Introductory Chapter: Space Flight

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"Πώς Γαία και Ήλιος ή δε Σελήνη αιθήρ τε ξυνός γάλα τ᾽ουράνιον και Όλυμπος ἐσχατος ἠ δ᾽ ἀστρων θερμὸν μὲνος ωρμὴθησαν γὶγνεσθαι".

"How did heaven's Earth and the Sun, or the Moon, the Solar Wind, and, the Milky Way Galaxy and ultimate Olympus (Dias/Jupiter), or the astral thermo-stability, were generated?" (Parmenides, on Nature, 500 BC).

1. Introduction

Would you answer to this 2500 year old question? Based on the archaeological findings, prehistoric human societies had similar cosmogonical and cosmological wonderings, verified to a minimum of 12,000 years ago. Cosmogony refers to the creation of cosmos, while cosmology to its structure. Cosmos symbolises the actual decoration of the universe with its various structures, including humans on Earth, via the eternal flow of the vital divine energies, as demonstrated by this 7500 year old randomly picked artefact of **Figure 1**.

An interesting highlight about our prehistory is that all the documented major civilisations around the globe shared similar memories, moral, and mental values, no matter the physical distances amongst them. These fundamental philosophical concepts are still in use, some with the same names and some with adjusted ones. However, all these core ideologies, that include a lot of superstitions too, lack the support of scientific data, especially when it comes to beliefs regarding space.

As a giant step ahead for the human civilisation and space science itself, major space centres have been established globally over the last century. Space centre scientific observations are performed using three types of instrumentation, namely, ground-based, suborbital, and spaceborne [1]. All three types are scientifically competing with each other, and, more importantly they couple each other by extending the frequency ranges outside the spectrum of the spaceborne instruments [2]. In this way, scientists obtain a richer range of scientific observations. The demands for more capable ground-based and suborbital facilities have been

Figure 1. Sample artefact, 5500 BC, archaeological museum of Za-dar/Dia-dora, Croatia.

increased over the recent years [3]. Expenses related to cleanroom procedures, space qualification, launch, and operation have been kept to a minimum [4–8].

On the other side, the more costly near-Earth orbit and, especially, deep space missions are totally justified by their qualitative basis of technological capabilities that they offer [9, 10]. High-resolution magnetometry, UV, X-ray, stray light imaging power, etc. are simply samples of the superior in-situ measurement data that these missions have been providing to the scientific community [11].

The winner in the race for deep-space was stemmed early in the race and as early as in 1964. The immense joint effort of regular people, U.S. Government, the outstanding work of the scientists at Jet Propulsion Laboratory (JPL), the technological miracles achieved at National Aeronautics and Space Administration (NASA), in just 6 years after NASA's establishment, lead to the success of Mariner IV [12]. The success is even greater if it is taken into consideration that the 4th of July Independence Day was in the not so distant 1776.

Mariner in 1967 carried a slightly modified instrumentation [13], which was further adjusted to meet the expectations of Pioneer 10/11 to Jupiter and Saturn (1972/1973) [14]. A Pioneer 10/11-based flight-spare instrumentation was modified for ISEE-C [15], outperforming the FGM-based ISEE-A/B spacecrafts [16], in return-science [17]. The successful ISEE-C and Pioneer 10/11 designs lead to highly stable and low-noise instrumentation designs for Ulysses in 1990. Until 2008, Ulysses studied solar space physics [18] and performed accurate in-orbit observations [19].

The Cassini-Huygens mission to Saturn, Titan, and Saturn's moons was launched on 15 October 1997 and ended gloriously on 15 October 2017. Some flight-spare instrumentation from Ulysees was modified and added to Cassini to support the first-time in space S/VHM [20]. Cassini applied the dual-magnetometer (DM) technique [21]. DM accelerates the pre-launch magnetic cleanliness and calibration program, records the post-launch field variation, and controls the redundancy in interplanetary missions [22]. It remains the most innovative interplanetary mission ever achieved [23]. It is also the topic of the next section.

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2. The Cassini-Huygens mission

The Cassini-Huygens mission exceeded all expectations and explored a planetary system that is different from ours. 635 GB of science data were collected and 453,048 fantastic images were transmitted back to Earth, as shown in **Figure 2**. This enhanced our knowledge regarding the solar system. The spacecraft travelled in total 4.9 billion miles (7.9 billion kilometres). Eighteen scientific instruments were onboard Cassini, and, a probe that landed on Saturn's moon, Titan. Titan is larger than planet Mercury. Scientists from 27 countries participated to the project. The mission assisted in verifying new remote sensing techniques and flight-proving this unique spacecraft design.

It took 7 years for the spacecraft to reach Saturn. In order to gain the required gravitational force to perform this journey, Casssini flew twice by Venus, by Earth and, then, by Jupiter, before reaching the Saturnian system. The mission was also supported by the Italian Space Centre (ASI), the European Space Agency (ESA), and the U.S. Congress. The Cassini-Huygens interplanetary spacecraft holds a record weight in its category of 6.1 tons, when fully fuelled. Cassini proved that Saturn produces lightning bolts ten thousand times more powerful than the strongest on Earth and equatorial winds in the range of 1100 mph. It also proved that the Titan has similarities with early Earth, due to its nitrogen-enhanced atmosphere. The complex organic structures in its atmosphere will eventually fall to its surface. This will be an equivalent point similar to the one when life is initiated on Earth. Further analysis of Titan's collected data will enhance our knowledge of how life was enabled on Earth. Subsequent study of the data collected by Cassini will assist in understanding how the universe itself and our solar system were created.

