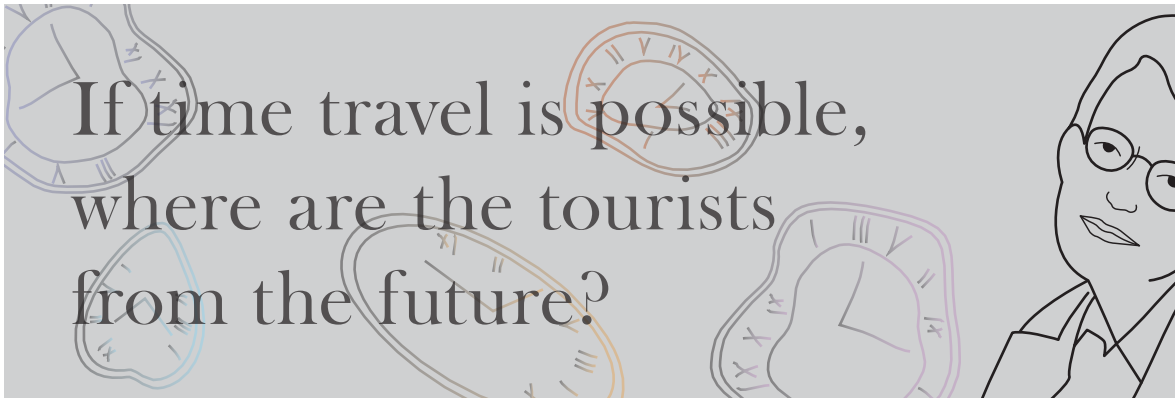
史前篇
PREHISTORY

約公元前4000年之前
CA. 4000 BCE

01 Out of Primal Chaos

The prehistory 15–4.5 billion years ago



The English physicist Stephen Hawking (1942–) has been confined to a wheelchair since the age of twenty as a result of a motor neuron disease related to amyotrophic lateral sclerosis, which left him with a paralysed body; at forty-three he contracted pneumonia and had to have a tracheotomy, which removed his ability to speak altogether. However, he never lost heart but spared no efforts in pursuing his research and in the end became the most distinguished theoretical physicist in the contemporary world. His renowned work, *A Brief History of Time: from the Big Bang to Black Holes*, published in 1988, established him as the highest authority on cosmology.

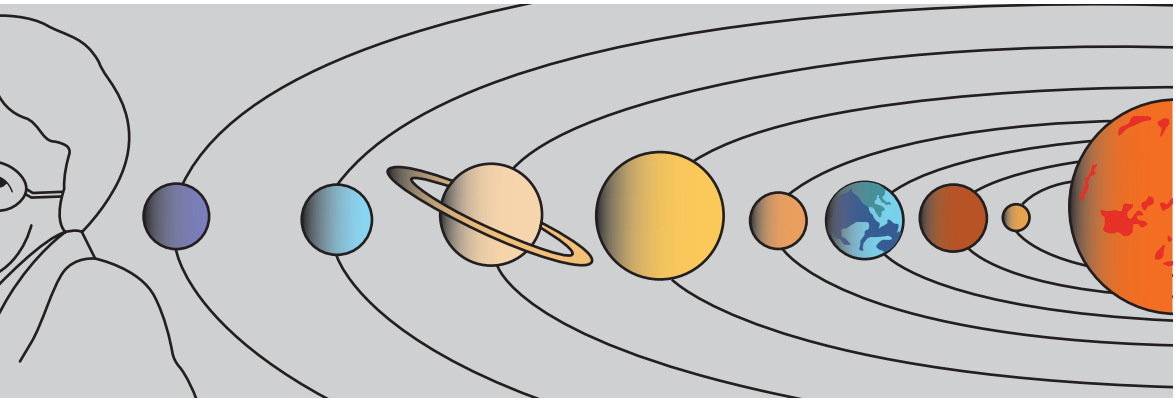
According to the findings of Hawking and other scientists, from the outer space, originally in the state of a vacuum, appeared at an unknown time a gravitational singularity in what is called "the cosmic egg". (Hawking thinks that within the limits of the space-time in which the singularity exists, all scientific laws and predictability cease to be effective.) This singularity exploded about 15 billion years ago with a Big Bang and formed the universe.

The universe expanded rapidly, largely because of the presence of "dark energy", after the explosion, occupying a space from zero to immensity, its diameter spanning a light year. The matter produced by the explosion gradually cooled down to form nebulae, which in time evolved into the galaxies.

There are numerous nebulae and galaxies in the universe. One of the galaxies is called the Milky Way. It came into existence 10 billion years ago. Within the Milky Way are numerous stars and planets. The former are still in a state of combustion, giving out light and heat while the latter have cooled down and give out neither light nor heat.

