

A Legal Perspective on Career Limitations upon Female Astronauts Due to Cosmic Radiation Exposure

Sami Mehmeti, Stefani Stojchevska

Abstract

Triggered by the contemporary assumption that female astronauts are facing a manifestation of gender-based discrimination regarding career options due to NASA's strict cosmic radiation exposure limit restrictions, the main purpose of this paper is to analyze the legal perspective of this issue through labor principles of opportunity and health. By recognizing galactic cosmic rays as a special type of radiation exposure naturally occurring within the astronaut's working environment, it is questioned whether such a severe health threat deserves to be used as a justification for labor discrimination. While examining the legal status of astronauts in labor relations may contribute in realizing the importance of an astronaut's profession as an individual as well as for the benefit of mankind, the capacities that space agencies, as employers, have in order to fulfill their obligation of eliminating health risks originating from cosmic radiation and solar storms, can be further examined in order to find out if this spaceflight opportunity limitation is just another well hidden demonstration of gender-based discrimination, mainly through the following determinants: 1) Duration of the space mission, and 2) Position of the space object. Also, given the fact that the notion of "outer space labor law" is still nonexistent, this paper additionally emphasizes the need for the establishment of international standards concerning protection

Dr.Sc. Sami MEHMETI, MA. Stefani STOJCHEVSKA

against cosmic radiation, in order for astronauts, irrelevant of their nationality, to receive equal health protection measures, as subjects to labor relations.

Keywords: labor law; cosmic radiation; discrimination; astronauts; space agencies;

1. Introduction

Certain factors such as nationality, race or gender represent characteristics of employees that can be classified as a base for differentiation of workers and thus, for labor discrimination. Kenneth Arrow defines labor discrimination by which *“personal characteristics of the worker that are unrelated to productivity are also valued on the market”*. (Arrow, 1971: 1)

Although labor discrimination should be a problem of the past, it still represents a significant issue for the majority of employees. Most forms of labor discrimination are very straight forward, while others are not so obvious. One of them is the recently supposed discrimination of female astronauts regarding space radiation concerns. This contemporary dilemma of whether female astronauts are facing a form of discrimination or health protection, viewed by aspects of labor law principles of health and opportunity, needs to be analyzed by focusing on the employers' capacity of responsibilities and duties, as well as the essence of this profession being regarded as *“patriotic”* and *“heroic”* while holding a turbulent history full of gender-based discrimination.

From a legal perspective, employment laws and regulations regarding astronauts were primarily set by certain standards during the time when man first started going into space. For instance, although American women had no restrictions to undergo the astronaut selection process in the early 1960s and could seemingly pass, it was still impossible for them to be eligible for an astronaut career due to the fact that all astronauts were required to be military test pilots, and that profession was not available to women back then. According to the appropriate time period, male astronauts were primarily considered to work in this particular field, thus creating the concept of manhood being incorporated in space flight since *“it was almost 23 years after the first American man was launched into orbit (1961) that the first American woman even got a look-in (1983)”*. (Salmon, 2011: 335)

During this temporal gap of employment discrimination, space programs were slow to employ women. However, with the emergence of new anti-discrimination laws of the time, NASA in response opened the space program to female applicants in 1978. This means that labor ideals regarding gender equality, have influenced the methods of how space agencies began to include woman as a growing workforce in American spaceflight programs. The preceding concept of outer space representing a male-dominant domain cannot remain nowadays, according to the principle of gender-based equality, as well as excluding certain privileges. In order to allow full integration of women in extraterrestrial workplace, society needs to move forward and overcome technological and political barriers while highlighting the requirement of labor law regulations to resolve the still existing issues about gender and sex. While nowadays male and female astronauts are seemingly equal regarding employment rights and space-influenced physical effects, certain inclinations among both genders may result in discrimination. Regarding the previously mentioned possibility of female astronauts facing discrimination ascribed to space radiation concerns as a firm consideration to represent a mild continuation of gender based discrimination manifested in the past. On the other hand, however, the following question arises: Can health risk serve as an exception for labor discrimination?

