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Psycho-Religious Experiences in Deep Space History: Astronaut's Latent Countermeasures for Human Risk Management

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Abstract: Current scientific developments have reached the stage where human aspirations of space exploration are not science fiction but a reality involving travelling to the Earth's orbit, the Moon and Mars. In the second half of the twentieth century, international space agencies (like NASA, European Space Agency, and Russia) witnessed the professional experiments of official and commercial space projects, gradually unveiling the universe's secrets. Astronautical research has predominantly been developed within the context of advanced materialism. The astronauts' physical health has been protected by the technology of space medicine, while the socio-cultural aspect of psychological well-being was less regarded. As space-travel time is getting longer and more solitary, the evaluation of the mental environment of the astronauts during space travel or in technical crisis is necessary. Also, can the private sphere of astronauts help the public sphere of space safety or security? When and how can religious behaviour (or psycho-religious potentiality) be effective in the space community of long-term missions? This paper explores the sacred experiences of past astronauts in the non-scientific aspects of fearlessness, courage, stability, and confidence. It argues a new hypothesis that while the space team can theoretically depend on the visual and systematic data of the latest information technology (IT) and artificial intelligence (AI), the success of deep space missions (including Mars exploration), in terms of human risk management, is not always irrelevant to the strength of individual spirituality as an internal countermeasure of self-positivity in absolute hope. Furthermore, this aspect can be proved in the case studies of the American Christians' willpower, Papal support, spontaneous Jewish astronauts, the institutional cooperation of the Russian Orthodox Church and its government, and the commitments of Asian and Islamic astronauts.

Keywords: astronauts; space; Mars; risk management; religious experience; security; countermeasure

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1. Introduction

A private pilot, Kenneth Arnold, claimed to see nine shiny unidentified flying objects over Mt. Rainier in the United States. The UFO sighting on June 24, 1947, was a crucial issue in the society of the 1950s [1,2]. Following this, the Sputnik project was the first artificial satellite to orbit Earth on October 4, 1957, for three months [3]. The leading nations of the Cold War promoted the development of space projects. There were around three hundred and thirty-three human orbital spaceflights from fourteen space programmes from the 1960s. The Vostok programme was a Soviet spaceflight project that competitively launched six spaceflights from 1961 to 1963 to send astronauts into the lower Earth's orbit for political and military situations. The United States launched Project Mercury as the first human spaceflight programme with six flights during the same period. The North American X-15, a hypersonic rocket-powered aircraft, was tested twice by the US Air Force and the National Aeronautics and Space Administration (NASA) as part of the X-plane series in 1963. The Voskhod space programme consisted of two one-day crewed missions in 1964

and 1965, while Project Gemini launched ten human spaceflights in 1965 and 1966, carrying ten crews and sixteen individual astronauts [4]. The Soviet Union continued the space project under the Soyuz programme, originally part of a Moon landing project that placed a cosmonaut on the Moon. Along with other mission objectives, they sent one hundred and forty-two spacecrafts from 1967 to the present. Although the Soviet Union's Luna 2 touched the surface of the Moon as the first human-made object on September 13, 1959, the US's Apollo 11 was the first crewed mission in space history to land on the Moon on July 20, 1969. There were numerous uncrewed landings between 1976 and 2013; however, Project Apollo carried the third United States' spaceflight, carrying eleven astronauts, including Neil Armstrong (Apollo 7), that landed on the Moon in 1969 [5,6].

The ambition of humanity to explore the Moon stopped due to the changes in international space politics. However, the space station movement emerged as an alternative policy. Skylab's first US space station operated the innovative project three times for about twenty-four weeks between May 1973 and February 1974, even though the third crew had no spare time for private recharge [4]. The Apollo–Soyuz Test Project (ASTP), the first crewed international space mission, launched in July 1975, was televised worldwide. The Space Shuttle programme launched one hundred and thirty-five space missions with five complete Space Shuttle orbiter vehicles from 1981 to 2011. China launched the China Manned Space Programme (Project 921) to enhance human spaceflight capabilities. The East Asian nation sent six spaceflights from 2003 to the present, even though Shenzhou 5 was the first human spaceflight [7,8]. The US's SpaceShipOne, a rocket-powered aircraft, completed its first private spaceflight with three humans in 2004. Virgin Galactic, a California-based commercial company, operated SpaceShipTwo as suborbital human spaceflights for space tourism, from 2018 [9]. SpaceX Dragon 2 was designed in 2020 as a partially reusable spacecraft for flights to the International Space Station (ISS). SpaceX performed commercial missions with non-professional astronauts, such as Inspiration4 and Axiom Mission 1, while Crew Dragon was a spacecraft capable of ferrying four crew members. The touristic cost for each seat was between USD 60–67 million. (For this, one might argue that the term "tourist" should only be used if there are no crew duties. However, everyone needs to have some kind of role at the beginning of commercial space flight tests).

Thus, scientists and engineers proved that technology can send humans to the unknown space from the second half of the twentieth century. Since then, human movement has become a significant research subject for space exploration, including colonising projects for the Moon (2025) and Mars (2033). The astronaut candidates were strictly selected within the conditions of excellent aviation career and good physical health by assessment and selection through the Behavioral Health and Performance Group (BHP) for NASA [10]. What about the psychological condition of the astronauts? How many astronauts would have a healthy mind before being appointed without internal wounds and a drug-, alcohol-, sexual-, or game-addiction background? If all of them were not atheists, was the religious consciousness positively beneficial for the security and risk management of space missions? While the rescue missions of the Soyuz MS-23 spacecraft for the stranded ISS astronauts (Roscosmos cosmonauts Sergei Prokopyev and Dmitry Petelin and NASA astronaut Frank Rubio) are on their way (20 February 2023), this paper explores the nature of spirituality by examining the expressions of past astronauts. It argues the critical insight that when space science and technology fail in their general operation, the psychological countermeasures of humans are not incompatible with the role of religion, especially in the personal sphere of mind control from fear, horror, emotion, uncertainty, insecurity and hopelessness. (The primary purpose of the article is not about the systematic interpretation of a philosophical or theological study on the subject of "space and human research". Rather, as a new hypothesis, it tries to explore and evaluate the psychological attitude of experienced astronauts from a non-scientific and non-medical perspective of deep space travel. The elements of religious behaviours, including the NOMA principle, prosocial character, meditation and spirituality, are considered in the contexts of mental health, risk management, stable space community, and the success of space missions.)

