SPACE RETURN

NEWS: NASA astronauts Sunita Williams and Butch Wilmore have returned to Earth after their Crew 9 Dragon Spacecraft splashdown safely off the coast of Florida.

WHAT'S IN THE NEWS?

1. NASA Astronaut Sunita Williams' Return to Earth

Extended Stay in Space Due to Technical Delays

1. NASA astronaut **Sunita Williams** and fellow astronaut **Butch Wilmore** initially embarked on a **short-duration space mission** to the **International Space Station (ISS)** in **June 2024** aboard **Boeing's CST-100 Starliner spacecraft**.

2. Their mission was originally planned to last for a **few days**, but **technical malfunctions** in the **Starliner's propulsion system** led to a **prolonged stay of nine months** in space.

3. The return journey, initially scheduled for **June 26, 2024**, was **postponed multiple times** due to **issues detected in key mechanisms** required for a safe flight back to Earth.

4. Eventually, NASA arranged for their return aboard **SpaceX's Crew Dragon** spacecraft, with the duo successfully **undocking from the ISS at 10:35 AM IST** and commencing their **17-hour return journey** to Earth.

Boeing Starliner: NASA's Crew Transport Spacecraft

Mission Purpose and Development

1. The **CST-100 Starliner** is a **Boeing-built spacecraft** designed specifically to **transport astronauts and cargo** to and from **low Earth orbit (LEO)** as part of **NASA's Commercial Crew Program**.

2. This spacecraft is intended to serve as an **alternative to SpaceX's Crew Dragon**, offering NASA more flexibility in **human spaceflight missions** to the ISS.

3. The **test flight mission** undertaken by **Williams and Wilmore** aimed to **validate the spacecraft's capability** for **safe and efficient crewed transport** to the ISS.

Key Features of Starliner

1. **Capacity**: Designed to **accommodate up to seven passengers** or a mix of **crew and cargo** for space missions.

2. **Reusability**: The spacecraft is **reusable up to 10 times**, with a **six-month turnaround period** between missions.

3. **Delays and Technical Issues**:

    - The Starliner's **return was delayed** due to issues in its **propulsion system**, causing concerns over **crew safety**.

    - These delays highlighted **engineering and operational challenges** in developing a **commercially viable crew transport system**.

SpaceX's Crew Dragon: The Alternative Transport to ISS

Crew Dragon vs. Cargo Dragon

1. SpaceX has developed **two variants** of its **Dragon 2 spacecraft**:

    - **Crew Dragon**: Primarily designed for **transporting astronauts** to the ISS.

- **Cargo Dragon**: Dedicated to **delivering scientific equipment, supplies, and payloads** to the ISS.

Development and First Mission

1. The **Crew Dragon program** was initiated as part of **NASA's transition** to **private companies** handling **space station missions** after the **retirement of the Space Shuttle in 2011**.

2. The first operational mission of Crew Dragon occurred in **2020**, successfully transporting **four astronauts** from the **United States and Japan** to the ISS.

Technical Details of Crew Dragon

1. **Two Major Components**:

    - A **reusable space capsule**, which serves as the primary module for **crew accommodation and control**.

    - An **expandable trunk module**, which provides **additional storage and power** for the mission.

2. **Launch Vehicle**: The spacecraft is launched into orbit aboard **SpaceX's Falcon 9 rocket**, a **two-stage reusable launch vehicle**.

3. **Automated Docking Capability**: Crew Dragon is equipped with **advanced docking systems**, enabling it to **autonomously dock** with the ISS without manual intervention.

SpaceX's Falcon 9 Rocket: Reusable Space Launch System

Design and Components

1. The **Falcon 9** is a **partially reusable two-stage rocket** designed to transport **crew and cargo** to **low Earth orbit (LEO) and beyond**.

2. **First Stage (Booster Stage)**:

    - Equipped with **nine Merlin engines**, developed in-house by SpaceX.

    - Contains **aluminum-lithium alloy tanks** filled with **liquid oxygen and rocket-grade kerosene** as propellant.

    - Capable of **returning to Earth and landing vertically**, enabling **reusability and cost savings**.

3. **Second Stage**:

    - Powered by **a single Merlin engine** that **propels the spacecraft into its designated orbit**.

- Unlike the first stage, it is **not reusable** and is discarded after deployment.

Health Impacts of Prolonged Space Travel

Space Anaemia: Reduced Red Blood Cell Production

1. **Space anaemia** is a condition where astronauts **experience a decline in red blood cell production** due to **microgravity-induced fluid shifts**.
2. **In microgravity**, bodily fluids **redistribute towards the upper body**, affecting blood circulation and reducing **haemoglobin levels**.
3. Unlike **terrestrial anaemia**, which is often caused by **nutritional deficiencies**, space anaemia is mainly **a physiological response** to the **absence of gravity**.

Bone Density Loss and 'Baby Feet' Phenomenon

1. Prolonged exposure to **microgravity causes gradual bone loss**, particularly in **weight-bearing bones** such as the **spine and legs**.
2. According to NASA, astronauts experience a **1% reduction in bone density per month** in space, making **recovery challenging** post-return.
3. **"Baby Feet" Effect**:
    - Due to **lack of weight and friction**, astronauts **lose foot calluses** over time.
    - This results in **soft, sensitive feet** upon returning to Earth, making it **uncomfortable to walk initially**.

Cosmic Radiation and DNA Damage

1. **Cosmic radiation** consists of **high-energy particles from outer space**, which can **penetrate the human body** and **damage DNA**.
2. Unlike Earth, where **the atmosphere and magnetic field** provide natural protection, astronauts in space are **highly exposed** to these particles.
3. **Health Risks**:
    - Prolonged radiation exposure can **cause genetic mutations**, increasing the risk of **cancer and other disorders**.
    - **Microgravity weakens the body's ability to repair damaged DNA**, leaving cells vulnerable to long-term effects.

Gaganyaan: India's First Crewed Space Mission

Mission Objectives and Significance

1. **Gaganyaan**, announced in **2018**, is India's **first human spaceflight program** designed to **demonstrate indigenous space travel capability**.

2. The mission aims to send **three astronauts** to **a 400 km orbit** for **three days** and return them safely to **Indian waters**.

3. If successful, India will join an **elite group** of nations—**the United States, Russia, and China**—in executing **crewed spaceflight missions**.

Challenges and Future Goals

1. **Human spaceflight is more complex than robotic missions** (e.g., Mars and Moon landings) due to the need for **life-support systems and safety mechanisms**.

2. **Short-term goal**: Demonstrate **low Earth orbit crewed spaceflight capabilities**.

3. **Long-term goal**: Lay the foundation for a **sustained human space exploration program**, enabling **future deep-space missions**.

4. Success in Gaganyaan will significantly **enhance India's technological prestige**, positioning ISRO among the **leading space agencies** worldwide.

Conclusion

1. The return of **Sunita Williams and Butch Wilmore** aboard **SpaceX's Crew Dragon** highlights the **challenges of commercial crewed spaceflight**.

2. **Boeing's Starliner delays** emphasize the **technical complexities** involved in developing **safe, reusable human space transport systems**.

3. **Prolonged space travel** presents **serious health risks**, including **anaemia, bone loss, and radiation exposure**, requiring **advanced countermeasures**.

4. **India's Gaganyaan mission** represents a **major milestone** in human space exploration, **paving the way for future deep-space missions** led by ISRO.

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