2. Legal status of Astronauts in labor relations regarding the importance of their profession

Concerning the legal status of astronauts, the Outer Space Treaty, in Article V declares that "*State Parties to the Treaty shall regard astronauts as envoys of mankind in outer space*". (United Nations, 2002)

While astronauts usually command, pilot or serve as a crew member of a spacecraft their status is consisted of a dual role, by simultaneously representing mankind, although their profession is not strictly diplomatic, but rather for extraterrestrial research purposes. Besides possessing knowledge and experience in certain scientific subjects, an astronaut's career is considered a virtuous profession, accompanied with traits that the person working as an astronaut needs to possess, such as a good morale, anti-corruption, unselfishness, ethical beliefs, etc. These traits are not and should not be distinct by gender or by any other discrimination preferences, as they are not dependent from those factors. An astronaut's

profession is protected by norms of international space law and holds great relevance and respect “because they principally have a scientific mission to achieve, are believed to carry activities out ‘for the benefit and in the interests of all countries’, not for the benefit and in the interest of a private company.” (Matignon, 2019)

It is necessary to establish the roles of both space agencies and astronauts as subjects to labor law or an employment relation in order to determine their rights and obligations regarding peculiar extraterrestrial circumstances. Individual subjects of labor law are considered to be natural persons and legal persons, where an employment relation is established between them. And contracts between employees (astronauts) and employers (governmental space agencies) usually begin an employment relation. Governmental space agencies are legal persons and regarded as employers who, among other workers in the space sector, also employ astronauts to assign them space missions, mostly for research purposes. This also includes private nongovernmental spaceflight companies however, in order for them to be comprehensible as subjects of labor law private international laws regarding spaceflight regulations must be incorporated. Astronauts on the other hand, are physical persons and have the role of employees and enjoy certain rights in respect of their extraterrestrial labor.

Institutes and norms regarding labor law often changed during history in compliance with the development of society and its systems. However, labor relations between workers and employers are established by concluding a contract of employment, or, the rights and obligations arising during the establishment of the employment relation and during the work period. This also applies for governmental space agencies and astronauts, where the space agency has an obligation to set up particular rights, methods of protection, norms and rules that will concern the needs of astronauts operating in outer space, by creating a so-called “*outer space labor law*” which have to be identical with standard labor laws, with the minor difference of covering and regulating situations characteristic for an extraterrestrial work force. These regulations should be internationally recognized and accepted, as there are multiple countries that have technological capacity to send astronauts into space. However, the problem arises with the factuality that astronauts primarily operate not by international law, but by the national laws from where they originate. In fact, the Rescue Agreement (1968) is one of the internationally recognized

treaties as a consisting part of space law regarding the wellbeing of astronauts whose articles can be considered as a model for certain questions connected to “*outer space labor law*”, which is still nonexistent.

3. Critical analysis of the cosmic radiation health threat in relation to health principles

Most working environments exist within Earth’s boundaries and respectively towards technology and various types of equipment are considered as acceptable conditions for human survival. Naturally, there are certain danger-prone professions and environments, however, they are regulated by internationally recognized norms and principles of labor law since safety and health are one of the most important principles of employment relations. Endangerment of the employee’s life and health is present in almost every profession and environment and labor law tends to justify for some employees to work in dangerous environments. With humans beginning to physically explore outer space, it was established that it represents a challenging environment due to various hazards, including cosmic radiation. But as the technological developments and manned spacecrafts increased, labor and workforce also became a necessity. Nonetheless, space is known to be one of the most extreme environments imaginable for mankind and the concept of long-duration labor guarantees severely critical health risks. In order for labor law to determine the contributing factors to the elimination of cosmic radiation hazards upon astronauts, the above mentioned actuality primarily sets two major determinants:

1. Duration of the space mission;
2. Position of the operating space object;

By questioning whether cosmic radiation has an increasing effect depending on the orbit’s distance or the space object’s location, and by analyzing temporal limitations regarding spaceflight missions, these supposed determinants from the aspect of labor law may contribute in establishing exceptional regulations for protecting the health of female astronauts on human spaceflight missions.

3.1 Duration of the space mission

Due to the fact that human organisms did not evolve for a self-sustaining life in outer space, they are vulnerable to the alien environment which causes negative health effects upon them. While there are other existing health threats in space, *“the biggest hurdle remains radiation. Without the protective cocoon of Earth’s magnetic field and atmosphere, astronauts receive substantially higher dose of radiation, heightening the chances that they will die of cancer.”* (Chang, 2014)

Since outer space is naturally consisted of cosmic radiation, space agencies are limited in eliminating galactic cosmic rays in the working environment and knowingly forced to expose astronauts to radiation hazard. This health threat, however, can differ by the goal and time span of the planned or already conducted space mission. While spaceflights vary by temporal duration, depending on the mission’s goal and purpose, health threats from cosmic rays are one of the greatest barriers that enable long-term manned spaceflights. In other words, *“radiation exposure can be acute (a high dose in a short period of time) or chronic (low levels of radiation over a long time).”* (Tate, 2013)

Since acute exposure occurs within a very short period of time, its identification is impossible, even as the least health-endangering type of radiation exposure during spaceflight missions. Contrastingly, chronic exposure occurs over a long period of time and is usually continuous. Cosmic radiation exposure therefore falls perfectly under this category. However, concerning labor norms and regulations, a significant specification should be made due to the major difference when a worker is being exposed to radiation continuously, and being exposed to radiation constantly.