2. Interrelation of Science with Religion

The relationship between science and religion is an ongoing public discourse since the concept of the former (science) is more visible in modern society [11,12]. The character of each interprets the other one as odd. For space exploration, a scientific source is more relevant to achieve human ambitions. However, when one regards the value of human well-being, science has a limitation in not perfectly understanding the internal intellection of astronauts [13]. The personal sphere of human attitude is relevant for understanding the natural function of religion, while the space habitat design is considered per the astronaut's physiological needs [14]. It means that astronauts should trust scientific logistics, but their mental security in risk moments should not just depend on mechanical and medical technologies [15]. As a human instinct, the astronauts unofficially expect the hopeful presence of a divine being through the positive attitudes of comfort and assurance. Such a psychological mechanism would be desperate, especially when part of the Virgin mission project to Mars encounters "an extremely hostile environment for human life, including the lack of gravity (microgravity = weightlessness), high speed (about 24,600 mph = 39,600 kph), harmful radiation, isolation, and the absence of night and day" [16,17]. The language of science is based on data and actual figures for fact and reality, while the language of religion is "more akin to poetry" in which the virtuous value, dignity, and goals of humanity can be alternatively considered for courage and self-confidence [11].

Physicists Neils Bohr and Werner Heisenberg commonly support the perspective that religion and science do not need to be split into opposing realities [11]. As a case study between Japanese Buddhism and science, John W. Traphagan argues that "there is no inherent conflict between the two counterparts, largely because there is no philosophical or theological tension between the scientific and religious worldview" [11]. The NOMA (non-overlapping magisteria) principle takes the perspective that they do not impinge to each other but different domains of inquiry [18]. Further, the conflict between the two realms of human activity is viewed as a product of Western cultural traditions, for religion is based on faith, and science is based on reason. Such a view maintains a positive potentiality in the form of diversity for space research that can be applied beyond low Earth orbit and exploring other planets [13].

3. Sacred Expression of Astronauts during Space Exploration

During general operation, the professional staff of space central centres require technical data or descriptions from astronauts for the exact prognosis of project process. However, astronauts often experience psychological problems or stressors, such as cognitive skills, homesickness, monotony, confinement, altered cycles of light and darkness, unstable rest, vibrations and radiation (cosmic rays) [19–23]. The non-scientific expressions of astronauts indicate the need for personal comfort either for short-term or long-term travel because internal composure can be the metaphysical source of willpower, passion, responsibility and perseverance in an emergence. In this contact, Elisa Raffaella Ferrè and Gerhard F. Haupt argued the necessity of "adequate pre-flight psychological training and in-flight psychological support to minimise [human] risk" [16,23]. There are many cases where individual astronauts demonstrated their religious sentiments in the second half of the twentieth century, which often aligned with the success of missions or at least preventing emotional conflicts during spaceflight. A condition of positive emotionality is also demonstrated as a good sign for isolation and loneness [24].

According to Joshua Ambrosius and Deana L. Weibel, the Evangelicals kept a space pessimism, i.e., "lower expectations of future events [involving] space" [25,26], even though space knowledge, interest and policy support, increased during the Trump–Pence age [27]. Kendrick Oliver, in *To Touch the Face of God*: *The Sacred, the Profane, and the American Space Program, 1957–1975*, mentioned that the professional members of the test-pilot community did not have the mentality that philosophy is efficient. The trend was consistent among astronauts of Mercury projects, who did their college education in engineering. They were far away from the personal responses "to inquiries about the spiritual and philosophical

meaning of their voyages in space" [28]. For example, most of seven Mercury astronauts in 1959 had religious faith. However, Scott Carpenter responded "I don't call it (my religion) particularly associated with this project". Deke Slayton's response was similar, i.e., "I don't feel that any particular extra faith is called for in this programme over what we normally have" [28]. It was familiar to the idiomatic expression of Soviet cosmonauts that they could not find any divine entity, such as God, angels, or paradise of the heavens [29].

On the other hand, many astronauts from the mid-1960s shared individual experiences of religion during space travel. During the Moon mission, the NASA astronauts demonstrated different expressions of God, faith or divine universe during or after their space experience. The most intriguing event was the recitation of the first ten verses of Genesis depicting the scene of God's creation of the universe by the three astronauts of Apollo 8. At that time, Gene Kranz, an Apollo flight director at Houston was left with an impression demonstrating that "I felt the presence of creation and the Creator" [12,28]. Despite Madalyn Murray O'Hair's legal complaint, which became a hot controversy between space projects and religious freedom, the reading on Christmas Eve, 1968, (on Apollo 11) received over eight million letters of national and international support, from 1969 to 1975, to justify religious expression in space [28,30]. The personal sentiment of Wernher von Braun, NASA's master rocketeer and builder of the Saturn V, inspired the scientific and technical community: "Astronomy and space exploration are teaching us that the good Lord is a much greater Lord, and Master of a greater kingdom" [31]. The official expression by Pope Paul VI, geared to the space achievement, suggested that the Moon landing was interpreted as "the ecstasy of this prophetic day" [31].

The celebration of communion on the Moon was initiated by Edwin E. Buzz Aldrin and his colleagues on Apollo 11 (Figure 1) [28]. The astronaut on his way back to the Earth quoted the scripture of Psalm 8: 3–4 as a symbolic aspect of their mission: "When I consider your heavens, the work of your fingers, the moon and the stars, which you have set in place, what is mankind that you are mindful of them, human beings that you care for them?" Charles Reagan Wilson claimed that Aldrin, a church elder, and Sunday school teacher, was a de facto religious representative even though the Church did not have any official role in the Apollo 11 voyage [12].

