76th International Astronautical Congress (IAC 2025), Sydney, Australia, 29 Sep-3 Oct 2025.


IAC-25-B3.IP.22

# UNIFORMS FOR PRIVATE SPACEFLIGHT MISSION COMMANDERS AND SPAFE FLIGHT ATTENDANTS

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**Abstract**

ASTRAX and the ASTRAX Group have been conducting research on the necessity of support crew and flight attendants for private spaceflight missions, along with the various service technologies required to enhance space travel experiences. At the same time, they have also been studying the need for specialized uniforms for these support crew members working in space.
This paper explores the functions, roles, and designs of uniforms worn by crew members and flight attendants who assist space travelers and private space missions, as well as the challenges involved in their development.

**Keywords: ASTRAX, civilian astronaut, space flight attendant, uniform**

## 1. Introduction

With the launch of private space travel services in 2021, people from various walks of life around the world are flying into space and carrying out a variety of missions and projects. As a result, humanity's living space and sphere of activity are steadily expanding into space, further expanding its possibilities.

In preparation for the arrival of the era of private space travel, ASTRAX has been training private astronauts (mission commanders) and space flight attendants since 2005 to support private spaceflights and prepare to provide services in space. (For details on the need, roles, and work of private astronauts and space flight attendants, see references [10], [18], and [44].)

ASTRAX has also conducted research on clothing suitable for the space environment, including materials, fashion, cleaning methods, and the need for traditional clothing. (For details, see references [19], [26], [50], [58], and [87].)
Furthermore, we have also examined the fashion and artistic value of spacecraft clothing (see reference [50]).

Based on the results of these studies, this paper examines the function, role, design, and challenges of clothing worn in space by crew and attendants who support space tourists and space mission guests.

## 2. The Need for Spacecraft Uniforms

The type of clothing worn onboard a spacecraft depends on the type of spacecraft development company (spacecraft), the spacecraft's flight method (suborbital or orbital), and the flight duration.

For Virgin Galactic and Blue Origin spacecraft, which perform relatively short suborbital spaceflights (approximately 10 minutes to an hour), all crew members wear overalls designated by their respective companies during the flight.

For long-duration spaceflights, such as orbital spaceflights, where the stay in space lasts for several days, astronauts wear specialized spacesuits during launch and return, but wear everyday clothes (or overalls) during their stay in space.

In previous spaceflights, even spacecraft staff (private astronauts and space flight attendants) who were not general travelers wore the same uniform, and there was no variation in clothing based on their role or job.

However, as spaceflights become more frequent in the future and a variety of people are able to go into space in a variety of outfits, uniforms tailored to the purpose and mission will be required to clearly distinguish between customers and the astronauts and space flight attendants who provide service, and to ensure smooth work onboard.

This is thought to have various benefits, such as clearly distinguishing between customers and service providers by staff working at airlines, cruise ships, hotels, etc., by wearing specialized uniforms, as well as for branding and image enhancement, cleanliness, and increased reliability.

Therefore, in Section 3, we will examine what specific uniforms are suitable for the space work environment when working or providing services in space.

## 3. Functions and Roles of Uniforms in Space

### 3.1 Functions of Space Uniforms

List the possible functions required for uniforms worn by personnel who regularly work in space (e.g., commercial astronauts and space flight attendants).

**(1) Addressing the unique challenges of space**

- Ease of movement in a zero-gravity environment
- Ease of emergency response
- Water-repellent properties against suspended liquids (Water-absorbent properties may also be necessary in some areas.)

**(2) Hygiene**

- Cleanliness
- Hygienic and hygienic features for continuous wear in a confined environment

**(3) Odor Prevention**

- Odor prevention is important for continuous wear in a confined environment

**(4) Temperature Regulation**

- Temperature regulation to match the temperature inside the spacecraft

### 3.2 Roles of Space Uniforms

List the possible roles for uniforms worn by personnel who regularly work in space (e.g., commercial astronauts and space flight attendants).

**(1) Identification**

- Easily distinguishable from ground control, other crew members, and space travelers.

**(2) Functionality**

- Functions to support work in a zero-gravity environment.
- Multipurpose pockets.
- Tool attachment points (e.g., Velcro).

(3) Psychological Aspects:

- Sense of expertise and security.
- Creating an extraordinary experience.
- Image enhancement.
- Branding.