Short-term and long-term spaceflights in low-Earth orbit (LEO) tend to be chronic, meaning that higher level of radiation exposure increases the likelihood of certain health effects, despite lacking influence over type or severity. Although occupational radiation exposure occurs routinely over a long period of time, astronauts experience constant exposure from galactic cosmic radiation within their working environment, which is simultaneously their living environment when their working hours end. Cosmic radiation, therefore, represents a constant health hazard. Although chronic exposure is unavoidable on Earth, workers are continuously exposed to hazardous radiation during their working hours. Astronauts operating in space also cannot avoid chronic exposure, however, their

profession gravitates towards the consideration that they are constantly exposed to cosmic radiation. This suggests the need for labor law to specify and regulate a new type of radiation or a subtype of chronic exposure depending on the continuation of the exposure, as well as the origin and severity of the radiation. Nonetheless, there are certain organ and career radiation exposure limits which are fundamentally determined by the astronaut's gender and age. "The NASA limit for radiation exposure in low-Earth orbit is 50 mSv/year or 50 rem/year" (NASA Human Research Program Engagement and Communications, 2007: 23)

Table 1: Exposure Limits

Career Exposure Limits for NASA Astronauts by Age and Gender*				
Age (years)	25	35	45	55
Male	1,500 mSv	2,500 mSv	3,250 mSv	4,000 mSv
Female	1,000 mSv	1,750 mSv	2,500 mSv	3,000 mSv

Note. Adapted from "Space Radiation iBook" (p.23), by NASA Human Research Program Engagement and Communications, 2007;

According to NASA, advantages regarding career exposure limits allegedly focus on age, rather than gender, presuming that younger astronauts should be exposed to less radiation, since their careers have just started. The mortality of older astronauts is speculated on a higher level, thus to prevail the possibility of younger astronauts developing subsequent health problems, assuming they will live longer and be more productive for their employers. However, as displayed in Table 1, another differentiation can be noticed regarding the second classification. The values concerning the exposure limits for female astronauts are also lower than those for male astronauts. If we attempt to make an approximate comparison of values regarding the astronauts' gender, it is unavoidable to assume that the strict radiation exposure restrictions are based on some principle or contrast. Since space agencies mainly seek to maximize their profit, it is unlikely that the exposure limits are based upon gender-discriminatory tendencies. Simply put, the individual attribute of gender is unassociated with the astronaut's productivity. While these exposure limits mainly apply for short-term missions, NASA and other ambitious space agencies tend to embark on more distanced celestial bodies, meaning that long-term

missions would rapidly expose astronauts to levels that exceed the current health limits and radiation exposure standards. However, ethical beliefs should represent the primary motivation for space agencies to ensure the astronauts' safety, health and productivity, regardless of their age or gender. Hence, *"NASA asked the Institute of Medicine (IOM) to outline the ethics principles and practices that should guide the agency's decision making for future long duration or exploration missions that fail to meet existing standards"*. (Institute of Medicine, 2014)

Presuming the poor likelihood of long term spaceflights and missions meeting the current health standards and exposure limitations, the Health Standards for Long Duration and Exploration Spaceflight dictates specific responsibilities for NASA that accordingly comply with several labor principles. Continuingly, America's national legislation recognizes the principle of voluntariness, meaning that as an employer, NASA should properly inform astronauts about the increased health risks of long duration spaceflights, guaranteeing the inability to compel astronauts to forced labor and impose a hazardous long-term spaceflight mission against their will. Providing equality of opportunity for astronauts to participate in the spaceflight mission is another relevant principle to further enable labor discrimination between astronauts regarding gender, age or any other personal traits. Since astronauts are entitled to the right to be protected within their extraterrestrial working environment, NASA has an obligation to enforce distinctive and lifelong health surveillance to protect the health of those astronauts that go aboard long-term spaceflight missions, simultaneously to research the effects of increased levels of cosmic radiation, and attempt to reduce similar health risks for future astronauts.

3.2 Position of the operating space object

Outer space, being the expanse that exists beyond planet Earth and between various celestial bodies, represents a broad term to describe the insignificant fragment where manned spaceflights usually operate. Although the Outer Space Treaty permits all states to freely explore outer space, this option, besides from technological advancement reasons, is limited due to the economic costs of launching manned spacecraft. Since it is impossible to operate throughout space as an infinite environment, labor law should identify specific orbits as working environments, from aspects concerning technological advancement and hazardous threats, since they both determine which orbit provides the maximum capacity for manned

spacecraft to operate, regardless of its temporal duration. However, there is no doubt that cosmic radiation is present throughout space as its containing atom fragments, and is characterized by its increasing hazardous effects depending on the distance of the operating space object which simultaneously serves as a working environment for astronauts.