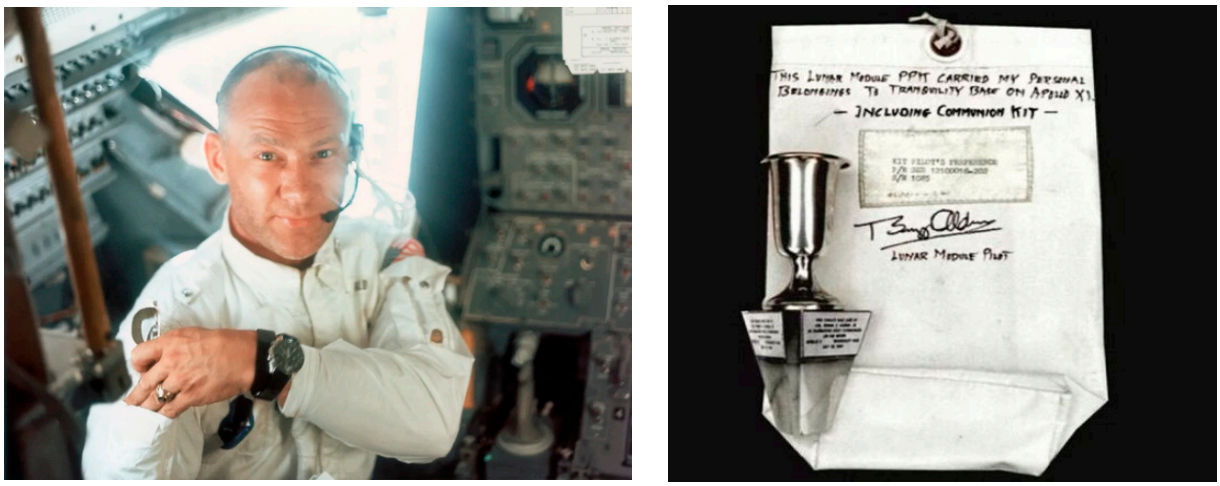

Figure 1. Buzz Aldrin holding communion elements in 1969, public domain.

Edgar Mitchell (1930–2016), a lunar module pilot of Apollo 14, officially described that "there is a sense of unreality here, with the absence of gravity and the tapestry of blackness broken only by an overwhelming glitter of stars that surrounded our craft" [32]. His non-scientific explanation was more specific in another statement that "the presence of divinity became almost palpable, and I knew that life in the universe was not just an accident based on random processes. The knowledge came to me directly" [26]. Mitchell brought one hundred microfilm Bibles—the entire King James Version—to the surface of

the Moon, but they returned to Earth with him. Jim Irwin (1930–1991), after the Apollo 15 mission, said that his Moon mission was a time of personal experience of having confidence in God. The narrative was that the moonwalker had a mechanical problem on the lunar surface in August 1971. Although the astronaut could have contacted the Houston centre for assistance, he decided to pray and experienced the solution in a flash: "I felt the power of God as I'd never felt it before" [31]. The sacred sentiment was not reported scientifically, but the mystical experience in his mind was of religious confidence.

Jeffrey N. Williams (1958–) in *The Work of His Hands: A View of God's Creation from Space*, confessed his sense of God's presence and his joy from outside the boundaries of the Earth, that may approximate to God's own perspective: "The significance of redemptive history recorded in the Bible was brought to mind when I could see, in a single panorama, the entire area in which it took place. All of that history, . . . was, in a sense, made visible in a fresh, tangible way when the biblical lands were in view out the window" [33]. Such psycho-religious experiences do not prove the increase in the success rate of space missions. However, the sacred mechanism of astronauts reflected the internal stability in the space community, which would be useful for human well-being research. Ihle, Ritsher, and Kanas presumed that the spaceflight experiences could bring positive psychological outcomes but they did not suggest any method to improve mental health for long-duration space mission [34].

4. Psychological Security and Religious Attitude in Human Risk Management

The space life of astronauts is dissimilar to that of earthly people, but, according to a NASA 2004 report, their weekday is composed of 15 h and 30 min for mission tasks that they start from approximately 6 AM to 9:30 PM (Greenwich Mean Time). The daily schedule includes three mealtimes and 2.5 h of physical exercise to maintain muscle tone and fitness [17]. They typically work 6.5 h, while 8.5 h are allotted for sleeping. The 24-h routine is filled up with the elements of work and sleep. They maintain a regular pattern of five and a half working days and 1.5 days off. Astronauts have private time or unofficial social gatherings on free evenings and weekends for the well-being of the space community. NASA also recognised the importance of the non-scientific sphere of personal recharge in the statement of human health that "Fun [time] is an essential ingredient to the quality of life" [35]. How do astronauts spend their spare time before the next workday? On top of contacting family, watching movies, Netflix, hobbies (reading books), exergames, music, and extra sleep, what would they do? What about the religious devotion (reading scriptures, koinonia fellowship, listening to gospel songs, meditation (prayer), or seasonal celebrations: Easter and Christmas)? This paper, in terms of the study of the so-called "Antonovsky-salutogenesis" [36,37], attempted to prove a new insight that while the recreational activities are conducted in a sphere of individual welfare and physiological security, the sacred behaviour of astronauts, which cannot be proven via scientific data, increases the communal vitality, enjoyment, and hope for accomplishing a successful mission.

Throughout the 1980s, space history included the religious diversity of astronauts as the cooperation projects of the US and the Soviet Union (Russia) were implemented with space agencies from Europe, India, China, Iran, Ukraine and Israel. Astronauts involved in commercial projects have also emerged in the last two decades. The multicultural space community initiated the international space projects with different gender experts (male and female) and dissimilar ethnic groups. Also, there were many atheists among the astronauts that were pilots, scientists, engineers, or commercial civilians (space tour or special participants). Nevertheless, one cannot also deny the groups of people with personal belief coming from diverse religious backgrounds, like Protestantism, Roman Catholicism, Judaism, Russian Orthodoxy, Islam, Buddhism, and Hinduism. The abstract, ideological, or subjective responses of these space men and women do not become the scientific sources in the decision-making procedure. However, personal religiosity (positiveness, solicitude, self-sacrifice, endurance, courage, and optimistic hope), is profitable for maintaining the

psychological security of the space community, especially when the technical systems fail. Thus, the subject of "spiritual change" has been a scientific concern for NASA and the Association of Space Explorers (ASE) for Human Behaviour Research [38]. A quantitative content analysis of three female astronauts and seven male astronauts, according to *Space Memoirs: Value Hierarchies before and after Missions*, demonstrated that "transcendence (a combination of Spirituality and Universality) rose dramatically after spaceflight" [39].

