始觀測的時間幾乎比劉松齡晚不了幾秒，但他結束觀測則比劉松齡晚了 10 分鐘之久。太陽的直徑估計爲 31'35"44"'。[14]

我們計算了劉松齡所觀測的日蝕次數，並把這些結果列成表格。中國人把蝕象時月球和太陽的直徑平分爲 10 等份。這些等份再分爲 60 分，分再細分爲 60 秒。我們把中國人的記錄[15] 轉換成一小時千分之一的十進位。

日蝕觀測開始、中間和結束時的標準誤差近於 3.4%，系統誤差爲 1.3%。由於「黑滴現象（Effect of Black Drop）」，誤差最大值產生於末次接觸（出淩——譯者注）的時間估計上，那個時代的觀測理論家們已經知道這點。他們也更精確地估算了日蝕時被遮蓋部分的百分比。[16]

月蝕

1750 年 6 月 20 日，劉松齡和鮑友管（Anton Gogeisl，1701–1771 年）[17] 在北京皇家觀象臺觀測月食。1750 年 10 月 31 日，宋君榮 （Antoine Gaubil，1689–1759 年）向巴黎的德利斯爾（Joseph Nicolas Delisle，1688–1768 年）報告了他們的觀測記錄，但他沒有提及劉松齡觀測的數值計算結果。劉松齡的計算結果公佈於 1768 年。[18]

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[14] Luigi Cipolla, *Phil. Trans,* 1774, 64: 37, 39.

[15] Andreas Rodrigues, 1799, 64: 31–32.

[16] Hallerstein, 1769, 1: 3; Shi, 2000, 136.

[17] 鮑友管（Gogeisl）的名字錯寫成了 Gogails（Antoine Gaubil, *Correspondance de Pékin 1722–1759, Publiée par Renée Simon*. Études de Philologie et Histoire (Geneve: Librarie Droz, 1970), p. 633）。

[18] Shi Yunli, 2000, 141.

1761 年 11 月 12 日夜間，耶穌會士在北京觀象臺觀測了月全食。魏繼晉（Florian Joseph Bahr，1706–1771 年）用 5 英尺長的望遠鏡、張舒（Inácio Francisco，1725–1792 年）用 7 英尺長的望遠鏡，索德超（José Bernardo de Almeida，1728–1805 年）用 8 英尺長的望遠鏡。同時，一位無法查對姓名的觀測者在皇家觀象臺用 8 英尺長的羅默（Olaus Christianson Roemer，1644–1710 年）望遠鏡進行觀測。他能夠在別人開始之前 34 秒進行觀測，而比別人晚 18 秒或更多結束觀測。其使用的是帶鐘擺的輕便時鐘。那天夜裏天氣晴朗、平和無風。月面陰影上那些最遠的點顯然是可消逝的，但仍有一些斑點。月面呈灼熱的鐵紅色。月食剛開始時，在月球的垂直上空、距離月球直徑大約三分之二處能看見一顆明亮的小星星。耶穌會士們期望能在月食結束後再次看到這顆小星星。但是月食結束後，這顆小星星離月球太近了、僅一指遠，沒有人辨認出它。依據哈雷（Edmond Halley，1656–1742 年）、凱西尼、格拉馬蒂西（Nicholas Grammatici，1684–1736 年）、勒莫尼埃的星表以及巴黎一位不知名作者的曆表，大家將食中的時間與北京預測的時間進行了對比。結果表明拉莫尼亞的星表最好，誤差沒有超過一分鐘。[19]

1771 年 10 月 23 日，耶穌會士在北京的聖若瑟駐所觀測月食。一位觀測者第一個作了彙報，他可能是齊類思。這次月食開始於 23 點 22 分 6 秒、結束于第二天淩晨 1 點 37 分 13 秒。這次月全食沒有留下觀測記錄。[20] 耶穌會士使用的是 8 英尺長望遠鏡。

1772 年 10 月 11 日夜晚，劉松齡在北京觀測了月全食。他使用的是較短的、6 英尺長的、帶有蕭特（Scott James Short，1710–1768 年）“英式”測微計的望遠鏡。[21] 廣州的耶穌會士也觀

[19] Luigi Cipolla, 1774, 64: 44–45.

[20] Luigi Cipolla, 1774, 64: 39.

[21] Zmago Šmitek, *Srečevanja z drugačnostjo, slovenska izkustva eksotike* (Radovljica: Didakta, 1995), pp. 131–132；Hallerstein, 1776, 20: 17.

測到了這次月食。他們的觀測資料沒有及時由休謨（Hume）和佈雷克（Blake）的船隻帶回，直到後來人們才發現這些資料，但上面沒有記載觀測者的名字。馬斯克林（Sir Nevil Maskelyne，1732–1811 年）對這些觀測記錄的準確性持懷疑態度，因爲僅在一天前，他們才根據太陽把時鐘調節好。大部分時間天空都很晴朗。他們從 22 點 54 分 26 秒一直觀測到第二天早晨 3 點 4 分 4 秒。[22] 廣州耶穌會士使用了 6 跨長的望遠鏡和約翰•阿諾德（John Arnold）在倫敦製造的擺鐘。約翰•阿諾德簡化了哈里森（John Harrison，1693–1776 年）的設計，並引入了用在彈簧上通過改變控制杆以彌補溫度變化的帶砝碼雙金屬環。[23]

月掩木星

1740 年 10 月 12 日，宋君榮觀測到月掩木星及木衛現象。同時，孫璋（La Charme，1695–1769 年）用 7.5 英尺長的望遠鏡觀察了這個現象。[24]

1770 年 7 月 5 日，北京耶穌會士在聖若瑟駐所用 8 英尺長的望遠鏡觀測到了月掩木星現象。觀測開始於 7 點 57 分 29 秒。兩分半鐘後，月球西側完全遮住了木星。10 點 18 分 37 秒，觀測結束。[25]

月球的其他觀測結果

1772 年 1 月 25 日 5 點 27 分 41 秒至 6 點 34 分 7 秒，北京耶穌會士在聖若瑟駐所觀測了月球遮掩處女座最亮一顆星星的始末。

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[22] Luigi Cipolla, 1774, 64: 47.