**(4) Increasing Crew Motivation:**

- The joy of wearing a stylish uniform.
- Making yourself look beautiful (elegant).

**(5) Symbolism:**

- Enhanced corporate image and brand.
- Fostering customer confidence.

### 3.3 Shape, Material, and Design of Space Uniforms

List possible shapes and designs for uniforms worn by individuals who regularly work in space (e.g., commercial astronauts and space flight attendants).

**(1) Functionality**

- Storage pocket,
- Wearable device,
- Life monitoring function

**(2) Safety**

- Simple protection (safety function in emergencies)
- Use of fire-resistant and radiation-resistant materials (protects the body from fire and contamination)

**(3) Comfort**

- Lightweight material designed for extended wear
- Temperature-regulating fibers

**(4) Materials**

- Lightweight
- Breathable
- Durable
- Flame-retardant
- Anti-static

**(5) Shape**

- Designed for ease of movement in zero gravity
- Possibility of modular design consisting of multiple parts

**(6) Unique ASTRAX Elements**

- Design reflecting the brand image
- Logo and symbol placement
- Possibility of Shibuki

ASTRAX is seeking to incorporate Shibuki art (painted art inspired by space, stars, and galaxies) to increase the diversity of fashion, such as in-spacewear (Reference [50][87] [104]). Shibuki Art is a color expression that symbolizes chance and diversity. It visually enhances the identity of our brand and mission, while psychologically instilling a sense of security and upliftment in travelers and crew. In the enclosed environment of space, the Shibuki pattern evokes the energy of nature and the universe, suggesting a new direction for uniform design that combines functionality and spirituality.


**Fig 1. Example of a flight suit that has undergone Shibuki**

Comparison with existing flight attendant uniforms in the aviation industry
Survey results from an SFA event

ASTRAX announced its space flight attendant project and conducted a survey on the image of a space flight attendant uniform at an event held by its group company, ASTRAX IMAGINE, to commemorate the United Nations World Space Week. The top three design proposals from the survey are shown below. The selection criteria is based solely on appearance.

1st 2nd 3rd

**Fig 2. The top three design proposals of uniform of Space Flight Attendant**

### 3.4. Differences in Uniforms for Private Astronauts and Space Flight Attendants

Consider the differences in the uniforms worn by private astronauts and space flight attendants based on their respective roles.

**(1) Private Astronaut (Mission Commander) Uniform**

Mission command and safety responsibility →
Uniforms that emphasize functionality

Roles change for each mission →
Functionality can be adjusted as needed

**(2) Space Flight Attendant Uniform:**

Customer service and psychological care →
Emphasis on design and friendliness

**(3) Differences in uniform design based on different roles:**

Further consideration is needed.

## 4. Space Uniform Challenges and Development Plan

**(1) Technical Challenges**

- Development of materials that can withstand the space environment (radiation, temperature changes)
- Technology for achieving both comfort and safety

**(2) Design Challenges**

- Balancing functionality and beauty
- Meeting the diverse needs of space travelers

**(3) Development Plan**

- Collaborative research with designers and engineers

**(4) Demonstration tests on board a spacecraft**

Future demonstration tests are needed.

**(5) Design principles learned from airline uniforms**

- Professionalism + approachability

**(6) Hybrid spacesuit/uniform combination**

- Lightweight pressurized suit

**(7) Coloring and Symbolism**

- Visibility in space
- Utilizing brand colors
- The potential of Shibuki art

We believe that colors and symbols that are universally accepted, transcending nationality and culture, are effective. In this respect, we believe Shibuki Art can function as an intuitive, universal visual language, symbolizing a sense of psychological security and multicultural harmony aboard the spacecraft. We plan to conduct future demonstration experiments to verify these effects.

**(8) Gender- and Multicultural-Aware Design**

- Design that takes into account diversity, including gender and cultural differences.

**(9) Unity through Universal Design**

- Consideration of the unity of all Earthlings, transcending nationality, race, gender, and age.

## 5. Future Plans and Outlook

The following items need to be considered and verified in the future:

**(1) Integration with wearable devices and applications**

・AR glasses
・Vital monitoring
・ASTRAX U2U
etc.

**(2) Standardization of uniforms for space hotels and lunar bases**

Undecided

**(3) Possibility of a future "ISO standard for space crew uniforms"**

Undecided

**(4) Functionality verification using a simulator**

Undecided

**(5) The potential of Shibuki Art**

By conducting empirical research on spacecraft uniforms incorporating Shibuki Art, we hope to explore the possibility of universal uniform designs that combine functionality, symbolism, and cultural value. This will not only lead to the development of clothing, but also to the creation of new value, including cultural experiences and psychological care in space services.