4.1. American Christian Astronauts

Although the American Protestant religion (as mentioned with Evangelicals) used to hesitate over the NASA space programme, the socio-cultural landscape of "the public pessimism and cynicism" has been progressively transformed [40]. Edward White II (1930–1967) of the *Gemini IV* project carried a Star of David, a goal crucifix and a Saint Christopher medal on his first space walk on 3 June 1965: "I had great faith in myself, and also I think that I had a great faith in my God. So the reason I took these symbols was that . . . this was the most important thing I had going for me" [41]. Gus Grissom and Roger B. Chaffee of Apollo 1 initiated the practice of taking the Bible to the Moon. Unfortunately, all crew members of the first Moon mission were killed during a launch rehearsal test in January 1967. Since Apollo astronauts were allowed to bring personal items with weight restrictions, the Christian canon (a small red-leather Bible), provided by the St Christopher Episcopal Church in League City, Texas, was taken to the Moon by David R. Scott of Apollo 15. It was left there in 1971 [42]. The cultural and ethnic backgrounds of all religious members of the Apollo projects were white American Christian males [41]. The central NASA policy did not officially recognise or encourage religious behaviour. Nonetheless, it was productive in creating human historical evidence and the cognitive accomplishment of astronauts, eliminating insecure emotions of fear, uncertainty, frustration, or conflict. Common psychiatric disorders, including personality disorder, psychosis, bipolar disorder, neurosis, depression, and anxiety, would harm the central nervous system (CNS) [43,44], but the sacred mind of positive hope could reduce the potential risk elements among the members of the space community.

The Christian ethos of the space programme that began from *Project Adam* (the world's first human-crewed spaceflight, in 1958, unfortunately not implemented) and Project Mercury (1958–1963), before the Apollo projects, was continued by William R. Lucas, the director of the Huntsville space centre, in the 1970s, as he was a lay reader in a Baptist Church and an invited speaker of the Billy Graham crusade [45]. While the Chapel of astronauts was established in the same era, Jerry Klumas maintained that many professional members (staff, engineers and scientists) of the Kennedy Space Centre and the Johnson Space Centre were part of the NASA Christian community: "The Christian community at NASA is not a minority; it is very significant, and NASA people are outspoken about being Christians" [45]. Bringing a Bible to space was repeated by Shannon Lucid, the daughter of missionaries on the *Mir* space station, in 1996. Jonathan D. Cohen proved the legal perception that possessing personal religious items in space is not a violation of the *Establishment Clause*, which prohibits religious abuse of government and political control of religion. The tenets of the *Free Exercise Clause* protect the right of private religious displays in the personal space of the space community [30].

As Rick Husband was involved in the Advanced Projects of the Crew Return Vehicle (CRV) returning to the Moon and traveling to Mars, he travelled into space twice by the STS–96 (1999) and STS–107 missions (2003). Unfortunately, when Space Shuttle *Columbia*, a Space Shuttle orbiter, failed to re-enter the atmosphere over Texas, all seven astronauts, including Husband passed away. However, his legacy of personal belief was carried on in his testimonies. Before his space flight, the commander of the final mission of Columbia cited Psalm 37: 4 in a speech at his local Houston church (Grace Community Church). He was fully confident about his mission and said that "If I ended up at the end of my life having been an astronaut but having sacrificed my family along the way, or living my life in a way that didn't glorify God, then I would look back on it with great regret

and having become an astronaut would not really have mattered all that much" [46]. The personal expression of Michael Anderson, a crew member of the Space Shuttle Columbia, who attended the same religious community, revealed the perspective of religiosity that became a psychological anchor in space risk management; "Rick and I (Anderson) both know we were put on this shuttle together for a reason, and we've tried to meet all [our] challenges with prayer, and God's been very good in answering our prayers" [46].

Regarding the notion of divine confidence, David Yonggi Cho (1936–2021), a close colleague of Billy Graham (1918–2018) and the leader of the biggest Protestant church in the world (the Yoido Full Gospel Church with over 750,000 members), taught a practical module of faith to experience their dream in reality [47]. For solving problems, s/he should first draw a picture of hope in mind and set a purpose: "Now faith is confidence in what we hope for and assurance about what we do not see" (NIV Hebrews 11:1). Through prayer, s/he should have a positive assurance in herself/himself without doubts: "Therefore I tell you, whatever you ask for in prayer, believe that you have received it, and it will be yours" (Mark 11:24). Finally, s/he should creatively conduct related efforts until the wish becomes a reality without giving up. NASA does not legally have to provide specific religious environments (time and space) as they have full right to select astronaut candidates based on the personal abilities and professional skills for their planned tasks. The astronauts on the International Space Station (ISS) also generally have a long walking-hours-a-day schedule, which does not give them much private time [30]. However, it does not mean that a private environment is not guaranteed in a personal sphere of space life. The initial activities of space tourism have been launched by commercial organisations, such as *SpaceX* in the 21st century (2020) [48]. As space tourism gradually becomes a reality for ordinary space flight participants, Deana L. Weibel even argues that "space exploration [could, under some circumstances, be interpreted] as a form of pilgrimage [to experience mystical universe]" [32].