[23] Robert Bud and Deborah Jean Warner, "Instruments of Science," *in An Historical Encyclopedia* (New York & London: Garland, 1998), p. 113.

[24] Antoine Gaubil, 1970, p. 640–641; 宋君榮致德利斯爾的信(1751 年 5 月 25 日)。

[25] Luigi Cipolla, 1774, 64: 40, 41.

1772 年 1 月 29 日 4 點 16 分 35 秒至 5 點 33 分 31 秒，耶穌會士在聖若瑟駐所用 8 英尺長的望遠鏡觀測了月掩天蠍星座的始末。[26]

天體間的距離

1774 年，赫爾出版了劉松齡寫於 1770 年 10 月 5 日的一封信，信中提及用一架測微計估算兩個天體間最小距離的步驟。同年，巴塞爾的實驗物理學教授丹尼爾•伯努利（Daniel Bernoulli，1700–1782 年）爲剛創刊的波德雜誌翻譯了劉松齡的成果。[27] 和劉松齡一樣，伯努利和波德（Johann Elert Bode，1747–1826 年）都是聖彼德堡以及其他科學院成員。

伯努利犯了一個錯誤，他說自己正從 1772 年出版的赫爾曆表中翻譯劉松齡的論證。事實上，那個曆表只在第 249 頁中提及 1770 年以來的一張測量表格，但那不是劉松齡的計算結果，劉松齡的計算結果僅在 1774 年那張表格重印時才發表。伯努利在翻譯時保存了劉松齡的圖片，但他沒有發表劉松齡的引證。在論述的結尾，他補充了一條赫爾的注釋。出版時，該注釋沒有和劉松齡計算結果一起發表。在那條注釋中，赫爾提到了奧迪弗雷迪（Audifredi） 於 1766 年在羅馬發表的關於日蝕的評論。多明尼加人奧迪弗雷迪以其在羅馬觀測到 1761 年的金星淩日現象以及 1769 年的彗星現象而享有聲譽。人們用拉朗德（La Lande，1732–1807 年）的方法討論 1764 年的蝕象始末。依據赫爾的朋友、斯德哥爾摩人瓦根廷（Wargentine）的觀測，拉朗德計算出了巴

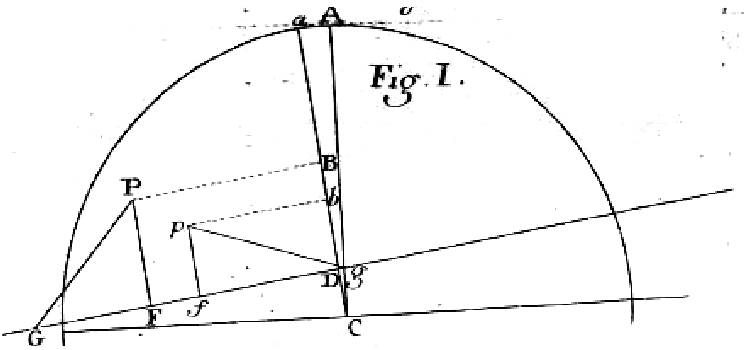
[26] Luigi Cipolla, 1774, 64: 42.

[27] Zmago Šmitek, *Zbornik za zgodovino naravoslovja in tehnike,* 1993, 12: 25；Zmago Šmitek, 1995, p. 91. 波德，1747 年 1 月 19 日出生於漢堡；1826 年 11 月 23 日在柏林去世。

黎和斯德哥爾摩的時差最多為 52"。在此基礎上，赫爾建議使用視差法來計算 1767 年的日蝕觀測結果。[28]

劉松齡在北京聖若瑟住所發明了一種在日蝕中使用視差估算月球與太陽之間距離的特殊方法。[29] 他測量了日蝕的幾個階段，用三角和解析的方法同時解決了這個難題。解析法與 1769 年拉朗德以及在其之後的赫爾合作者皮爾格拉姆（Anton Pilgram）的演算過程一致。[30] 考慮到巴黎和北京經線之間的差異，拉朗德使用了北京的觀測結果。[31]

劉松齡的確是用三角學方法表示天體間最小距離的第一人。在第一張圖片中，Ca 表示月球的軸線，CA 表示赤道的軸線。線條 Gg 表示月球軌跡。GP 和 gp 表示日蝕開始與結束時太陽中心與月球中心之間的距離。在另一張圖片上緊靠著畫有斜邊分別為 GP 和 gp 的直角三角形，劉松齡欲探究它們的邊、角之間關係。



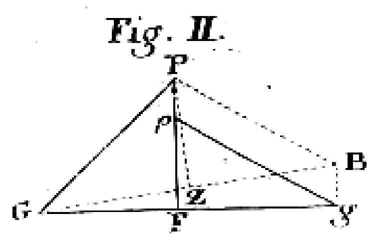
圖（一）

[28] Maximilian Hell, *Ephemerides Astronomicae*, 1774, p. 174.

[29] Joannes Nepomuk Stoeger, *Scriptores Provinciae Austriacae Societatis Jesu ab ejus origine ad nostra usque tempora*. Viennae: Typis congregationis mechitharisticae, 1855, pp. 120, 131; Hallerstein, 1774, 18: 156, 159.

[30] Hallerstein, 1774, 18: 158; Joannes Nepomuk Stoeger, 1855, pp. 120, 131.

[31] Maximilian Hell, 1773, 17: pp. 77–78.