Most space objects, including the International Space Station (ISS) operate in LEO. Although the ISS contains certain areas that are solidly shielded, astronauts are primarily protected by Earth's magnetic field. Still, this does not guarantee the general safety and health of astronauts from galactic cosmic rays.

"During missions beyond low Earth orbit (LEO), radiation exposures from bursts of solar radiation, called solar particle events, could impair an astronaut's performance and result in mission failure... Space travel beyond LEO is also associated with exposure to galactic cosmic rays..." (Kennedy, 2014)

Labor law should define LEO as a regular working environment. Although considered as the least hazardous zone, it still represents a serious health threat to astronauts, regardless of age or gender. In order to compromise various labor manifestations and its employees, an analysis of potential space orbits identified as working environments for manned spaceflights must be conducted. Since generalization is a common characteristic for labor law, in these particular space-related cases, it should be replaced with concreteness, to specifically regulate the working conditions that determine the protection of their safety and health, while associating astronauts with public servants. Failing to ensure workers' safety and health will result with the employer loosing profit and being deprived from productive workers. This simultaneously applies for space agencies and astronauts, creating a perspective for a productivity and profitable spaceflight mission. If space agencies are unsuccessful in eliminating the hazards within their maximum capability, and having undistinguished safety and health regulations, the national budget (in case of a governmental space agency) suffers great losses, as well as their quantity of productive astronauts.

Regarding the radiation environment of deep space, there is a significant difference from the radiation environment manifested in LEO:

"Beyond the Earth's magnetic field, crews are exposed directly to GCR radiation and to SPE radiation. Spacecraft or planetary habitats thus require their own measures to avoid radiation overexposures." (Schimmerling, 2011)

Due to the much larger flux of high-energy galactic cosmic rays, orbits that expand above LEO, are even more hazardous and will likely affect astronauts more than it is regulated. But with the speed of technological advancements and tendencies for more ambitious space exploration, it would soon become a necessity for labor law to set up and provide certain regulations concerning occupational safety and health principles if space agencies wish to consider deep space orbits as future working environments for astronauts. Nonetheless, LEO spaceflight missions are currently considered “less hazardous working environments” due to the fact that space agencies have not yet started conducting human spaceflight missions in more distant orbits. Knowing that LEO is the most common extraterrestrial region for operating spaceflights and missions, and that radiation exposure may vary in terms of avoiding hazardous radiation effects upon space objects and astronauts by limiting the dose of cosmic radiation to the lowest level possible, space agencies and space legislators should ask themselves if it is even feasible within the capacity of labor safety and health regulations, to presume the notion of so-called “safe zones” within LEO;

This mainly questions “*spacecraft transfer from low-Earth orbit to translunar coast necessitated transverse of the regions of geomagnetically trapped electrons and protons known as the Van Allen belts*” (Bailey, 2008)

When manned spacecraft travel beyond LEO, astronauts are automatically exposed to cosmic radiation originating from the Van Allen radiation belts. As previously mentioned radiation exposure does not occur equally and varies depending on the highly energized atomic nucleus. Therefore, the situated region which resembles a gap between the inner and outer Van Allen belts lies between two and four Earth radii, otherwise alluded to as the “safe zone”. Regarding employers and their ambitions to explore deep space in the future, some may think that financial interests of space agencies and their ethical beliefs may contradict. Does this mean that space agencies would be “limited” in conducting planned space missions and programs, and along with that, loosing profit with this restriction, all in order to protect the astronaut’s safety and health?

While this zone may represent a shelter from solar storms and cosmic radiation regarding unprotected space objects and astronauts, by decreasing the costs to build the space object and to invest in suitable health protection equipment for astronauts, the presumed exposure to relatively small doses of radiation can be challenged by the unpredictable

nature of space weather. This opposes the obligation of space agencies as employers to inform astronauts about every risk and hazard of their working environment, regarding the particular orbit, since *“it turns out that when the solar storm is strong enough, even this safe zone can become a major hot zone for dangerous radiation”*. (Weintraub, 2004)

On the other hand, this might create a contradicting dilemma concerning the legal obligations of the space agency: either to enforce the continuous observation of space weather occurring within the particular orbit where their space object is launched, and simultaneously represents the astronaut’s working environment in order to avoid rapidly increasing cosmic radiation exposure, or to circumvent the “safe zone” within the Van Allen radiation belts.