混沌初開

150–45 億年前的歷史



霍金，英國人，生於 1942 年。20 歲時，因肌肉萎縮而全身癱瘓，要終生坐輪椅；43 歲時，又因肺炎要做穿氣管手術，以致從此不能說話。可是他沒有氣餒，仍然努力不懈，潛心研究，終於成為近世最傑出的理論物理學家。1988 年，他寫成《時間簡史》一書，奠定了他作為宇宙學最高權威的地位。

根據霍金等科學家的研究結果，本來處於真空狀態的太空不知何時出現了一個人們稱為「宇宙蛋」的奇點。（霍金認為，奇點存在於特定的時空中，在其範圍內所有科學定律和預見性都失效。）這個奇點在大約150 億年前發生大爆炸，形成宇宙。

大爆炸使宇宙迅速膨脹，其所佔空間從無到有，直徑兩端的距離一下子就擴展到一光年，此後更因為「暗能量」的大量湧現而不斷膨脹。大爆炸所產生的物質後來逐漸冷卻，形成星雲，進而演化為星系。

宇宙內有無數的星雲和星系，其中一個星系叫銀河系，它形成於一百億年前。銀河系內又有無數的恆星和行星。恆星仍然處於燃燒狀態，所以又發熱又發光；行星經已冷卻，所以既不發熱也不發光。

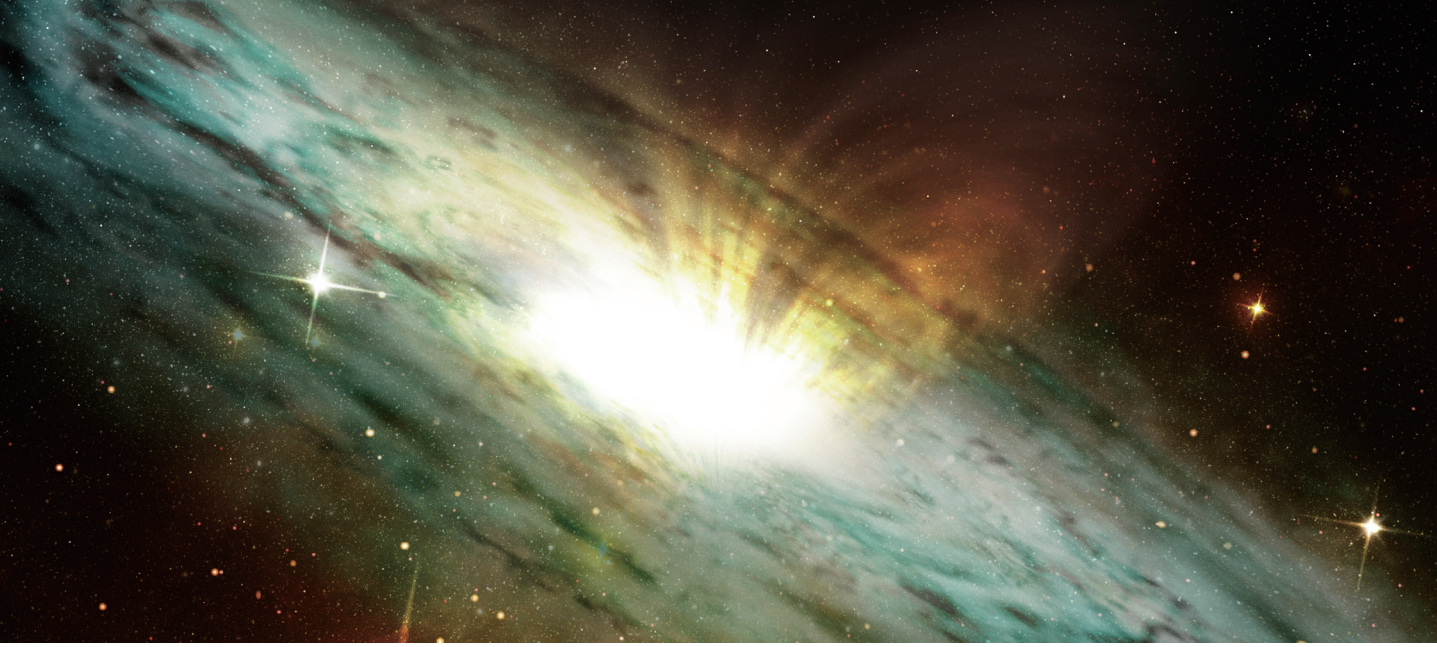


Figure 1.1 Big Bang
圖1.1 宇宙大爆炸

The galaxies revolve in the universe on fixed orbits; stars revolve in the galaxies on fixed orbits as well. Planets, as dependencies of the stars, revolve round the star to which each belongs. They are attracted to each other by universal gravitation, which keeps them at a safe distance apart all the time.

The Sun is a small star in the Milky Way. Its precursor was a nebula. About 5 billion years ago, this nebula collapsed and contracted owing to the explosion of a supernova nearby. In the contracted nebula, the centre was occupied by the sun, with planets revolving round it on oblong-shaped orbits. The larger planets are eight in number: Mercury is the star closest to the sun; the others in order are Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

The Earth, besides revolving round the Sun, also rotates on its axis. This is a formless axis on which the Earth self-rotates, its two ends being the North and South Poles, perpendicular to the equatorial plane and forming an angle of 66.5 degrees with the Earth's orbital plane. The Earth's rotation gives rise to day and night; owing to the slanting position of the axis, the Earth's revolution (taking 365.24 days to complete one cycle round the Sun) gives rise to the four seasons. It can be imagined that once the angle of the Earth's axis changes, global climatic changes will follow. This has happened before.