圖（二）

簡單的圖片上，GP 和 gp 顯然是相等的，因爲兩者都代表月球在首次和末次與太陽接觸時越過的太陽半徑。太陽中心和月球中心的最小距離肯定在首次與末次接觸的中間。這樣，劉松齡證明了 GP 和 gp 之間距離相等。三角形 GPB 是等腰三角形，點 Z 中分了斜邊 GB。直線 PZ 是三角形 GPB 的高，同時也是太陽中心和月球中心之間的最小距離。

從日蝕的觀測結果同樣我們可以計算太陽圓周中弦的長度。太陽圓周首次接觸月球用 G 來表示，末次接觸用 g 來表示。我們也可以計算 Bb 的距離，Bb 與 Pp 以及 Bg 的距離相等。線條 Gg 和 Bg 是直角三角形的直角邊，因此它們的比例與角 PGZ 的正切是一樣的。

如果我們把已知的角 PGZ 加到小角 BgG 上，我們會得到角 PGF。PGF 是已知的直角三角形斜邊 GP 的角，我們能夠推算三角形 PGF 中所有未知要素，這就是直角邊 GF 和 PF。

那樣我們就知道等腰三角形 PGB 邊的長度以及邊與斜邊夾角的度數。這足以求解三角形了。三角形的高是日蝕中太陽和月球之間的最小距離。

接著，劉松齡用解析法對自己以前解決問題的三角法作了補充。很多問題與其說是用三角法計算的，還不如說是用解析法。劉松齡在一頁半長的計算中使用了平方根、指數和畢達哥拉斯定理。他運用了有觀測記錄的原始表格部分，這是在 9 點 17 分 53 秒和 9 點 18 分 21 秒之間所作的 16 次觀測。這一時期，太陽和月球之間中心的表觀距離幾乎沒有什麼變化。

對於博斯科維奇（Bošković）、劉松齡以及其他耶穌會士而言，幾何論證比現代使用微積分的數學方法更可行。但是中國數學家很少運用幾何學，而幾何學對天文學有一定影響。因此在耶穌會士來華之前，中國人沒有真正運用幾何學或力學模式來研究宇宙和太陽系。[32]

木衛

伽利略（Galileo）最先描述了木星的衛星。他試圖以自己的資助人梅迪奇（Medici）公爵的名字來命名這些木衛。他建議船員在公海上觀測衛星以準確計時。但劉松齡所處的時代，機械鐘錶的發展削弱了在船上觀測木衛以準確計時的重要性。

劉松齡所處時代的天文學家對木衛作了大量觀測。劉松齡運用的木衛理論和星表是英國皇家學會院士雅各·霍奇森（Jakob Hodgson）博士送給他的。[33]

劉松齡觀測了 1750 年 7 月 29 日至 1750 年 10 月 22 日之間行星陰影裏三顆木衛的隱沒。他在日出前的清晨作了八次觀測，在日落後的傍晚作了另外四次觀測。他對木衛一作了六次觀測，對木衛二作了四次觀測，對木衛三作了兩次觀測。宋君榮把自己同事劉松齡所作的觀測記錄在 10 月份寄給了巴黎的德利斯爾。[34]

[32] Joseph Needham and Wang Ling, *Science and Civilization in China* (Cambridge: Cambridge University Press, 1959), 3: 177, 446.

[33] Antoine Gaubil, *Phil. Trans,* 1753, 48/1:317.

[34] Antoine Gaubil, 1970, 632–633.

1756 年 1 月 10 日至 1756 年 7 月 8 日間，宋君榮在京對三顆木衛的隱沒作了 15 次觀測。他使用的是 13 英尺長的望遠鏡，其中有三次測量他使用的是更長的、達 20 英尺長的望遠鏡。[35]

赫爾發表了格拉茨（Graz）狹義相對論天文學教授特恩伯格（Karl Tirnberger，1731—1780 年）[36] 對木衛所作的觀測記錄。特恩伯格分別于 1770 年 2 月 14 日、1770 年 4 月 22 日、1770 年 7 月 29 日和 1770 年 8 月 5 日在格拉茨天文臺進行了觀測。1770 年 7 月 10 日，木星在"沖"位：地球在木星與太陽之間，木星看起來更大一些。因此，特恩伯格的一些觀測至少是在木星及木衛看起來更大一些、條件較好的夜晚完成的。

特恩伯格首先觀測了木衛一的隱沒，然後是木衛三，最後兩次他觀測了木衛一的再次出現。前兩次觀測時，天空一片晴朗，第三次時，天空晴朗無雲，最後一次則是多雲。1770 年 2 月 5 日，他觀測到只有三分之一月牙的月亮怎樣在 0 時 33 分 12 秒遮掩了金牛星座。[37] 1772 年，特恩伯格成爲克朗尼茲（Schemnitz）採礦學院的機械學和水力學教授。他接替的是耶穌會士波達（Nikolaus Poda von Neuhaus，1723–1798 年）神父的職位。波達在授課結束時出版了一本關於施蒂裏亞州（Styria）礦業方面的書。1766 年，特恩伯格已經在格拉茨博物館就化石研究與波達合作過了。波達是格拉茨數學和物理學教授、自然歷史博物館館長

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[35] Antoine Gaubil, *Novi Commentarii Academiae Scientiarum Impe-rialis Petropolitanae 1754 et 1755,* 1760, 5: 480.

[36] 卡爾・特恩伯格（1731 年出生于圖伊；1749 年 10 月 19 日在維也納進入初修院；1780 年在下奧地利州的肖特魏因去世）的簡歷如下：1744–1750 年，格拉茨，高中；1750–1751 年，維也納，初學生；1752 年，萊奧本，溫習人文學科；1753—1757 年，維也納，學習哲學、溫習數學；1758 年，尤登堡，人文學科教授、神學院負責人；1759–1762 年，格拉茨，研究神學；1763 年，尤登堡，第三次任命；1764–1771 年，格拉茨，狹義相對論天文學教授、天文臺負責人、物理部的保管人；1772–1773 年，申尼茨，機械學、液壓學教授；1773–1780 年，肖特魏因（Ladislaus Lukács, *Catalogus generalis seu Nomenclator biographicus personarum Provinciae Austriae Societatis Jesu (1555–1773)* (Romae: Institutum historicim S. J., 1988), 3: 1716; Joannes Nepomuk Stoeger, 1855, 365–366; Carlos Sommervogel, *Bibliothèque de la Compagnie de Jésus*, 1898, 8: 52 ）。

[37] Karl Tirnberger, *Ephemerides astronomicae,* Viennae, 1771, 16: 256.

