

## ASTR 4800 - Space Science: Practice & Policy

### Today: NASA's Budget

- Next Class: **Meet at Fiske Planetarium** for guest lecture from Lockheed Martin's Space Architects Tim Cichan & Christy Edwards.
  - Review NASA websites on the *Lunar Gateway* & *Humans on the Moon* referenced under Schedule for Oct. 5.
- Exam #1 on Monday, Oct. 10.
  - Includes all readings & lectures through Oct. 7.
  - See PowerPoint class notes on class website
  - Also allowed to bring one page (front & back) with notes.

Astroonomy 4800 - Space Science: Practice & Policy

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## SPACE IN THE NEWS: ASTEROID MINING

Presented by Jake Spicer

- The "Asteroid Mining Cooperation" set to start in 2025
  - Thousands of asteroids will be probed both from the main belt as well as those close to Earth's proximity.
- According to Asterank, the top 10 asteroids being tracked have materials valued at a total of 2 trillion USD
  - Psyche belt estimated to have an estimated value of 12,000 quadrillion USD
  - Space projects globally over 4 years spent "only" 18 billion
  - Materials extracted/extracting from asteroids have utilized 3D printing
  - Precious materials: water, iron, nickel, cobalt, platinum, etc.
- Some can be used for rocket fuel!

**Iron Meteorite**

**Stony Meteorite**

**Earth's Crust**

**Industrial metals**

- Iron
- Nickel
- Cobalt
- Oxygen
- Silicon
- Aluminum
- Calcium
- Sodium
- Hydrogen
- Magnesium

**Market Growth Rate By Region**

**Expected Growth Rate**

- High
- Mid
- Low

Class Question(s): Given the explosive history of resource extraction and with such large amounts of money at stake, do you feel this will have adverse effects on our global space economy? Who will see the benefits? How do you think this improves the quality of living on Earth?

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# NASA Budget

Haley Smallwood and Caroline Doran

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## NASA's Strategic Plan

Vision : Exploring the Secrets of the universe for the benefit of all  
Mission : NASA explores the unknown air and space, innovates the benefit of humanity, and inspires the world through discovery

**Discover :**  
Expand human knowledge through new scientific

**Explore :**  
Extend human presence to the moon and on towards mars for sustainable long-

**Advance :**  
Enhance Capabilities and operations to catalyze

**Innovate :**  
Catalyze economic growth and drive innovation to address

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### "Moon to Mars Planning Manifest"

CV	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
<b>ESDMD-Led</b>	Artemis I (Orion Flight Test)	Artemis II (Orion Flight Test)	Artemis III (Orion Flight Test)	Artemis IV (Orion Flight Test)	Artemis V (Orion Flight Test)	Artemis VI (Orion Flight Test)	Artemis VII (Orion Flight Test)	Artemis VIII (Orion Flight Test)	Artemis IX (Orion Flight Test)	Artemis X (Orion Flight Test)
<b>SMD-Led</b>	Lunar Gateway (Lunar Surface Services Module)	Lunar Gateway (Habitation Module)	Lunar Gateway (Power Module)	Lunar Gateway (Service Module)	Lunar Gateway (Lunar Surface Access Module)	Lunar Gateway (Lunar Surface Access Module)	Lunar Gateway (Lunar Surface Access Module)	Lunar Gateway (Lunar Surface Access Module)	Lunar Gateway (Lunar Surface Access Module)	Lunar Gateway (Lunar Surface Access Module)
<b>STMD-Led</b>	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)	Lunar Lander (Lunar Surface Access Module)

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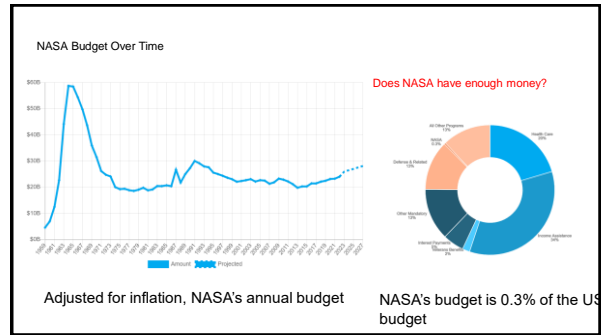
### Agency Priority Goals (APGs)