4.2. Roman Catholic Astronauts

The Catholic Church has had its own observatory since the 16th century. The space policy of the papacy that originated from Pope Leo XII's astronomical observatory (*Specola Vaticana*) in 1891 was established based on the traditional concept that space exploration is a way of coming closer to the Creator [48]. The Catholic Church's support of astronomical science was continued by Popes Pius XI and Pius XII, who considered astronomy as "a profound act of worship: a route to a deeply personal encounter with the Creator" [48]. Pope John Paul II, in the 1980s, confirmed the philosophy of the previous Popes that scientific enterprise as an activity is parallel and equal to the work of theology [48]. For Pope Francis, astronomy was an internal part of the human purpose if one reads his 2016 saying: "Scientific research . . . can, and should be a source of deep joy . . . through us, this universe can become aware of itself and of its Maker. This is the gift and responsibility given to us as rational creatures in this cosmos" [48]. Guy Consolmagno claimed that early papal pronouncements used to be limited to prayers for the safety of the astronauts, including Pope Paul VI's message [49] to the Apollo 11 astronauts (20 July 1969) and over the Apollo 13 astronauts (15 April 1970): "[for conquerors of the moon], glory to God in the highest and peace on Earth to men of good will" [12]. Pope John Paul II promoted how space exploration impacted humankind in 1984, in that "the benefits of space travel would be made available to the benefits of all [humankind]" [48]. Afterward, a space suit was presented to the Pope by six Russian cosmonauts in 1988. Such mental support from the Roman Pope was demonstrated in a creative statement of "chapel on the moon" that "I encourage the building of the chapel-house on the moon" [49]. Pope Benedict XVI had a personal dialogue with twelve astronauts at the International Space Station (ISS) in 2011:

> **Pope—** "when you are contemplating Earth from up there, do you ever wonder about the way nations and people live together down here, about how science can contribute to the cause of peace".

> **Kelly—** " . . . because the space station is run entirely on limitless solar power, better development of that technology could reduce the struggle over energy resources—A cause of much violence and war in the world" [50].

The Apostolic Nunciature to the UN supported the accessibility and use of space and the use of the space economy for the benefit of all people [50]. Pope Francis, in a dialogue with the ISS crew, stated Outer Space as (Figure 2) "our common home, our common good, a gift for the enjoyment of all humanity" [50]. The policy of the Vatican did not directly support the plan of sending a crewed spaceflight to the Moon or Mars; nevertheless, Catholic astronauts individually carried on their religious behaviour if one analyses their psychological experiences. For example, astronauts took the Blessed Sacrament and conducted the voluntary ritual of the Eucharist in space. Especially, three Catholics received the rite on Space Shuttle Mission STS–59 (Space Transportation System) in April 1994 [51]. Sidney M. Gutierrez, Kevin P. Chilton and Thomas D. Jones gathered on Sunday on the flight deck during private time. The Koinonia (κοινωνία) fellowship and prayer time were followed by a short communion service [52]. One of them, Chilton, pilot of *Endeavour*, managed the Blessed Sacrament [53]. Jones (first spaceflight) confessed his religious experience and mental security in space life:

> I thanked God each night before falling asleep for these glorious views of Earth and for the success of our mission thus far. I asked for the continued safety of our crew and a joyful reunion with our families. I was conscious of the special gift of each day in space, aware of the unique privilege I had been granted. And I remembered Father Tom Bevan's words on the beach back in Florida [53].

> Jones, who experienced four Space Shuttle flights, shared his feeling that "Endeavour was rolled nearly upside down to aim its radars at Earth. What a privilege to work there for 12 h each day! . . . , I couldn't help but marvel at the infinite power behind its creation" [52]. In this regard, *Sky Walking: An Astronaut's Memoir* examined the interrelation between religion and mental health confidence, showing that the Catholic Jones maintained an optimistic outlook which was based on this faith [53] and that he took "solace in believing that his father and grandparents are going to relay his prayers directly to God" [54].

Figure 2. Pope Francis talking with the six astronauts at the ISS in 2017 © AFP/Getty.

Heidemarie Stefanyshyn-Piper, involved in the project of the ISS's assembly, especially, in expanding the station's living quarters (2006), was asked a question, "does not science conflict with your faith?" Her spontaneous response was positive in a harmonious concept

between science and religion that "the core of what I believe is that we are put here on Earth by God . . . .we [through science and technology] are learning more and more about the universe from satellites and telescopes, but none of that negates the fact that there is a God" [55]. Further, the experience of Michael Hopkins, who performed the Eucharist weekly on the ISS during his twenty-four weeks stay in 2013, was another non-scientific testimony in which the astronaut could secure mental peace, liveliness and self-confidence [51].

4.3. Jewish Astronauts

Unlike the connection of Catholics with Rome, the Jewish astronauts did not have a direct influence on the leadership of the religious organisation during their space mission. Instead, the religiosity of Judaism was formed based on personal dedication, which was crucial to the private sphere of space community life. There were approximately nineteen Jewish astronauts from 1969, even though they had different nationalities. Among them, Boris Valentinovich Volynov was the first Russian cosmonaut with two space journeys in the Soyuz programme: Soyuz 5 and Soyuz 21 [56,57]. For Jews, the Jewish New Year, Rosh Hashanah (or Yom Teruah), is an important date they remember as the first of the Jewish High Holy Days. The day mentioned in the book of Leviticus (23:23–25) is around the late summer/early autumn of the Northern Hemisphere or the late winter/early spring of the Southern Hemisphere. Jewish astronauts celebrated New Year's day in the Russian Mir space station.

Meanwhile, J. Hoffman took various symbolic objects to observe Jewish holidays, including a mezuzah on his bunk on the Discovery (Figure 3). Between 1985 and 1996, the Jewish astronaut carried much other paraphernalia, such as a yad, menorahs, Torah scroll, dreidel, Torah breastplate, hand-woven tallit and kiddush cups [51,58]. He also read and meditated upon the first line from B'reshit (Genesis 1), stating that "God created the heavens and the earth," while the religious possessions of many astronauts, according to Donald H. Harrison, were a big deal in space [30,56]: "There were several dreidels I took up, one from the synagogue. I also took a mezuzah (donated to the Jewish Museum in New York), a Torah, both tallits from my two sons from their bar mitzvah, and a menorah" [58]. Rabbi Osadchey, who was Hoffman's spiritual leader, also mentioned that Jewish law allows the sacred possessions of astronauts even on other planets, including Mars [58].