The first option indicates additional costs which will supposedly minimize the employer’s profit and would also not succeed to eliminate the serious health risk of astronauts being overly exposed to cosmic radiation, thus failing to comply with the already existing safety and health standards concerning radiation exposure limits and being rapidly deprived of the productivity of astronauts aboard the space object.

The second alternative proposes for the space agency to send a human crew in LEO despite knowing the health risks may occur. Although the radiation exposure might be higher than the “safe zone”, still there is a less chance of reinforced observation of the space weather within the particular orbit, thus decreasing the additional costs for the space agency that, again, minimized their profit expectations, and ensuring that safety and health standards regarding radiation exposure will not be overrun.

Concerning employment relations, the first options is more likely to respect the obligations and rights of both employers and workers, thus guaranteeing the wellbeing of astronauts and preventing for the additional costs of the space agency to further increase, while minimizing their profit expected from the spaceflight missions.

4. Legal capacities within the obligation of space agencies to eliminate health risks originating from cosmic radiation

Being a fundamental labor law principle, one of the employers’ obligations is to ensure occupational safety and health concerning the working environment of his employees. As an interdisciplinary notion concerning the wellbeing of employees, it constitutes a long-term

protection for the employers regarding unpredictable and highly uncontrollable financial loss situations originating from the hazardous consequences of not applying occupation safety and health measures. In order to determine the legal obligations of space agencies to attempt to eliminate cosmic radiation, their legal capabilities to define all possible methods to mitigate radiation exposure risks must be established. Since radioactivity, particularly cosmic radiation is a natural phenomena, radiation risks may exceed terrestrial borders however it cannot surpass national and even international authority. Safety standards, including standards for labor conditions, depending on the public authority that stipulated them, could potentially be adopted by specialized agencies that share identical safety and health concerns for their employees. According to the Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards,

“An existing exposure situation is a situation of exposure which already exists when a decision on the need for control needs to be taken. Existing exposure situations include situations of exposure to natural background radiation.” (International Atomic Energy Agency [IAEA], 2014)

Cosmic radiation, being part of astronauts' working environment, it cannot be expected for the space agency to have a full obligation to eliminate its hazardous effects, since it primarily does not possess the capacity of conducting such a thing. However, space agencies should not be released of any efforts necessary to protect its employees when preparing for a spaceflight. Depending on whether they are governmental or private, space agencies may be eligible to stipulate certain health standards.

The above mentioned IAEA standards, for instance, include exposure of aircrew or space crew to cosmic radiation as one of the main sources for an existing exposure situation, as well as being additionally recognized as an occupational exposure. The difference is that aircrew members that presumably fly below the Karman line are not regarded as workers and therefore considered as a whole, possibly as civilians too, while members of a space crew are more likely to be regarded as individual workers. However, it is only stated that *“the regulatory body or other relevant authority shall establish, where appropriate, a framework for radiation protection that applies to individuals in space based activities that is appropriate for the exceptional conditions of space.”* (International Atomic Energy Agency [IAEA], 2014)

The term “regulatory body” is often regarded as a state agency or a public cooperation that manifests authority over a certain human activity in a regulatory capacity. Although space agencies are associated as governmental organizations, the results of their missions are not only regarded for public benefits and national interests, but rather seen as beneficial for all of mankind. While standing as a dilemma, it seems much straight forward to address this assumption for private space companies, as they would be considered as independent regulatory bodies, while still possessing the role of employers in labor relations. Private space companies, if they were to manifest authority over particular health concerns, those standards would specifically apply within national borders, while excluding international level.

Nonetheless, governmental space agencies and private space companies both hold authority of a statutory identity to conduct their spaceflights while simultaneously being part of a national executive branch. Risks associated with working conditions should be especially implemented within national labor law in order for astronauts to ensure the likelihood of mission success. On the other hand, risk management in an extraterrestrial workplace cannot be achieved without the obligation of employees to comply with stipulated exposure limits, safety regulations and health standards.

Health standards are one of the many mechanisms to manage occupational risks. However, there is an unavoidable possibility of manned spaceflights being fatal, especially early attempts to explore deep space. Although it is beneficial for mankind to further acknowledge a plethora of relevant scientific discoveries, the question arises whether labor law should be selective concerning certain space agencies to conduct high-risk manned spaceflights. The fundament of this presumption lies in the most common issue concerning health standards - their limitation and narrowness as an obstructive characteristic. On one hand, health standards often do not include space-based activities, nor even consider cosmic radiation as a frequent health threat. For instance, in 1970 the US labor law known as the Occupational Safety and Health Act (OSHA Act) was approved in order to “ensure safe and healthful working conditions for every working man and woman in the nation insofar as practicable, [so] that no workers will suffer diminished health, functional capacity or life expectancy as a result of their work experience.” (Occupational Safety and Health Administration [OSHA], 1970)