以及天文臺台長。當波達擔任克朗尼茲礦業學院的礦冶院長後，格拉茨天文臺台長就由特恩伯格擔任。1770 年，波達在維也納時介紹了如何操作赫爾那著名的礦業泵，該泵在克朗尼茲市被用於從礦井裏抽水。

劉松齡在接近 70 歲時把木衛觀測記錄交給了其年輕的同事們。他利用中國幅員遼闊與非常遙遠的地方進行了合作觀測。從 1772 年 10 月 15 日至 1773 年 12 月 15 日，他使用索德超神父 13 英尺長的望遠鏡進行了觀測。齊類思神父在 1772 年 5 月 13 日至 1773 年 1 月 20 日間使用了同樣的望遠鏡。

傅作霖（Felix da Rocha，1713–1781 年）神父在長城的另一側進行了觀測。同時，他繪製了西韃靼地區即今天新疆維吾爾一帶的地圖。[38]他寫道：“這個地方離北京非常遠。該地區併入清帝國的版圖已經有十六年了，其南面邊界在地理經度 35 至 36 度處與西藏、印度接壤，在其之外的北面、地理經度 50 至 52 度處是西伯利亞。”

傅作霖第一個注意到哈喇喀爾齊斯河。這條河從群山之中流出，直至在今天新疆維吾爾自治區東面地區的地理經度 47° 48'、北京經線以西 24° 15' 處匯入更大的噶勒劄爾巴什池（Behapacan）。1772 年 7 月 9 日晚，月球遮住了所觀測的恒星。傅作霖在 9 點零 8 分開始觀測，1 小時 37 分後結束。因爲雲層很厚，他觀測不到根據北京星曆表所預測的月食。他用的是克利斯蒂安・梅耶（Christian Mayer，1719–1783 年）的星表。[39]

傅作霖在經度 47° 20'處的霍博克賽裏（Abaha-Oula）地區完成了第二次觀測。1772 年 7 月 13 日，正午前 7 分鐘，齊類思在北京觀測到離開木星背影的木衛一的軌道。這顆衛星在六月份時曾被遮住。根據巴黎的星曆表，人們預測在 1772 年 7 月 28 日 3 點 22 分 40 秒可以看到這顆衛星。根據北京的星曆表，則要比這

[38] Hallerstein, 1776, 20: 21–22.

[39] Hallerstein, 1776, 20: 23.

再晚 69 秒才可以看到。齊類思在 1772 年 8 月 6 日繼續觀測，但是傅作霖於 1772 年 7 月 13 日、14 日在韃靼地區的不同地方都作了觀測。

傅作霖在地理經度爲 43º 59'的西韃靼地區伊犁作了第三次觀測。伊黎河流經今天的哈薩克斯坦南部，注入巴爾喀什湖。1772 年 10 月 11 至 12 日夜晚，傅作霖觀測到一次月食。這裏的月食比北京早 2 小時 23 分。北京觀測到的月全食比傅作霖在伊黎河岸的觀測晚了 2 小時 54 分。在北京，月球離開蝕區比在伊犁晚了 2 小時 24 分。在伊犁能看到整個月食過程的時間爲 2 小時 51 分鐘，而北京僅比它長了兩分鐘。根據這些觀測記錄，傅作霖計算出伊犁與北京之間相距正好是 36º 。

在伊犁，達爾刳喇嘛在其父親去世後執掌了政權。他管轄的範圍遠至高加索以及今天烏茲別克斯坦和土庫曼尼亞邊界的阿姆河達爾加河岸。達爾刳喇嘛還管轄俄羅斯西伯利亞邊界今天哈薩克斯坦北部的托博爾（Tobol）。伊斯蘭教是該省的主要宗教。這樣，劉松齡介紹自己同伴的天文工作時，也附帶介紹了民族學和政治學。[40] 1761 年，德・奧特羅什（Abbé Jean Chappe D'Auteroche，1728–1769 年）在西伯利亞托博爾斯克州的托博爾東面 600 公里處觀測了金星凌日現象。

劉松齡把自己對 1717 年至 1774 年間木衛觀測記錄所作的科學研究報告送給了赫爾和蘇西耶（Etienne Souciet）。[41] 1772 年 8 月 20 日和 1773 年 9 月 25 日，木星沖日。因此，當劉松齡及其同伴仔細觀測木星時，環境不是特別有利。但這並沒有太妨礙他們，因爲他們想研究的是衛星週期而不是木星表面。使用了溶解度非常好的新望遠鏡。在蘭伯特（John Lambert，1728–1777 年）的專業期刊《天文學》介紹下，行星天文學發展很快。《天

[40] Hallerstein, 1776, 20: 25.

[41] Karel Dežman, *Laibacher Wöchenblatt. Organ der Verfassungs—Partei in Krain. Gedr. bei Leykam in Graz* (Laibach: Kleinmayr & Bamber, 1881), pp. 50–55, 2.