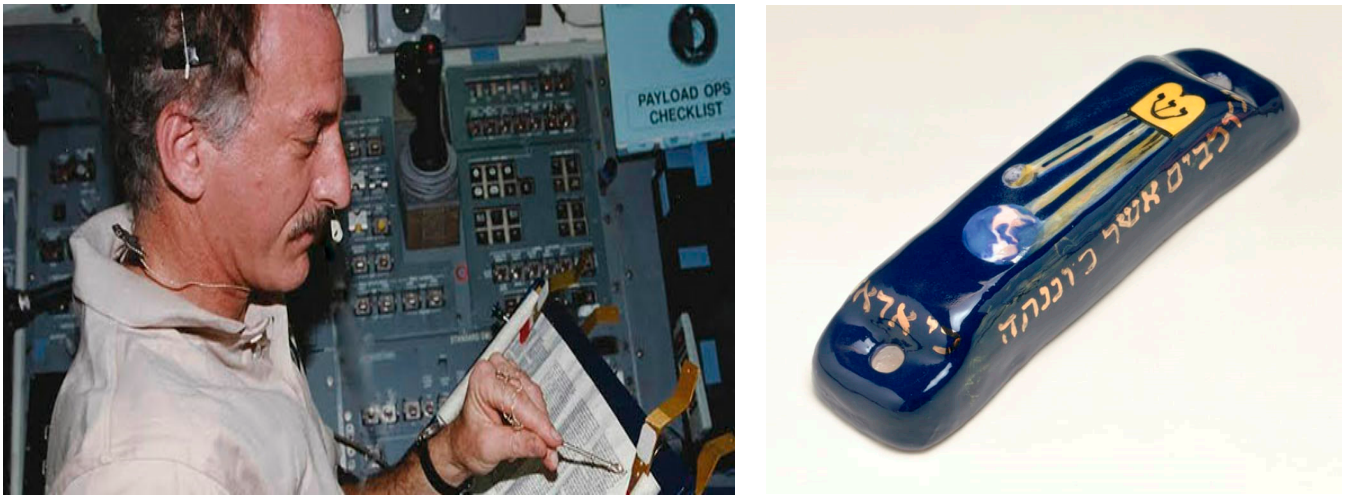

Figure 3. Torah and Mezuzah, taken by Hoffman, public domain.

Judith Resnik (USA) was a female Jewish astronaut, while Ilan Ramon (Israel) travelled with a microfilm Torah on the Space Shuttle *Columbia* (2003) [49,51,59]. He even asked his local Rabbi Zvi Konikov for guidance on the Sabbath and kosher food in space life [60]. Canadian Steve MacLean was the same, keeping a Torah on the ISS in 2006. Gregory

Chamitoff, a Jewish family of Russian origin, carried a pair of mezuzot in 2008; he believed that the sacred object would remind him of his home and identity in terms of willpower and self-courage during the space project [60].

David Wolf, who achieved four space missions from 1993 to 2009, not only took a mezuzah (=klaf) which is a piece of parchment inscribed with scriptures of the Torah, but also carried the combined prayers of his family congregation [61,62]: "we Jewish astronauts do consider ourselves as representing the Jewish community. We take it seriously. I carried a mezuzah, and it is on my door now" [63]. Under NASA's permission, this personal belief encouraged him to fly on the spacecraft Atlantis to Russia's Mir space station, celebrating Rosh Hashanah, Yom Kippur and Chanukah [63]. During the COVID–19 pandemic, Jessica Meir, who was spiritually robust and influential, encouraged the people on Earth with advice on how to stay mentally healthy in isolation for psychological sustainability [63]. The illustration of the female Jewish astronaut implies an advanced character of religious fortitude as a countermeasure against a unique environment.

4.4. Russian Orthodox Cosmonauts

The Russian cosmonauts indicated there was a cultural–scientific collaboration between the state and religion from around the 2000s. In this regard, during the space race of the Cold War, Gherman Titov, the second Soviet cosmonaut, stated that he did not witness God or angels through his seventeen Earth orbit experiences in 1962: "the rocket was made by our people. . . . I believe in man, his strength, his possibilities and his reason" [63]. The counter-religious announcement of the space man was a critical issue as there was an ideological war between science and religion in the Soviet State. The predominant environment of space military, industrialisation and political bureaucratisation confronted the socio-cultural transformation of a counter strategy when the period of space travel was getting longer and more solitary. The relationship between the spiritual and material became compatible for security, peace and hope in the space community. Gherman Titov eventually confessed his conviction with the suggestion that:

> I, like all my cosmonaut friends, grew up in our socialist reality and studied in our Soviet schools. [but, now] I have a bible in my library, [and] this is why we discussed whether cosmonauts, in the course of their studies and training, should somehow be informed a little about this god and religion business [64].

The close interactions of cosmonauts with the Russian Orthodox Church were demonstrated in the material culture of icons at the International Space Station (ISS). The cosmonauts placed religious icons in certain areas of the spaceship as designated sacred spaces beyond the space station walls [65]. Since the low Earth orbit space stations of the Salyut programme (Salyut 5, 6, 7 from 1976), *Mir* (from 1986 to 2001) and Zvezda (from 2000), there was the continuation of displaying divine images as expressions of their faith, either personal or institutional [65]. Salmond, Walsh and Gorman defined such a space-social phenomenon as an example of "heterotopic practice" in which cosmonauts maintained the behaviour of travelling with icons, displayed them in private or common spaces for the members of the space community and brought the theme back home [65].

For instance, two print icons of Saint Anastasia, with the Patriarch's blessing, were delivered to the *Mir* station in 1995 as part of "Project Anastasia—The Hope of Peace" [65]. Vasil Tsibliev took a small icon of St. Nicholas to both Mir–22 (1996) and Mir–23 (1997). The sacred images of Gagarin and Tsiolkovsky were also placed in the space station in 1998. For the first Expedition (a crew team), icons were displayed on the aft wall of the Zvezda module. Those icons included Saint Theodor of Tiron, the gilt Orthodox cross, the Mother of God with Child, Christ Pantocrator and Saint Sergius of Radonezh. Although Zvezda was not designed for the icon display, Yuri Gidzenko enjoyed the decoration of the icons, copies of the New Testament and a cathedral painting of the Troitse-Sergieva Lavra [65]. Unlike US NASA, when the Russian Orthodox Church cooperated with their government for space projects, bringing icons into space became more visible and official from 2004 [65]. In this way, the display of Russian icons was interpreted as the crew's choice, implying

their religio-cultural traditions and the social freedom of the post-Soviet society [65]. The Soyuz TMA–5 received a copy of the Kazan icon and an icon of the Archangel Michael sent by Anatoly Nikolayevich Perminov, the general director of Russian Federal Space Agency (2004–2011) (Figure 4): "the icons of the Kazan Mother of God and the Archangel Michael ... will come to reflect the combination of traditional spiritual symbols and contemporary achievements in the field of space exploration" [65].