## 6. Conclusion

This study summarized the results of an examination of the uniforms of private astronauts and space flight attendants.

While this is far from sufficient to be considered research, we hope it will serve as an opportunity to consider the field of space uniforms.

ASTRAX plans to use this opportunity to further explore the field of space uniforms in the future.

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IAC-25-B3.IP.22

# 民間宇宙飛行士ミッションコマンダーや宇宙フライトアテンダントの制服

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**Abstract**

ASTRAX and the ASTRAX Group have been conducting research on the necessity of support crew and flight attendants for private spaceflight missions, along with the various service technologies required to enhance space travel experiences. At the same time, they have also been studying the need for specialized uniforms for these support crew members working in space.
This paper explores the functions, roles, and designs of uniforms worn by crew members and flight attendants who assist space travelers and private space missions, as well as the challenges involved in their development.

**Keywords: ASTRAX, civilian astronaut, space flight attendant, uniform**

**アブストラクト**

ASTRAX と ASTRAX グループでは、宇宙旅行時代を見据えて、民間宇宙飛行ミッションにおけるサポートクルーやフライトアテンダントの必要性や様々なサービス技術について研究を行ってきた。同時に、そのようなサポートを行うクルーが宇宙で着る制服の必要性についても研究を行っている。そこで、この論文では、宇宙旅行者や宇宙飛行ミッションを行うお客様をサポートするために働くクルーやアテンダントが宇宙で着る服についての機能や役割、形状や課題について発表を行う。

**キーワード:** ASTRAX, 民間宇宙飛行士, 宇宙フライトアテンダント, 制服

## 1. はじめに

2021 年に民間企業による宇宙旅行サービスが開始され、世界各国の様々な立場の人々が宇宙飛行を行い、様々なミッションや企画を実践している。それにより、人類の生活圏や活動領域は確実に宇宙へと広がりつつあり、その可能性もますます拡大している。

ASTRAX では、民間宇宙旅行時代の到来に向けて、2005 年から民間人の宇宙飛行をサポートするために、民間宇宙飛行士（ミッションコマンダー）や宇宙フライトアテンダントの養成し、宇宙でサービスを提供するための準備を行っている(民間宇宙飛行士や宇宙フライトアテンダントの必要性や役割・仕事などについては参考文献【10】【18】【44】を参照）。

また、ASTRAX では、宇宙環境に適した衣服に関して、素材やファッション性、クリーニング方法、民族衣装の必要性などについても研究を行ってきた。（詳細については参考文献【19】【26】【50】【58】【87】を参照）
さらに、宇宙船内衣服のファッション性やアート性についても検討を行ってきた（参考文献【50】参照）。

本論文では、これらの研究の結果を踏まえて、宇宙旅行者や宇宙飛行ミッションを行うお客様をサポートするために働くクルーやアテンダントが宇宙で着る服の機能や役割、形状や課題について検討を行う。

## 2. 宇宙船内用の制服の必要性

宇宙船内で着る服の種類は、宇宙船開発企業（宇宙船）の種類や、宇宙船の飛行方法（サブオービタルかオービタルか）、宇宙船の飛行時間などによって変わってくる。

サブオービタル宇宙飛行のうち、比較的短時間の宇宙飛行（10 分～1 時間程度）を行うヴァージンギャラクティックやブルーオリジンの宇宙船の場合、飛行の際は、全員それぞれの企業で決められているツナギを着ることになっている。

オービタル宇宙飛行のような、宇宙滞在時間が数日にわたる長時間飛行の場合、打ち上げ時や帰還時には専用の宇宙服を着るが、宇宙滞在中は普段着（あるいはツナギなど）で生活することになる。

これまでの宇宙飛行の場合、一般旅行者ではない宇宙船搭乗スタッフ（民間宇宙飛行士や宇宙フライトアテンダント）であっても、みんな同じ服装で統一されており、役割や仕事によって服装が異なるということはなかった。

しかし、今後、宇宙飛行の回数がもっと頻繁になり、さまざまな人たちが様々な格好で宇宙に行けるようになると、顧客と、サービスを行う宇宙飛行士や宇宙フライトアテンダントとの間の立場の違いを明確にし、宇宙船内での仕事が円滑に行えるように、目的やミッションに合わせた制服が必要となることが予想される。