文學》創刊于劉松齡去世的那一年。相當一段時間，木星的所有觀測記錄都發表在蘭伯特的期刊上。[42]

在中國觀測的恒星

1744 年，劉松齡和戴進賢奉旨增修《靈台儀象志表》和鑄造天文儀器，並把其作爲《欽定儀象考成》的一部分。皇家觀象臺的許多漢人、滿人都參與了這項工作。後來，齊類思和鮑友管也加入進來。1757 年，《欽定儀象考成》三十五卷本印行出版，乾隆爲其作序。[43]

中國的慣例與歐洲有點不同，書的封面上不印製作者的名字。書首是乾隆親筆書序，落款爲「丙子冬十有一月」（1757 年）。接下來是奏議，介紹了編寫《欽定儀象考成》的主旨。卷首上（“禦制璣衡撫辰儀說”卷上——譯者注）修訂了南懷仁（Ferdinand Verbiest，1623–1688 年）的《靈台儀象志》。奏議起始於乾隆九年（1744），結束於乾隆十五年（1754）。

其他卷討論了所印製的新恒星目錄，這比南懷仁的更加完善。1687 年，南懷仁把 1129 顆恒星分爲 259 個星座。戴進賢、劉松齡和同伴們把 3083 顆恒星分爲 300 個星座。[44] 卷首下的第一卷時間標注爲 1744 年，儘管在此之前補充和完善南懷仁的《靈台儀象志》這一工作已經在戴進賢領導下進行了。在最後，乾隆向民眾諭示該書準備付梓，時間爲 1753 年。作者從文學角度詳細地論述了對中國古星名的保留。文才兼備的大臣們盡力幫助戴進賢和劉松齡在新目錄中辨認那些中國古星的名字。劉松齡和同伴使用了那個時代最精確的儀器。

[42] Thomas Hockey, *Galileo's Planet Observing Jupiter before Photog-raphy* (Bristol, Philadelphia: Institute of Physics, 1999), pp. 39, 207.

[43] Zmago Šmitek, 1995, pp. 91, 132; Joseph Needham and Wang Ling, 1959, 3: 454.

[44] Tsuchihashi and Chevalier, Catalogue d'Étoiles fixes, observés a Pékin sous l'Empereur Kien Long (Chhien-Lung), 1914, III–IV.

《欽定儀象考成》這部著作由幾個目錄組成：恒星總紀、恒星黃道經緯度表、恒星赤道經緯度表、月五星相距恒星黃赤經緯度表、天漢經緯度表。

北京的哥白尼學說

明末，鄧玉函（Terrentius，1576–1630 年）帶了一副望遠鏡來到中國。1634 年，該副望遠鏡獻給了崇禎皇帝。鄧玉函參與了新曆法的編修。[45] 鄧玉函在伽利略之後不久當選爲羅馬切西科學院的第七位院士，就在乘船出發至遠東之前，他加入了耶穌會。鄧玉函曾從中國寫信給伽利略，但是佛羅倫斯人伽利略對如此遙遠的地方不感興趣。鄧玉函與開普勒（Kepler，1571–1630 年）成功地保持通信聯繫，並把中國人測算蝕象的方法寄給了後者。

鄧玉函所處的時代，人們並不太接受「地動說」，因此他可以在同伴中判斷出誰贊同哥白尼觀點。在熊三拔（Sabastino de Ursis，1575–1620 年）的《簡平儀說》（1611 年）以及接受伽利略用望遠鏡發現天體的陽瑪諾（Manuel Diaz，1574–1659 年）[46] 的《天問略》（1615 年）中，可以見到日心說觀點。[47]

在去世那年，開普勒應贊同哥白尼學說、1646 年 12 月曾在澳門停留的蔔彌格（Michael Boym，1612–1659 年）[48] 之請，把《魯道夫星表》（1627 年）送給了北京的穆尼閣（Nikolaus Smogulecki，1610–1656 年）。[49] 儘管屬於哥白尼體系，1678 年，

[45] Jean Étienne Montucla, *Histoire des mathématiques,* Paris: Henri Aloais, 1799, 2: 471.

[46] 陽瑪諾，1574 年出生於葡萄牙的卡斯特爾夫朗科，1593 年 2 月 2 日在葡萄牙進入初修院，1659 年 3 月 4 日在杭州去世（Josef Koláček, *Čínské epištoly,* Velehrad: Refugium Velehrad-Roma, 1999, p. 17）。

[47] Nathan Sivin, On "China's opposition to Western Science during Late Ming and Early Ch'ing", in *ISIS,* 1965, 56: 201.

[48] 蔔彌格，1612 年出生於立陶宛的利沃夫城，1631 年 8 月 16 日在克拉科夫進入初修院，1659 年 8 月 22 日在廣西去世（Josef Koláček, 1999, p. 17）。

[49] Joseph Needham and Wang Ling, 1959, 3: 444; Nathan Sivin, “Copernicus in China”, in *Studia Copernicana. Varšava,* 1973, 6: 86.

《魯道夫星表》在盧布爾雅那還是非常暢銷。後來，盧布爾雅那的耶穌會士買了這些曆表，劉松齡很小的時候就讀過它們。

鄧玉函的同伴祁維材（Kirwitzer，1588 或 1590–1626 年）[50] 和在南京傳教的穆尼閣都支持哥白尼學說。[51] 17 世紀 50 年代，穆尼閣的朋友中有一位中國學生叫薛鳳祚（約 1620–1680 年）。那時，他們合作編譯、刊刻了一部關於日月交食的書，名爲《天步真原》（天體運動的真正緣由），並在書中第一次用中文描述了對數。1653 年，薛鳳祚刊印了中國第一本數表及其論證。[52] 他們使用的是佛拉哥（Adriaan Vlacq，1600–1666 年）爲商人和科學家編制的簡易對數表，該表出版於 1636 年，後來由耶穌會士帶入中國。

在耶穌會士來華之前，中國人把宇宙空間想像成空無一物，而非水晶球宇宙體系，因此他們沒有真空的概念，而至遲于劉松齡出生時，歐洲科學界仍對真空爭論不休。1643 年，托裏拆利（Torricelli）首次進行真空實驗時，爭論就已經開始了。在這之後的五十年，爭論愈演愈烈。亞里斯多德（Aristotle）甚至笛卡爾（Descartes）的物理學都否認氣壓計、泵或銀河空間中存在真空。劉松齡在維也納的合作者赫爾對宇宙和銀河空間產生較大興趣，1789 年，他就相關問題出版了一本書。

耶穌會士帶給中國的是過時的赤道座標和托勒密——亞里斯多德的水晶球體系“地心說”，而這在歐洲正爲第穀·布拉赫以及哥白尼所駁斥。這也是中國人批評耶穌會士天文學的部分合理之處。[53] 伽利略發展了哥白尼學說之後，來華耶穌會士不接納哥白

[50] 祁維材，1588 年或 1590 年出生于波希米亞的卡登城，1606 年 2 月 28 日在布隆城進入初修院，1626 年 5 月 22 日在澳門去世（Josef Koláček, 1999, p. 15）。

[51] Sivin, 1973, p. 86.