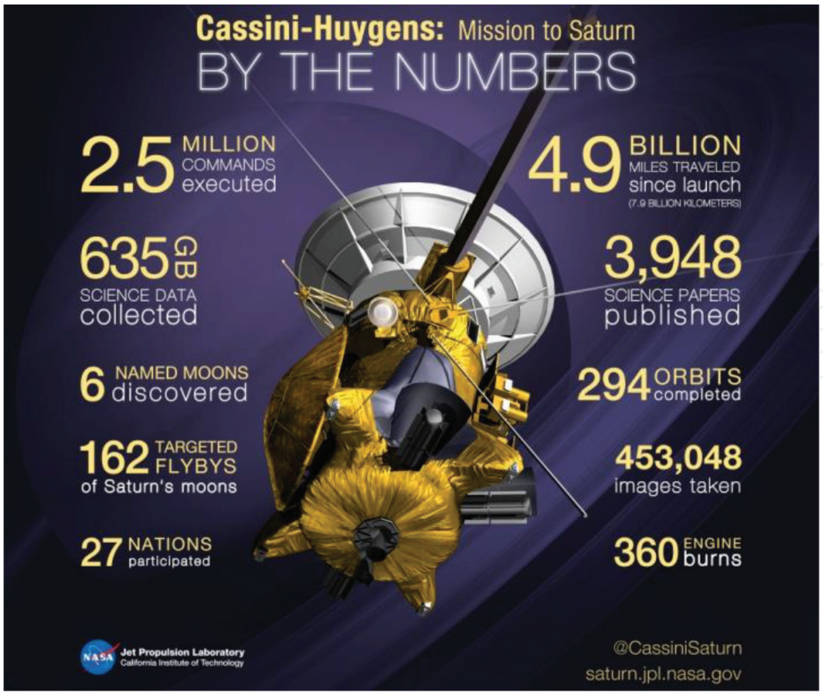

Figure 2. Cassini-Huygens by the numbers. Courtesy of JPL, NASA.

3. Juno-teaser for the space fans

Following the success of the Cassini-Huygens mission to Saturn (Chronos = time), Titan (King) and Saturn's moons, the Juno (Hera) mission to Jupiter (Dias) was the first competed mission selected for NASA's New Frontiers program to perform first-time in-depth observations of Jupiter's structure, atmosphere, and polar magnetosphere. The spacecraft was launched from Cape Canaveral Air Force Station on the 5th of August, 2011. Juno entered a polar orbit of Jupiter on the 5th of July, 2016.

JPL released the following composite image on the 7th of March, 2018, as shown in **Figure 3**. It consists of data collected by the Jovian Infrared Auroral Mapper (JIRAM).

- Do you think there is a connection between **Figures 1** and **3**?
- If yes, what do you think that this might be?

Please, visit NASA's JPL website to find the solution and more information regarding Space, Cassini-Huygens, and Juno. Additionally, valid educational material on Physics and the flow of liquid or air masses will assist you in solving the puzzle.

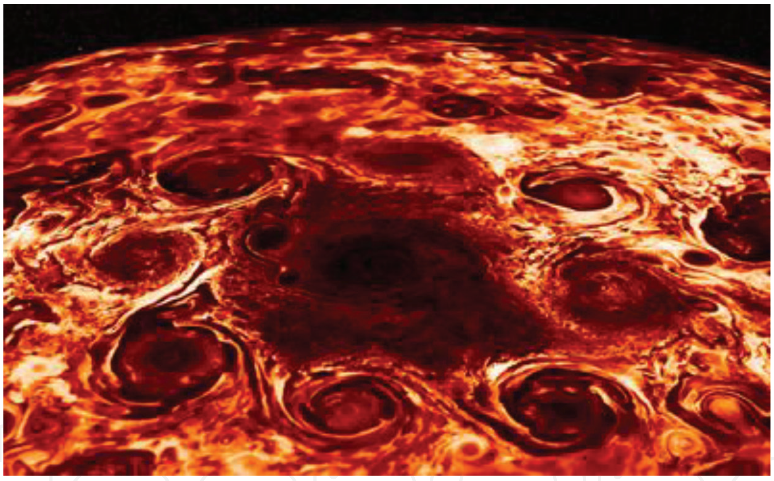

Figure 3. Cyclones encircle Jupiter's North Pole. Courtesy of JPL, NASA.

4. Conclusion

Space has always been intriguing people's imagination. However, space flight has only been feasible over the last 60 years. In this book, recent research results are presented in the areas of simulation, spacecraft navigation, propulsion, suborbital flight and seep-space operations. We hope this book will be advantageous to researchers and to also inspire the younger generations into pursuing studies and careers within the space industry.

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