Within the United States Department of Labor, OSHA may promote worker safety and health however its regulations do not apply to all workers that are included in labor relations. In other words, *“OSHA does not have oversight over self-employed persons, employees of state and local governments or other federal agencies that regulate worker safety under the authority of other federal laws (including workplaces in nuclear energy and weapons manufacture, mining, railroad, and aviation).”* (Kahn et al., 2014: 78)

Regarding space sector employees, OSHA regulations only protect ground-based workers, while excluding astronauts. This grants space agencies with the right and authority to regulate planned and conducted aerospace activities, as well as to establish safety and health-related requirements that astronauts need to fulfill for operating in an extraterrestrial environment. Astronauts should also respect their obligations and utilize the provided health and safety measures by their employers. On the other hand, national and international health standards can be either mandatory or voluntary. This complex situation, referring to radiation exposure, incapacitates for all astronauts worldwide to be protected equally, indirectly indicating nationality-based discrimination. However, in compliance with national labor law, astronauts are obliged to act upon the laws and regulations of their country of origin. This gives astronauts a non-equivalent status, which contradicts their status as *“envoys of mankind”*. Society tends to allow high-risk human activities without any reluctance in relation to communal interest. Consequently, every national space agency worldwide possessing proper developmental technology to launch manned spacecrafts regulates its own safety and health standards. However, due to the variety of safety and health requirements and standards that reflect the employer’s capacity to protect its employees, the conducting of space agencies’ authority is uncertain. Hence, *“does this imply that as a global society we should let individuals engage voluntarily in extremely hazardous activities in those countries and cultures that are more favorable to risk?”* (Galliott, 2015: 239)

This question further emphasizes the principle of voluntariness and the prohibition of forced labor. Space agencies should respect astronauts’ will to participate in a spaceflight, being previously informed of potential health threats. Therefore, cosmic radiation exposure does not have to be a forced necessity directly associated to health-endangerment. In order for this principle to be equally realized, space agencies should offer this alternative to all the astronauts that they particularly selected for the spaceflight,

which highlights the principle of opportunity. Along with the willingly accepted health risks of cosmic radiation, comes the awareness of space agencies to recognize the potential, personal sacrifices that astronauts undergo for the profitable success of the space mission, and more importantly, the benefit of mankind.

Regarding countries and cultures that are more favorable to risk, labor law could specify and regulate certain requirements for space agencies, that would serve as a matrix, in order to compose stricter ethical principles, safety and health standards to further advance the guarantee astronaut's physical and psychological wellbeing, which are most likely to be mandatory, leaving no option for space agencies to even doubt whether they should consider to protect their astronauts or not.

This assumption effectuates another discriminatory question. Depending on ethical beliefs and past manned spaceflight conducting, certain space agencies have better predispositions to carry out high-risk space-based activities than others. Therefore, they can handle cosmic radiation exposure regulations more effectively. For instance, since the U.S. and Russia, and their national space agencies respectively, were there among the first to send humans into space during the Space Race, they can and should rightfully manifest dominance in spaceflight capability. Opposite to this technological and legal advantage, recently developed space agencies such as ESA, do not yet manifest such qualities. Safety and health standards stipulated by more experienced and dominant space agencies should represent the main sources of regulation for other space agencies. In order for newer space agencies to not be excluded or discriminated, moral principles of astronauts' safety and health must be applied universally, meaning that all space agencies as employers, besides a legal obligation, should also have a moral obligation to protect astronauts from extraterrestrial hazards and health risks. International labor law should generally recognize these standards to highlight the principle of nationality-based equality, which fully respects the legal status that astronauts should globally enjoy.

5. Discrimination possibility of the female astronaut's career options

Even nowadays women often feel discriminated compared to men since they were deprived from their basic human rights in the past. Although women in respect of the workforce are regarded and properly protected as

a special category of workers, space agencies as employers, specifically NASA, do not manifest any forms of consequential gender-based discrimination upon female astronauts, at least not from a social perspective reflected in employment opportunity and equal treatment.

According to Article 11 from the Convention of Elimination of All Forms of Discrimination Against Women (1979): *“State Parties shall take all appropriate measures to eliminate discrimination against women in the field of employment in order to ensure, on a basis of equality of men and women, the same rights”* (United Nations General Assembly, 1979)

This precept is reinforced by previously analyzed determinants of the position of the operating space object and duration of the space mission, which do not suppress any labor rights of female astronauts. The following paragraphs of this article highlight the equal social status of women referencing their extraterrestrial workplace and dangerous health hazards, not making a significant distinction on any particular basis in the process.