[52] Joseph Needham and Wang Ling, 1959, 3: 52, 454.

[53] Joseph Needham and Wang Ling, 1959, 3: 438; Christopher Scheiner, *Rosa Ursina sive sol ex admirando fa-cularum & macularum suarum phoenomeno varius necnon circa cen-trum suum & axem fixum ab occasu in ortum annua circaq. alium axem mobilem ab ortu in occasum conversione quasi menstrua, super polos proprios,* Libris quartour mobilis ostensus a Ch. Scheiner, Bracciani: apud And. Phaeum, 1630, 4: 765.

尼學說。當然也有例外，如傅聖澤在 1710 年極力想把哥白尼學說介紹給中國人。1716 年 4 月，傅聖澤把自己贊同哥白尼觀點的討論五大行星的文章、拉・伊爾星表和佛拉格對數一起呈給康熙皇帝，他把佛拉格星表亦呈給了康熙。法國耶穌會士支持傅聖澤，但葡萄牙耶穌會士、1719 年住在葡萄牙會院的紀理安（Kilian Stumpf，1655–1720 年）以及戴進賢都反對他。[54]

劉松齡沒有公開表明自己關於太陽系內天體運動的觀點。1757 年，在博斯科維奇的努力下，羅馬裁判所收回將那些"宣稱地球自轉"的書籍革出教門的命令。消息傳到北京後，法國耶穌會士立即借此向公眾宣傳日心說。蔣友仁（Michel Benoist，1715–1774 年）是第一位在宮中講授哥白尼學說的耶穌會士。1760 年，蔣友仁呈上《坤輿全圖》爲乾隆祝壽之際，向乾隆介紹了日心說。[55] 乾隆的叔父是一位非常能幹的數學家，他檢視了蔣友仁的著作。何國宗[56] 和贊成哥白尼學說者以及史學家錢大昕（1728–1804 年）爲蔣友仁的中文書稿修改潤色。這份手稿一直在中國最傑出的天文學家中傳閱，直至 1799 年、1802 年和 1803 年出版爲止。[57]

一些中國天文學家不清楚圍繞伽利略觀點產生爭論的歐洲背景，因此對蔣友仁介紹的日心說產生困惑。儘管如此，蔣友仁仍備受乾隆寵愛。1773 年 1 月 12 日，法國人帶來了新式反射望遠鏡。乾隆對這個望遠鏡贊許有加，同時也想知道該如何使用，於是蔣友仁負責教乾隆操作步驟。在那次筵席上，太監們對新望遠鏡也讚不絕口。乾隆立刻就比較出反射式望遠鏡比以往舊式望遠鏡的先進之處。[58]

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[54] John Witek, 1982, pp. 181, 184, 186, 188, 238, 329, 330.

[55] Wong, George H. C, China's Opposition to Western Science during Late Ming and Early Ch'ing, in *ISIS,* 1963, 54: 46; Nathan Sivin, 1973, p. 95.

[56] 何國宗，北京人，1766 年去世。

[57] Nathan Sivin, 1973, p. 95; Zurndorfer, "Vendre la science à la Chine au XVIII siècle," in *Etudes Chinoises,* 1988, 7: 75, 88.

[58] Aimé-Martin, *Lettres édifiantes et curieuses concernant l'Asie, l'Afrique et*

乾隆借此機會詢問蔣友仁是否「所有歐洲天文學家都認爲地球可以自轉？」蔣友仁回答說幾乎都是這樣認爲的，但在真實體系中問題並不像爲計算天體運動找到一個更好方法那麼多。乾隆帝在吃飯時問及歐洲葡萄酒的口感，蔣友仁很高興地把自己在這方面的豐富知識告訴了皇帝。[59]

北京天文學家開始使用新的、法文本的哥白尼學派星表來預測天象，而不再使用以前哈雷、勒莫尼埃和格拉馬蒂西的星表。但是大部分中國人僅僅接受使用新方法的結果，而不是接受日心說原理。人們用蔣友仁的圖（《地球圖說》）來勘誤舊圖。[60] 這樣，18 世紀末，哥白尼學說最終在中國取代了第穀・布拉赫學說。[61]

l'Amérique, II-IV (Paris: Société du Panthéon Littéraire, 1843), 4: pp. 196–198, 208；蔣友仁 1773 年 11 月 4 日致姓名未知人的信。

[59] Aimé-Martin, 1843, 4: 217, 220；蔣友仁 1773 年 11 月 4 日致姓名未知人的信。

[60] Aimé-Martin, 1843, 4: 122；蔣友仁 1767 年 11 月 16 日從北京寄給德・奧特羅什的信；Wang Yusheng（王玉笙）, P. Andreas Pereira and his Contribution to Mathematics and Astronomy in China, in *History of Mathematical Science,* 2000, p. 225.

[61] Joseph Needham and Wang Ling, 1959, 3: 443–444.