The Moon is a satellite of the Earth, revolving round the Earth, taking 29.53 days for one cycle.

It had taken about 0.5 billion (500 million) years from the explosion of the supernova to the formation of the Earth. We will take a close look at the evolution of the Earth in the past 4.5 billion years in the following chapter.

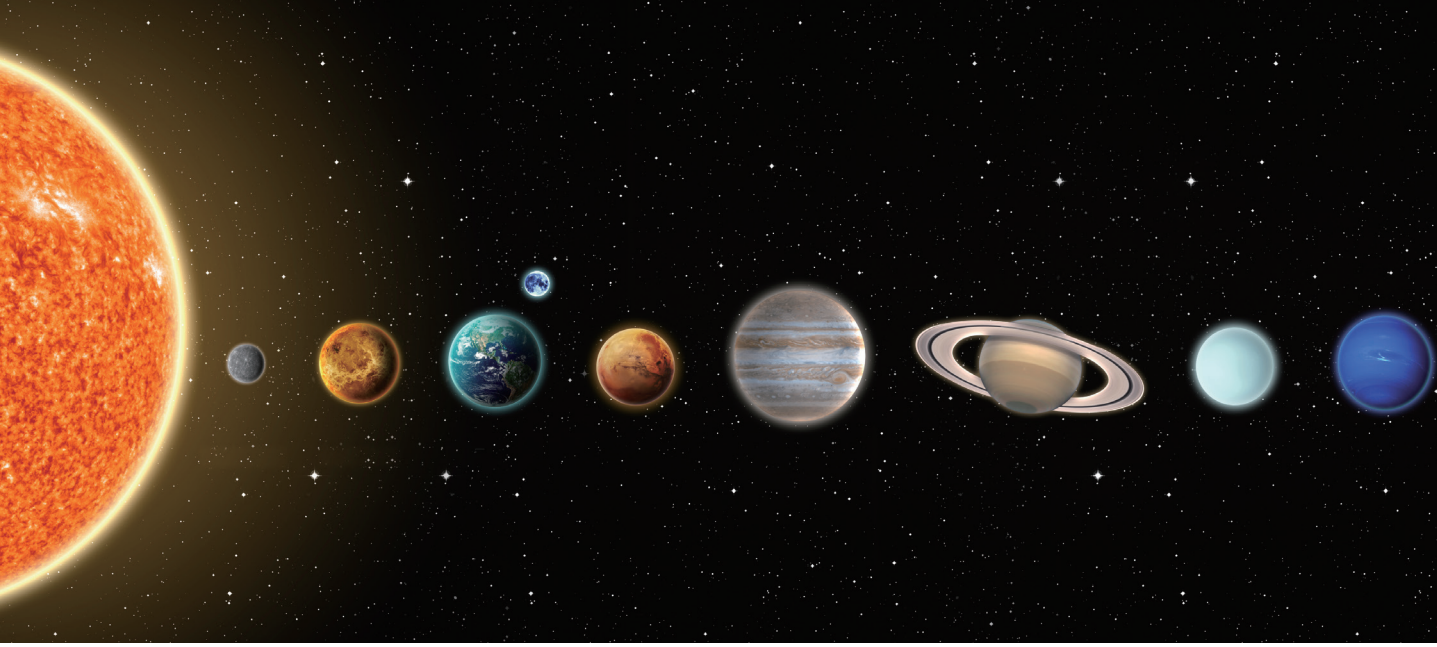


Figure 1.2 Solar system
圖1.2 太陽系

星系按照一定的軌道在宇宙內運轉，恆星也按照一定的軌道在星系內運轉。行星作為恆星的附庸則繞着所屬恆星運轉。萬有引力讓它們互相牽引，彼此之間長期保持穩定的距離。

太陽是銀河系中一顆小恆星。它的前身是一團星雲。大約五十億年前，這團星雲因附近一顆超新星爆發而塌縮。星雲收縮後，中間形成太陽，外圍形成行星，比較大的有八個，它們循着橢圓形的軌道環繞太陽旋轉。最接近太陽的行星是水星，其他依次是金星、地球、火星、木星、土星、天王星和海王星。

地球除了環繞太陽旋轉外，還繞着地軸自轉。地軸是一條有質無形的地球自轉軸，它的兩端是南極和北極，和赤道面相垂直，和地球的軌道面相交成 66.5 度角。地球自轉造成晝夜；因為地軸傾斜的緣故，公轉（繞着太陽旋轉，一周需時 365.24 日）造成四季。可以想像，一旦地軸的傾斜度出現變化，世界各地的氣候就會有所改變。這情況以前就曾發生過。

月亮是地球的衞星，它繞着地球運行，一周需時 29.53 日。

從超新星的爆發到地球的形成，中間經過大約五億年。我們將會在下一章細看地球在過去 45 億年演化的情況。