これは航空会社やクルーズ船やホテルなどで働くスタッフが専用の制服を着ることで顧客とサービス提供側とを明確に区別できるようにすることや、ブランディングやイメージアップ、清潔感や信頼性の向上などさまざまな意義があると考えられる。

そこで、3 項では、宇宙で仕事をしたり、サービス提供を行ううえで、具体的にどのような制服が宇宙での作業環境に適しているかについて検討を行う。

## 3. 宇宙での制服の機能や役割

### 3.1 宇宙制服の機能

宇宙で定常的に仕事をする人（民間宇宙飛行士や宇宙フライトアテンダントなど）が着る制服として必要となる機能について、その可能性を列挙する。

**(1) 宇宙特有の課題への対応**

・無重力環境での動きやすさ
・緊急時対応のしやすさ
・浮遊した液体物に対する撥水性
（部分的にはあえて新水性を持たせて吸収する機能も必要かもしれない）

**(2)衛生**

・清潔感
・閉鎖環境で連続して着るために、衛生的で衛生管理ができる仕組み

**(3) 防臭**

・閉鎖環境で連続して着るために、衛生だけでなく防臭効果も重要

**(4) 温度調節**

・宇宙船内の温度環境に合わせた温度調節機能

### 3.2 宇宙制服の役割

宇宙で定常的に仕事をする人（民間宇宙飛行士や宇宙フライトアテンダントなど）が着る制服の役割について、その可能性を列挙する。

**(1) 識別性**

・地上管制センターや他のクルー、宇宙旅行者からの識別を容易にする

**(2) 機能性**

・無重力環境下での作業をサポートする機能
・多目的ポケット
・ツール取り付け部（マジックテープ等）など

**(3) 心理的側面**

・専門性と安心感
・非日常体験の演出
・イメージアップ
・ブランディング

**(4) クルーのモチベーションを向上：**

・かっこいい制服が着れる喜び
・自分が綺麗（エレガント）にみえる

**(5) 象徴性**

・企業イメージ、企業ブランドの向上
・顧客安心感の醸成

### 3.3 宇宙制服の形状・素材・デザイン

宇宙で定常的に仕事をする人（民間宇宙飛行士や宇宙フライトアテンダントなど）が着る制服の形状やデザインについて、その可能性を列挙する。

**(1) 機能性**

・収納ポケット、
・装着型端末、
・生命モニタリング機能

**(2) 安全性**

・簡易防護性能（緊急時の安全確保機能）
・耐火・耐放射線素材の活用（火災や汚染から身体を守る素材）

**(3) 快適性**

・長時間着用を想定した軽量素材
・温度調整繊維

**(4) 素材**

・軽さ
・通気性
・耐久性
・難燃性
・帯電防止機能

**(5) 形状**

・無重力での動きやすさを考慮したデザイン
・複数のパーツからなるモジュール式デザインの可能性

**(6) ASTRAX 独自の要素**

・ブランドイメージを反映したデザイン
・ロゴやシンボルマークの配置
・シブキの可能性

ASTRAX では、宇宙船内服などのファッションの多様性を向上させるために、シブキアート（宇宙や星や銀河をイメージしたペイントアート）のデザインを導入しようとしている（参考文献【50】【87】【104】）。シブキアートは偶然性と多様性を象徴する色彩表現であり、視覚的にはブランドやミッションのアイデンティティを高めると同時に、心理的には旅行者やクルーに安心感や高揚感を与えると考えている。宇宙という閉鎖環境において、自然や宇宙のエネルギーを想起させるシブキの模様は、機能性と精神性を兼ね備えた新しい制服デザインの方向性を提示するものと考えている。（図 1 参照）


**図 1 シブキを施したフライトスーツの例**

・既存の航空業界におけるフライトアテンダントの制服との比較
・SFA のイベントでのアンケート結果

ASTRAX では、グループ会社の ASTRAX IMAGINE が開催した国連世界宇宙週間記念イベントにて、宇宙フライトアテンダント事業の発表と、宇宙フライトアテンダントの制服イメージについてのアンケート調査を行った。その時のアンケート結果のうち、1 位～3 位のデザイン案を以下に示す。なお、選考の基準は見た目だけである。