Book Review: *The Spiritual Itinerary of Georges Lemaître*[1]

Patrick TAVEIRNE

書評：《喬治・愛德華・勒梅特的靈性之旅》

譚永亮

Modern studies of the relationship between theology and science are now half a century old, and may be dated back to a seminal work by Ian G. Barbour, *Issues in Science and Religion*, first published in 1966. Others continued his pioneering work in the 1980s and 90s, and this topic has lately been something of a booming phenomenon in universities in Europe and America. Michael Fuller, an Anglican priest with a background in organic chemistry, in his article, “Science and Theology. An Introduction”[2] points out the difficulty of defining the term “religion”. Therefore many writers in the field prefer the term “theology”. Generally, “theology” seems to signify a way of thinking, of applying our rational selves to the asking of questions about God, and about the relationship of God

[1] Dominique Lambert, L’itinéraire spirituel de Georges Lemaître. Suivi de “*Univers et Atome*” (conférence inédite de G. Lemaître). The Spiritual Itinerary of Georges Lemaître: Followed by *“the Universe and the Atom”,* an unpublished talk of G. Lemaître. Brussels, Lessius, 2007, 222 pages.

[2] Michael Fuller, “Science and Theology: an Introduction”, *Chinese Cross Currents* 9–3 (July 2012) 116–123.

with the Universe we see around us—and with ourselves, as a part of that Universe. St Anselm of Canterbury described theology as fides quaerens intellectum, "faith seeking understanding," a description which many have found helpful. The word "science" is similarly hard to define. But science can be characterized as a rational, objective, deterministic, and reductionist method or way of interrogating the world around us. According to Barbour, "science" and "theology" can interact in a fourfold way: conflict or opposition, independence, dialogue, and integration.

The astrophysicist Monsignor Georges Henri Joseph Édouard Lemaître (17 July 1894–20 June 1966) reflected a lot about this interaction between science and theology and tried to integrate both disciplines in his personal, scientific and apostolic life. He was a Belgian secular priest and canon, astronomer and professor of physics at the Catholic University of Louvain (Leuven). He was also the first person to propose the theory of the expansion of the Universe, widely misattributed to Edwin Hubble (1889–1953). He was also the first to derive what is now known as the Hubble's law and made the first estimation of what is now called the Hubble constant which he published in 1927, two years before Hubble's article. Lemaître proposed what became known as the "Big Bang" theory of the origin of the Universe, which he called the "hypothesis of the primeval atom."

Father Lemaître is well-known for the above mentioned contributions to science, but less-known for his apostolic activities as a secular priest, in particular the accompaniment of Chinese students studying in Belgium and his rudimentary reflections on the interaction between science and theology. Similar to the Jesuit Pierre Teilhard de Chardin (1881–1955) under the influence of the Great War (1914–18), he had both a sacerdotal and scientific vocation. Lemaître was not a theologian, but a scientist in the first place. He was a passionate reader of the spiritual works of Léon Bloy and Jan Van Ruusbroek. Professor Dominique Lambert's[3] book L'itinéraire spirituel de Georges Lemaître narrates Lemaître's discreet but significant activities as a secular priest, fully compatible with his scientific activity at the University of Louvain.[4] The author shows convincingly how an authentic spirituality is compatible with scientific research and how a believer, without any embarrassment, can be an actor in advanced scientific research.

In Chapter Five of his book Dominique Lambert focuses on Professor Lemaître's apostolic life, in particular his "Chinese connection" with the well-known Father Vincent Lebbe (1877–1940) and the Chinese students in Belgium. Since 1927 the young professor Lemaître during a retreat at the major seminary of Malines (Mechelen) experienced the call to spend some time with foreign students, besides his scientific research on the nebulae (galaxies). Originally, he was thinking about the International Circle of foreign students in Louvain. But particular historical circumstances decided otherwise.

Following the Great War, a number of Chinese students originally studying and working in France moved to Belgium as they lost their part-time jobs in the French factories. Moreover, from 1920 until 1927 Father Lebbe returned to Europe in order to take care of the Chinese students. Of the more than 400 Chinese students, who corresponded with Lebbe seeking assistance, about one third of them stayed in Belgium. In 1926, Lebbe established a "Chinese Home" for the 30 Chinese students studying in Louvain at Ladeuze Square. Lebbe received generous assistance from the Benedictine abbot of St. Andrew in Loppem near Bruges, Dom Theodore Nève, who he had

[3] Dominique Lambert is a Ph.D. in sciences (physics) and philosophy of the Catholic University of Louvain and professor at the University of Namur.
[4] I am indebted to Fr François Barriquand for pointing out this book to me.

met earlier in Rome during his theology studies. In the same year, a secular priest from Verviers, Father Boland, influenced by Lebbe, established a society of secular priests who were prepared to serve under the jurisdiction of Chinese bishops (The Society of the Auxiliaries of the Mission, SAM). Moreover, the ordination of the first six Chinese bishops in Rome on 28 October 1926, under the influence of Lebbe as well, enhanced the general interest of Belgian Catholics in China.

Lemaître was a colleague of the brother-in-law of Lebbe, Jacques Thoreau, a geologist and professor at the School of Engineers (University of Louvain) where Lemaître taught analytical mechanics. Thoreau undoubtedly influenced Lemaître in his concern for Chinese students. Moreover, the brother of Thoreau was a Benedictine monk at the monastery of St. Andrew. Earlier Lemaître had taught a young Chinese seminarian, introduced by Lebbe, French and catechism classes. In return the seminarian taught Lemaître the rudiments of Chinese during his stay at the House Saint Rombaut in Malines (1920–1923).

In July 1929, Msgr Ladeuze rector of the Catholic University of Louvain chose Lemaître to become his representative on the Sino-Belgian Interuniversity Committee, responsible for the allocation of scholarships to Chinese students in Belgium. On 11 October 1929, Lemaître was appointed director of the "Chinese Home." He succeeded Father Boland, who earlier had contacted Lemaître to assist him in welcoming and accompanying Chinese students. Lemaître, a devoted member of the "Friends of Jesus" introduced this priestly fraternity to Boland. During a general assembly of this fraternity at the monastery of St. Andrew in Loppem in 1928, Lemaître met abbot Dom Nève. Both became good friends. One year earlier, the latter had established the "Chinese Catholic Foyer" of which Lemaître became a member.