Figure 4. The image of the Kazan Mother of God in the space station (Soyuz TMA–16), public domain [65].

Sergei Krikalev circled more than one thousand times on the ISS with his icon of the Valaam Mother of God, to which miracle-working powers were attributed by an Orthodox monastery of Valaam Island [65]. Their testimony explained that when the crew survived a sudden drop in air pressure and the icon returned to Earth, its colour was perceived to have grown brighter [65]. The institutional support of spirituality for Russian cosmonauts was continuously developed if one checks the fact that Father Iov Talats of the Transfiguration Cathedral became a spiritual mentor of cosmonauts from 2007, including Fedor Yurchikhin, Alexander Samokutiaev, Valery Korzun and Pavel Popovich [65]. There is no certain scientific record of its advantage, but also there is no negative feedback about the mentorship programme of the space community. The veteran cosmonauts expressed the feeling of an increase in their spirituality for self-direction and personal values [66].

Meanwhile, Maksim Suraev personally possessed a cross and a relic of the True Cross given by Father Iov in 2009. Aleksandr Kaleri carried three identical silver icons of the Kazan Mother of God in 2011 [66]. "Russian Orthodox cosmonauts also celebrated Christmas on the ISS in the same year as they had the day off" [67]. Another narrative is that Yuri Lonchakov autonomously kept three sets of identical colour-printed images of Saint Nicholas and other selected saints in 2013 [65]. Further, "an Orthodox priest was invited to bless crew members (Scott Kelly, Russian Mikhail Kornienko and Gennady Padalka) and the Soyuz rocket in Kazakhstan in 2015" [51]. Thus, the relationship between science and religion was not hostile. Rather, the Russian government and Orthodox Church performed a mutual interchange for the space project despite not all cosmonauts being interested in

divine culture. The internal well-being of cosmonauts was systemically guided with the support of national religion, while the state agency operated the technical systems.

4.5. Asian and Islamic Astronauts

The last three decades of space history have seen the involvement of various ethnic people from oriental and Islamic backgrounds. The cross-cultural transnationalism of society became a general phenomenon of space projects. All astronauts were experts in their field of professionalism. Many were atheistic in term of interpreting space; however, it does not disprove the spiritual expression of Buddhism, Hinduism, and Islam in the space community. In this regard, Ellison Onizuka, active in the Young Buddhist Association from the Kona Hongwanji Temple, Hawaii, wore a medallion with the Japanese Jodo Shinshu crest during his space flight on the Discovery mission (Figure 5: the left person) [68]. He was the first Hawaiian, Japanese-American, and Buddhist astronaut: "[in a dialogue with his friend], you're really aware that you're on top of a monster, you're totally at the mercy of the vehicle." The personal expression of Onizuka is related to Chang and Kwan's security or confidence concept of internal ethnic identity, which represents "a sense of attachment and a feeling of belonging that sustain group membership" of the Japanese-Hawaiian American Buddhist community [69].

Figure 5. Ellison Onizuka, Japanese American Pacific Islander and Sunita Williams, an Indian American, public domain.

Kalpana Chawla was the first Indian woman to go into space (Figure 5: the right person). Her first mission was with the Space Shuttle Columbia flight STS–87 for fifteen days and 16 h [70]. The seven Columbia crew members had different faith traditions: Kalpana Chawla (Hindu), William McCool (Catholic), Ilan Ramon (Jewish), Rick Husband (Christian), Laurel Clark (Unitarian), David Brown (Episcopalian) and Michael Anderson (Baptist). Chawla, a pantheist, was interviewed in 1998, saying that "The first view of the Earth is magical. . . . in such a small planet, with such a small ribbon of life, so much goes on. It is as if the whole place is sacred. You get the feeling that I need to work extraordinarily hard with other human beings to respect that" [71]. During her shuttle flight, the vegetarian female astronaut requested a Ravi Shankar raga (North Indian Hindustani classical music) to be played for mental stability and tranquillity in keeping the belief of Sikh heritage [72]. After Chawla died in the Space Shuttle Columbia disaster (2003), Sunita Williams, of Hindu origin, possessed a personal copy of the Bhagavad Gita (a part of the epic *Mahabharata*) on the ISS in 2006, along with a picture of Om (a sacred spiritual symbol) and Upanishads (late Vedic Sanskrit texts) in 2012 [51]. When the Indian Space Research Organisation (ISRO) launched a PSLV–C51 rocket, another Secure Digital (SD) card version of the Bhagavad

Gita was sent into space in February 2021 [72]. Although there were no public announcements, astronauts, in a personal sphere, promoted religion as a divine strength to sustain their vitality.

The non-scientific support for the success of space missions would be evident if Islamic astronauts' official or individual expressions from the Middle East, Africa and Asia were analysed. The practice of religious worship requires routine attention in which they pray five time in a day facing toward Mecca [73]. There were eleven Muslim astronauts from nine countries, including a female: Syria, the Soviet Union, Azerbaijan, Saudi Arabia, Kyrgyzstan, the US, Kazakhstan, Malaysia, Afghanistan, and United Arab Emirates [51]. Sultan bin Salman bin Abdul-Aziz Al Saud, the first Islamic astronaut from Saudi Arabia in 1985, "made his accommodations to his religion," bringing a small Koran with his mother's written prayer [73]. While Musa Khiramanovich, the first Soviet Islamic cosmonaut, who spent five hundred and seventy-four days in space, along with Salizhan Shakirovich Sharipov (Soviet-raised Islamic cosmonauts), disregarded special accommodations or activities, including Ramadan. Anousheh Ansari, the first female Muslim from the US took the 2006 Soyuz mission of Soyuz TMA–9. The experience of the Iranian-born astronaut was unveiled in an interview in which she saw the complementary character of science with religion: "I [Ansari] think they are very complementary. When I look at the universe, I see a delicate balance and it helps to strengthen my spirituality" [73].