Title	APG Statement
<b>Climate Change Research</b>	Use the global vantage point of space to advance our understanding of the Earth system, its processes, and changing climate. By September 2023, NASA will advance climate change research by delivering two new observing systems and an upgrade to NASA's primary global Earth systems model.
<b>James Webb Space Telescope</b>	After launch, deployment, and start of science operations, the James Webb Space Telescope will study every phase in the history of our universe, ranging from the first luminous glows after the Big Bang, to the formation of other stellar systems capable of supporting life on planets like Earth, to the evolution of our own solar system. By September 30, 2023, NASA will complete commissioning of the James Webb Space Telescope, the most powerful and complex space telescope ever built, and begin Webb's Cycle 2 observations.
<b>Artemis</b>	Advance America's goal to land the first woman and the first person of color on the Moon and pursue a sustainable program of exploration by demonstrating capabilities that advance lunar exploration. By September 30, 2023, NASA will launch Artemis I, deliver the Core Stage for Artemis II to Kennedy Space Center for processing, and have multiple companies under contract to develop systems for sustainable human lunar exploration.
<b>Space Technology Leadership</b>	Ensure American global leadership in space technology innovations through increased partnering with industry and demonstrating key lunar surface and deep space technologies. By September 30, 2023, NASA will demonstrate leadership in space technology by: <ul style="list-style-type: none"> <li>Enhancing partnerships with industry through delivery or completion of milestones for at least 4 Tipping Point opportunities, and</li> <li>at least 3 critical small business technology transitions to develop capabilities that support NASA and commercial needs;</li> <li>Testing and delivering at least 3 new technologies that will be demonstrated on the lunar surface or in lunar orbit; and</li> <li>Completing at least 2 major milestones for projects that increase the Nation's capabilities in deep space.</li> </ul>

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Budget Authority (\$M)	FY 2021	FY 2022	FY 2022	FY 2023	FY 2023 Request		
	Enacted <sup>1</sup>	Request <sup>2</sup>	Enacted <sup>3</sup>	FY 2023	FY 2024	FY 2025	FY 2027
<b>Deep Space Exploration Systems</b>	5,396.5	6,750.2	6,791.7	<b>7,478.3</b>	8,786.1	8,510.4	8,912.3
Common Exploration Systems Development	4,538.7	4,483.7	-	<b>4,665.4<sup>4</sup></b>	3,613.8	3,111.9	2,845.6
Artemis Campaign Development	1,872.1	2,062.0	-	<b>2,600.3</b>	2,973.8	3,489.3	3,833.9
Human Exp Requirements & Architecture	9.5	9.5	-	<b>48.3</b>	48.9	49.5	50.0
Mars Campaign Development	176.2	195.0	-	<b>161.3</b>	161.6	162.7	162.8
<b>Space Operations</b>	4,101.9	4,147.6	4,041.3	<b>4,266.3</b>	5,181.4	5,400.6	5,011.1
International Space Station	1,321.6	1,307.6	-	<b>1,307.6</b>	1,289.9	1,302.1	1,302.5
Space Transportation	1,871.9	1,770.2	-	<b>1,769.5</b>	1,798.8	1,848.7	1,889.2
Space and Flight Support	980.3	947.2	-	<b>975.0</b>	1,031.7	1,033.1	1,033.1
Commercial LEO Development	16.1	102.6	-	<b>224.3</b>	228.2	229.4	302.1
Exploration Operations	0.0	0.0	-	<b>TBD<sup>5</sup></b>	832.9	972.3	1,037.2
<b>Space Technology</b>	1,100.0	1,420.0	1,100.0	<b>1,477.9</b>	1,468.7	1,466.0	1,525.9
Earth Science	2,903.2	2,200.0	-	<b>2,415.1</b>	2,460.3	2,589.0	2,722.3
Planetary Science	2,693.2	3,300.0	-	<b>3,166.3</b>	3,188.1	3,187.4	3,176.4
Astrophysics	1,770.9	1,575.2	-	<b>1,556.0</b>	1,587.0	1,578.5	1,620.5
Heliophysics	791.0	797.2	-	<b>792.2</b>	802.6	842.0	851.9
Biological and Physical Sciences	79.1	109.1	-	<b>100.4</b>	102.1	104.1	106.2
<b>Aeronautics</b>	826.7	914.8	880.7	<b>871.5</b>	960.9	1,010.7	1,030.9
Mission Services & Capabilities	1,918.3	2,028.9	-	<b>2,154.4</b>	2,197.5	2,241.5	2,286.3
<b>STEM Engagement</b>	127.0	147.0	137.0	<b>151.1</b>	151.1	152.2	159.3
Safety, Security, and Mission Services	2,926.5	3,049.2	3,020.0	<b>3,208.7</b>	3,272.9	3,338.4	3,405.2
Engineering, Safety, & Operations	1,918.2	1,022.4	-	<b>1,054.3</b>	1,075.4	1,096.9	1,118.9
Construction and Environmental Compliance & Restoration	445.8	390.3	410.3	<b>424.3</b>	432.8	441.5	450.3
Construction of Facilities	387.7	315.6	-	<b>348.1</b>	353.4	360.5	367.6
Environmental Compliance and Restoration	56.1	74.7	-	<b>76.2</b>	79.4	81.0	82.7
Inspector General	41.7	49.9	45.3	<b>41.4</b>	41.6	41.6	41.4
<b>NASA Total</b>	<b>21,711.3</b>	<b>24,081.6</b>	<b>24,021.1</b>	<b>25,473.1</b>	<b>26,491.4</b>	<b>27,072.1</b>	<b>27,114.8</b>

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How is the Budget Made?