Due to a difference of opinion between Lemaître and Boland about how to manage the Chinese Home, Lemaître resigned as director without any problem. Moreover, he continued to help Chinese students. Towards the end of the 1930s he integrated them in research projects at his laboratory. They collaborated with his research on the trajectories of cosmic rays, in particular his brilliant Chinese student Zhang Yongli 張永立 (1913–1972), who later became a professor of mathematics and physics at Yunnan University. In the 1950s, Lemaître headed the Academic Committee for Chinese Students in Louvain. During this time he had to deal with a good number of Chinese clergy coming to Louvain without the mandate of their bishops.

On the interaction between science and theology, Professor Lambert in two chapters: (6) To Protect Theology from Science? Two Ways towards a 'Hidden God' and (7) To Protect Science from Theology? The *Un'Ora* Affair[5] illustrates how Father Lemaître's ideas changed from a "concordant" or a synthetic view to a "discordant" or a methodological and radical separation of science from theology in the 1930s. Lemaître developed this "thesis of the two ways" (spiritual and natural) towards truth, following his "hypothesis of the primeval atom" in 1931. Lemaître's modern distinction between transcendence (the domain of revelation and salvation) and immanence (the domain of science and astrophysics) was related to the biblical theme of the hidden God, "Deus absconditus." Lemaître wrote, "I think that every one who believes in a supreme being supporting every being and every action, believes also that God is essentially hidden and may be glad to see how present physics provides a veil hiding the creation." This modern

[5] The *Un'Ora* was a controversial papal address on the hypothesis of a supernatural creation of the world based on the expanding model of the universe to the Pontifical Academy of Sciences by Pope Pius XII on 22nd November 1951.

conceptual and radical separation of science from theology did not exclude the possibility that the same believer can live both his scientific and religious vocations without being torn apart. The unity comes from the religious dimension of scientific research as such. In Lemaître's words, science is "truth-seeking at the service to God."

When it concerns the human being, Lemaître is not prepared to radicalize his "thesis of the two ways" or conceptual separation of science from theology. The scientific description of the human being also entails philosophical and ethical questions which physical cosmology does not encounter. Lemaître certainly shared Pope Paul VI's view of science as being fully respectful of the human. Lemaître accepts that scientific practices can be questioned from an ethical point of view and that human beings should never become victims of scientific progress.

In 1936 Lemaître became a member of the Pontifical Academy of Sciences and in 1960 he was appointed president of the Academy. The presidency of Msgr Lemaître coincided with the last preparatory phases of the Second Vatican Council. Lemaître was very "ecumenical" minded so that a wide variety of scientists would be represented in the Academy and could inform the Pope directly about the most advanced domains of the sciences. At the same time, he was concerned about the autonomy of scientists within the Academy so that they could work according to their own methodologies without any restrictions or interference from the Church. Jesuit Father P. Teilhard de Chardin's ideas were different. The latter proposed to establish a "scientific commission," like the "Biblical commission," in order to inform authorities about the points one can be sure that humanity will take a stance on tomorrow… The two models of the "Academy" and the "Commission" remain the basic issue of the Church's present reflection on how to develop a proper relationship with the scientific community. According to Lambert, the choice of an Academy rather than a Commission accords with Lemaître’s ideas of the need for real openness towards the sciences without any attempts at assimilation or control by the Church magisterium.

Lemaître’s “thesis of the two ways” corresponds to the conclusion of the Anglican cleric Michael Fuller, namely that “despite this recognition that there can be a number of ways of viewing the relationship between science and theology, there appears to be a common perception that these disciplines are radically different, and that they must be opposed to one another.” Professor Dominique Lambert in his concluding chapter: When the star stops presents Monsignor Lemaître as a double star. Still, Lambert’s last sentence of his excellent book: “the father of the Big Bang and the “Friend of Jesus” have never stopped being the same star,” shows how this radical opposition can be reconciled in one and the same person.

約稿

爲鞏固中國與國際間在研究香港、中國及海外華人團體這方面的學術工作，雙語性質的「天主教研究學報」將接受以中文或英文的投稿，並附以相對語文的摘要。間中或包括書評及有關本中心活動的簡訊。從今期起，本刊將只以電子方式每年出版一次。我們鼓勵讀者及作者以本刊作互動討論的平台，並歡迎對本刊批評及提出建議。

「天主教研究學報」以同儕匿名審稿方式選稿以維持特定的學術水準。本刊的性質可大體屬於人文科，以科學方法研究天主教與中國及華人社團，同時著重文本及考察的研究。本刊歡迎個別投稿及建議期刊專題。本刊下期專題爲「宗教交談」。

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To enhance academic exchange and bridge the worlds of China and international scholarship, in a domain concerning Catholicism in Hong Kong, China and the worldwide Chinese-speaking community, the *Hong Kong Journal of Catholic Studies* is a bilingual publication that welcomes contributions in Chinese as well as in English. Each issue has articles in both languages, with abstracts in the other language. Occasional book reviews and news on the activities of the centre will also be included. We shall publish one issue per year, starting from this issue in electronic format only. We encourage our readers and authors to regard our journal as a forum of interactive debate and welcome all comments and suggestions.

Submissions will be reviewed by external referees on a double-blind basis aiming at the highest professional standards. Evaluation is based on scholarly quality and originality. The scope of the journal is broadly defined as humanities as well as scientific approaches to Catholicism and the Chinese world, with an emphasis on research based on documentary sources and field study. Both individual submissions and projects for guest-edited issues are welcome. Our next guest-edited issue will be on inter-religious dialogue.

Submission Guidelines

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