Examinations of the physical effects of space upon the human body presume that female astronauts tolerate identical physical effects of space travel as their male colleagues, including health threats from galactic cosmic rays: both men and women are affected by cosmic radiation. Concerning labor relations, while both genders are considered equal regarding employment, intellectual capacity and responsibility, it is suspected that female astronauts at NASA are supposedly dealing with gender-based discrimination regarding strict space radiation restrictions. However, this dilemma has a dual nature since *“both male and female astronauts are not allowed to accumulate a radiation dose that would increase their lifetime risk of developing fatal cancer by more than 3 percent”*. (Kramer, 2013)

Despite both male and female astronauts being seemingly equal regarding the level of cosmic radiation risk, Peggy Whitson, the former chief of NASA’s Astronaut Corps, stated that *“depending on when you fly a space mission, a female will fly only 45 to 50% of the missions that a male can fly”*. (Kramer, 2013)

Hence, it is allegedly believed that this restriction manifests the limitation of the principle of opportunity, which contradicts labor law health principles. Nevertheless, it is necessary to make a comparison by analyzing whether gender, as the primary basis for female astronaut discrimination, is represented as a biological, rather than a social structure. It should be confirmed that cosmic radiation health protection is valid, according to women’s anthropological constitution.

Regarding occupational safety and health, women share a greater tendency of developing various occupational hazards and health issues or biological effects than men. This may originate from a biological background or within the working environment which allude to certain occupational hazards that may only be specific to women and contribute in the predispositions of female workers to develop particular health issues. By analyzing outer space as a workplace being constantly exposed to cosmic radiation, while it is no mystery that galactic cosmic rays effects both genders, the anthropological structure of the female body increasingly contributes for female astronaut's tendency to develop ovarian or breast cancer by cosmic radiation exposure in certain amounts. Although gender is either considered as a social or biological structure, concerning female astronauts, it is primarily perceived as a social structure, while ignoring the biological predispositions of the female body. Classifying women in the workforce as a special category of workers should usually be based on their anthropologic constitution, rather than the equal social status in the working environment. Labor principles tend to neglect the biological aspects of the female gender, thus making any restrictions seem as gender-based discrimination, which assumingly limits their career options compared to men. Even if space agencies increase the percentage of missions that female astronauts can fly equally to men, women would most likely become subjects in determining the health impact of galactic cosmic ray exposure during spaceflights and missions, besides equally employed workers.

The Occupational Cancer Convention (1974) in Article 5 stipulates that: *"Each Member which ratifies this Convention shall take measures to ensure that workers are provided with such medical examinations or biological or other tests or investigations during the period of employment and thereafter as are necessary to evaluate their exposure and supervise their state of health in relation to the occupational hazards"* (International Labour Organization [ILO], 1974)

According to previously conducted medical and biological examinations regarding the physical effects of cosmic radiation manifested through specific and increased health issues, female astronauts should also ask themselves if it is worth the risk, since they are already guaranteed the principle of voluntariness to prevent forced labor in future spaceflights and missions. On the other hand, NASA should also have a moral obligation to additionally protect female astronauts as productive employees. Both subjects of labor relations should have their own responsibilities when

facing a serious health hazard and not solely relating upon the worker's voluntarism. By speculating whether cosmic radiation health risks are eligible to represent an exception for labor discrimination, the non-equivalency of both principles leads to the solution that since health standards are mostly based on ethical beliefs, space agencies are obligated with the responsibility to provide precise restrictions regarding cosmic radiation exposure limits towards female astronauts as individual biological subjects, with the aim to establish identical international standards. This creates a multinational differentiation, considering international labor law. The practice of female astronauts flying to space less than their male colleagues, only applies NASA astronauts. Since NASA does not represent a monopoly in terms of launching manned spacecraft while simultaneously establishing labor relations, other space agencies including ESA or Roscosmos, do not seem to apply this restriction upon their female astronauts. If this regulation only applies to NASA, it consequentially excludes international labor law, while additionally emphasizing the non-equality of astronaut's legal status. While national regulations can be considered as a valid source of authority, international cosmic radiation health restriction concerns should apply to all astronauts no matter their nationality, since their achievements reflect upon the benefit of humanity.

6. Conclusion

While an astronaut's profession holds great relevance and a distinct legal status concerning the establishment of labor relations with space agencies as employers, is it also necessary to define cosmic radiation as an individual health threat present in extraterrestrial working environments as well as determining space agencies' legal capacities to eliminate hazardous effects upon astronauts, primarily dependent on the technical aspects of spaceflight missions. Although this may seem as one of their fundamental obligations, it simultaneously produces a discriminatory assumption regarding labor law, being directly related to the supposedly limited career options of female astronauts.