1 位　　2 位　　3 位

**図 2. 宇宙客室乗務員の制服デザイン案上位 3 案**

### 3.4.民間宇宙飛行士と宇宙フライトアテンダントの制服の違い

民間宇宙飛行士と宇宙フライトアテンダントが着る制服について、それぞれの役割に応じた違いについて検討する。

**(1) 民間宇宙飛行士（ミッションコマンダー）の制服**

・ミッション指揮・安全責任 →
機能性重視のユニフォーム

・ミッションごとに役割が変わる→
必要に応じて機能がアレンジできる

**(2) 宇宙フライトアテンダントの制服**

・顧客サービス・心理的ケア →
デザイン性と親しみやすさを重視

**(3) 役割の違いに応じた制服設計の違い**

今後詳しく検討する必要がある。

## 4. 宇宙制服の課題と開発計画

**(1) 技術的課題**

・宇宙環境（放射線、温度変化）に耐えうる素材の開発
・快適性と安全性を両立させるための技術

**(2) デザイン的課題**

・機能性と美しさのバランス
・宇宙旅行者の多様なニーズへの対応

**(3) 開発計画**

・デザイナーやエンジニアとの共同研究

**(4) 宇宙船内での実証実験**

今後実証実験を行う必要がある。

**(5) 航空会社の制服から学ぶデザイン原則**

・プロフェッショナル性＋親しみやすさ

**(6) 宇宙服と制服のハイブリッド化**

・軽量版与圧スーツ

**(7) カラーリング・シンボル**

・宇宙空間での視認性
・ブランドカラーの活用
・シブキアートの可能性

カラーリングやシンボルにおいては、国籍や文化を超えて普遍的に受け入れられる表現が効果的であるのではないかと考えている。この点でシブキアートは、直感的でユニバーサルなビジュアル言語として機能し、宇宙船内における心理的安心感や多文化調和の象徴となり得るのではないかと考えている。これらの効果については今後実証実験を行っていく予定である。

**(8) 性別・多文化対応デザイン**

・性差や多文化など、多様性を考慮したデザイン

**(9) ユニバーサルなデザインによる統一性**

・国籍や人種や性別や年齢などを超越した、地球人としての統一性を考慮

## 5. 今後の計画・展望

今後、以下のような項目について検討や検証を行っていく必要がある。

**(1) ウェアラブルデバイスやアプリケーションとの統合**

・AR グラス
・バイタルモニタリング
・ASTRAX U2U
など

**(2) 宇宙ホテル・月面基地における制服の標準化**

未定

**(3) 将来的な「宇宙クルー制服 ISO 規格」の可能性**

未定

**(4) シミュレーターを使った機能性の検証**
未定

**(5) シブキの可能性**

シブキアートを取り入れた宇宙船内の制服の実証研究を進めることで、機能性・象徴性・文化的価値を併せ持つユニバーサルな制服デザインの可能性を探ることが期待される。これは、単なる衣服の開発にとどまらず、宇宙サービスにおける文化的体験や精神心理的ケアを含めた新たな価値創出につながるのではないかと考えている。（参考文献【104】参照）

## 6. 結論

本研究では、民間宇宙飛行士や宇宙フライトアテンダントの制服について検討した結果をまとめた。

研究というには全く不十分ではあるが、宇宙での制服という分野を考えるきっかけになればと考えている。

今後 ASTRAX は、これを機会に、宇宙制服という分野についても深掘りしていく予定である。

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日本における ASTRAX 無重力飛行サービス

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【5】ASTRAX Space Services Platform By Using Blockchain Technology,
ブロックチェーン技術を活用したアストラックス宇宙サービスプラットフォーム

【6】ASTRAX Universal Service Platform By Using Blockchain Technology,
ブロックチェーン技術を活用した ASTRAX のユニバーサルサービスプラットフォーム

【7】Mission Control Center To Support Commercial Space Missions And Passenger'S Activities Inside Of The Cabin,
商業宇宙ミッションと乗客の機内活動を支援するミッションコントロールセンター

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商業宇宙ミッションと顧客活動を支援するミッション支援管制センターとサブオービタル宇宙船シミュレータ

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Zero G-Naut と商業宇宙ミッションと顧客活動を支援するミッションコマンダー（船内）

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NFT とメタバース技術による ASTRAX 太陽系経済圏構想

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宇宙用トイレ「宇宙ベンキング」の開発

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