In the Mars simulation HI-SEAS mission IV, six volunteers, between 25 and 36 years of age, simulated a one-year period of staying in a Mars-type environment (on the Mauna Loa volcano on Hawaii Island), considering the community abilities of motivation, well-being, competence, relationships with colleagues and family at home, autonomy, interactions with mission control, and performance. The outcome of the scientific experiment related to the decreases or fluctuations in autonomy and interactive skills. Goemaere, Caelenberg, Beyers and Binsted found that these socio-community phenomena could be improved by positive psychological variations in happiness, self-endorsed motivation, cooperation and performance. For them, technology was interpreted as "the lowest common denominator" [74]. In the context, Sheikh Muszaphar Shukor used the "Guidelines for Performing Islamic Rites (*Ibadah*)" at the ISS in 2007, designed not by the Malaysian National Space Agency (MNSA: Agensi Angkasa Negara) but by its Department of Islamic Development (JAKIM: Jabatan Kemajuan Islam Malaysia) under the Angkasawan program (of Soyuz TMA–11): "[in an interview before his space flight] I am not sure how it would be done, but I will share my experiences [with] all the Muslims all over the world . . . ." [75]. The practical regulations provided support with the daily prayer method in a low-gravity environment, finding the direction of Mecca from the space station, attitude, ritual washing, diet, limited foods (pork and alcohol) and Ramadan on a 90-min day–night cycle (low Earth orbit) [76]. It did not seem easy to obey all the guidelines after conducting official space duties. However, the Malaysian cosmonaut personally fasted and celebrated *Eid al-Fitr* (the Festival of Sweets) at the space station by sharing cookies with his colleagues to mark the end of Ramadan [73]. His mission was successful under such religious happiness and motivation. As such, UK's first Muslim astronaut candidate, Hussain Manawer, through his training experience of the XCOR Lynx commercial spacecraft (though not eventually launched), empathised on the importance of mental health: "It's good for people to see the positive side of a religion that gets missed a lot" [77].

5. Conclusions

Space history shows that about five hundred and seventy people have been in space since the 1950s [51]. Among them, the NASA Astronaut Corps once mentioned that there were forty-one active astronauts: twenty-five males (61.0%) and sixteen females (39.0%) in December 2022 [76]. The number was even higher, one hundred and forty-nine in 2000. Regarding space well-being and welfare, the astronauts were given privacy (having a personal space and time) during their mission [77]. Not everyone was interested in sacred behaviour, but certain people considered the prosocial role and value of religious comfort

and hope in challenging moments. While much previous research pointed out the psychological issues of space exploration without specific solutions, this paper demonstrated the psycho-religious experiences of astronauts as latent countermeasures of human risk management in the sphere of personal life in the space community. The sacred expressions indirectly reflected the less anxious status of the human mind [17]. The uncertainty of the mission operation was supported by the assurance of personal spiritualty. The paper does not provide actual data evidence for the non-scientific ripple effect of astronauts' religiosity. However, it proves that the space agencies of NASA, Russia and other nations did not ignore the divine nature of religion, the final bastion for the team to overcome technological failures. The approach can be applied, particularly for long-term astronauts for Moon inhabitancy and Mars exploration (2.5–3 years). The chance of miracles may not be irrelevant for the perseverance of absolute hope. If keeping astronauts mentally healthy is one of the key strategies for a mission's success, one cannot deny the privacy of religious behaviour that affects psychological health in a community environment [17].

The testimony of American Christian astronauts in the Apollo programmes' case studies give a good illustration regarding mental security. They spontaneously conducted the religious rituals of communion, payers, Christmas celebrations, and reading the Bible. The behaviours of Protestantism were connected with the internal happiness and satisfaction of each astronaut. The passionate support of the past and current popes, including Pope Francis, formed the scientific policy of the Roman Catholic Church. The astronauts were encouraged and gained spiritual energy, which became the anchor of their mentality during the space mission. The Jewish community headquarters did not systematically mentor the astronauts' space life, but individuals carried sacred items into space for their own benefits. Especially, J. Hoffman demonstrated his religiosity between 1985 and 1996 by keeping various elements of worship and prayer. The Russian space project involved an interactive relationship between the government (state) and the Orthodox Church (religion). Their institutional cooperation over the space projects officially recognised religious behaviour, where the Church publicly provided sacred icons and images to their cosmonauts. The involvement was the symbolic announcement of religious freedom in space, while it indirectly testified to the natural profit of space security or an environment of well-being for the space community.

Although the number of Buddhist and Hindu astronauts was fewer than other groups, the personal dedication of Asian astronauts became a source of cultural pride to the ethnic supporters. The behaviour of the Islamic astronauts was complicated by their religious activities under the official guidelines. Nevertheless, in many cases, it did not cause any trouble for the regular operation of a space mission. Instead, they believed in the physiological advantages which aided their minds in risk management. Thus, this paper was not about a philosophical approach of "space and human research" but hypothesised that as space-travel time exhibited a long-term prospect for Moon habitation projects (2025–2030) and the colonisation of Mars (2033–2040), the psychiatric well-being of astronauts should be considered at the top of the list for physical assistance with space medicine (drug and therapy) [17]. If past astronauts' psycho-religious experiences (canonical texts, private services, casual fellowship (with therapeutic recreations), sacred music and meditation (prayer)) did not have a negative impact, it would be economical to regard the prosocial nature of personal spirituality alongside advanced entertainment systems (exergames within VR/AR), Netflix, (AI) pets and private hobbies (reading, simple sports, and drawing) [78,79]. An astronaut's attitudes of positivity, confidence, assurance, and trust, that are the socio-cultural elements of religious psychiatry, should not be underestimated as a mental tonic for communal sustainability during long-term space exploration [51,80–92].

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