Gender should not always be perceived as a social structure, but rather as a biological differentiation in particular labor relations. This only emphasizes the non-equality of the principles of health and opportunity concerning the regulation of biologically based cosmic radiation exposure

limits. It is only natural for both male and female astronauts to be affected by cosmic radiation, being allowed by their equal social status and their equivalent right if employment. However, from the aspect of anthropologic construction, male and female astronauts cannot be entirely equal due to their distinct biological tendencies to react differently to cosmic radiation and development of gender-based health issues.

The right of special protection for female astronauts operating in an extraterrestrial environment represents an obligation for space agencies. It should not be understood in the discriminatory manner that female astronauts are inferior and therefore less capable human beings than their male colleagues. On the contrary, female astronauts are equally capable and responsible in the performance of her space-related activities, as male astronauts. This health protection measure should not be interpreted that female astronauts are placed in more privileged or non-privileged working positions, which represents gender-based discrimination, but rather as a set of measures that protect their biological nature.

While space agencies should always guarantee the social equality of female astronauts in terms of employment and receiving health protection, that status must differ regarding their biological traits in compliance with their capabilities to eliminate cosmic radiation health risks, since there is a temporary absence of internationally recognized safety and health standards applicable towards the hazardous effects upon both male and female astronauts, caused by the amount of exposure to galactic cosmic rays while operating in an extraterrestrial working environment.

List of References

- Arrow, K.J. (1971). *The Theory of Discrimination*. Industrial Relations Section: Princeton University
- Bailey, J.V. (n.d.). *Radiation Protection and Instrumentation*. Retrieved from <https://history.nasa.gov/SP-368/s2ch3.htm>
- Chang, K. (2014, January 27). *Beings Not Made for Space*. Retrieved from <https://www.nytimes.com/2014/01/28/science/bodies-not-made-for-space.html>
- Galliot, J. (2015). *Commercial Space Exploration: Ethics, Policy and Governance*. Ashgate: Ashgate Publishing Limited

- Institute of Medicine. (2014). *Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities and Decision Framework*. Retrieved from <https://www.nap.edu/resource/18576/Long-Duration-Spaceflight-RB.pdf>
- International Atomic Energy Agency. (2014). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*. Vienna: International Atomic Energy Agency
- International Labour Organization. (1974). *Occupational Cancer Convention*. Geneva: International Labour Organization
- Kahn, J., Liverman, C.T., & McCoy, M.A. (2014). *Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework*. Washington, DC: The National Academies Press.
- Kennedy, A.R. (n.d.). *Radiation Effects*. Retrieved from <http://nsbri.org/research/browse-by-team/radiation-effects/>
- Kramer, M. (2013, August 27). *Female Astronauts Face Discrimination from Space Radiation Concerns, Astronauts Say*. Retrieved from <https://www.space.com/22252-women-astronauts-radiation-risk.html>
- Matignon, L.G. (2019, April 11). *The Skylab Strike and the need for an Outer Space Labour Law*. Retrieved from <https://www.spacelegalissues.com/the-skylab-strike-and-the-need-for-an-outer-space-labour-law/>
- NASA Human Research Program Engagement and Communications. (2007). *Space Radiation iBook*. n.p.
- Occupational Safety and Health Administration. (1970). *Occupational Safety and Health Act [OSHA]*. Retrieved from <https://legcounsel.house.gov/Comps/Occupational%20Safety%20And%20Health%20Act%20Of%201970.pdf>
- Salmon, K. (2011). Review of "Integrating Women into the Astronaut Corps: Politics and Logistics at NASA, 1972 - 2004" By Amy E. Foster. *International Journal of Gender, Science and Technology*, 4(3), 335
- Schimmerling, W. (n.d.). *The Space Radiation Environment: An Introduction*. Retrieved from <https://web.archive.org/web/20120426022341/http://three.usra.edu/concepts/SpaceRadiationEnviron.pdf>
- Tate, K. (2013, May 30). *Space Radiation Threat to Astronauts Explained*. Retrieved from <https://www.space.com/21353-space-radiation-mars-mission-threat.html>

- United Nations. (2002). *United Nations treaties and principles on outer space: Text of treaties and principles governing the activities of states in the exploration and use of outer space, adopted by the United Nations General Assembly*. New York: United Nations.
- United Nations General Assembly. (1979). *Convention of Elimination of All Forms of Discrimination Against Women [CEDAW]*. New York: United Nations
- Weintraub, R.A. (2004, December 15). *Earth's Safe Zone Became Hot Zone During Legendary Solar Storms*. Retrieved from https://www.nasa.gov/vision/universe/solarsystem/safe_zone.html