- President Budget Request
  - Gets sent to Congress, explains the breakdown of each category in detail
- Fiscal Year begins Oct. 1
  - If budget is not approved by then, NASA is allowed to keep spending at the same rate they spent at during the previous fiscal year (called a continuing resolution)
- The budget always gets adjusted prior to approval
  - 3% increase in FY 2022 vs. 7% proposed increase

**FY22 Budget Proposals: NASA**  
\$ in 1 are the FY21 amounts

Category	Biden Request	House Bill	Senate Bill
NASA Total (\$23.3 B)	23.3	23.3	23.3
Space Technology (\$1.1 B)	1.1	1.4	2.0
Human Exploration (\$6.3 B)	6.3	6.3	12%
Space Operations (\$4.0 B)	4.0	4.0	0%
Aeronautics (\$0.8 B)	0.8	0.8	10%

American Institute of Physics | aip.org/ni

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Class Exercise

Why does Congress adjust the budget so much?

Is the budget being "sold" correctly, further, what do you think NASA can do to better advocate for themselves?

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Mars Campaign Development	176.2	195.0	-	<b>161.3</b>
Deep Space Exploration System	\$7.5 Billion			

Highlights:

- Common Exploration Systems Development
  - Artemis goal of landing the first woman and first person of color on the moon's south pole
  - SLS for completion of Artemis I and preparation for Artemis III and IV
  - Orion program to finish Artemis II crew vehicle
- Human Exploration Requirements and Architecture
  - Support strategy and architecture development for Moon and Mars exploration.
- Mars Campaign Development
  - Habitation systems required for deep space missions
  - Human support such as exercise equipment, diagnostic sensors, models of human physiology.

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<b>Space Operations</b>	4,101.9	4,147.6	4,041.3	<b>4,266.3</b>
International Space Station	1,321.6	1,327.6	-	<b>1,307.6</b>
Space Transportation	1,871.9	1,770.2	-	<b>1,759.5</b>
Space and Flight Support	890.3	947.2	-	<b>975.0</b>
Commercial LEO Development	18.1	102.6	-	<b>224.3</b>
Exploration Operations	0.0	0.0	-	<b>TBD</b>
Space Operations: \$4.2 Billion				

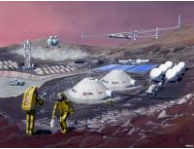
- ISS - main part of budget
  - Overall maintenance; support through 2030
- Space Transportation
  - Crewed missions and crew support/safety
- Space and Flight Support
  - General safety for astronauts; training and research to better support
  - Includes extra funding for additional rocket testing
- Exploration Operations
  - TBD, contingent on requirements assessments after Artemis I
  - Moving from "Common Exploration Systems Development"

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Budget Authority (\$M)	FY 2021 Enacted <sup>1)</sup>	FY 2022 Request <sup>2)</sup>	FY 2022 Enacted <sup>3)</sup>	FY 2022 Enacted <sup>4)</sup>
Space Technology	1,100.0	1,425.0	1,100.0	1,437.5
Space technology	\$1.5 Billion			

Highlights :

- Develop technologies to improve capabilities and reduce cost of space missions while strengthening the space industry
- Testing developments at the Moon which are critical for crewed missions.




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Budget Authority (\$M)	FY 2021 Enacted <sup>1)</sup>	FY 2022 Request <sup>2)</sup>	FY 2022 Enacted <sup>3)</sup>	FY 2022 Enacted <sup>4)</sup>
Science	7,290.7	7,931.4	7,614.4	7,988.3
Earth Science	1,996.5	2,250.0	-	2,411.5
Planetary Science	2,693.2	3,200.0	-	3,160.2
Astrophysics	1,770.9	1,575.2	-	1,566.0
Heliophysics	751.0	797.2	-	760.2
Biological and Physical Sciences	79.1	109.1	-	100.4

Science: \$7.9 Billion

- Earth Science
  - Climate change research; greenhouse gas monitoring; wildfire research and technology
- Planetary Science
  - Mars Sample Return Mission; Lunar Discovery and Exploration program (VIPER mission); continued funding for Europa Clipper, Psyche and Dragonfly
- Astrophysics
  - JWST, HST, Chandra funding
  - Nancy Grace Roman telescope funding, launch proposed for 2027
  - Cancelled SOFIA in accordance with 2020 Decadal survey



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STEM Engagement	127.0	147.0	137.0	150.1
STEM engagement				

Highlights :

- Invests in the nation's next great scientists, engineers, and so on.
- Creates unique opportunities to inspire a diverse set of students towards the future STEM workforce.

Original nasa charter from 1958 doesn't say anything about outreach

Question : Considering many of the goals and motivations for NASA are similar to what the 1958 NASA Charter laid out, why would NASA now include such and emphasis on STEM engagement and inspiring the next generation?



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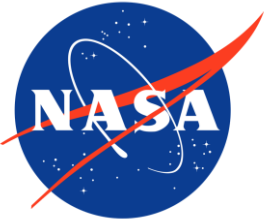
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Construction and Environmental Compliance & Restoration	445.8	390.3	410.3	424.3
Construction of Facilities	387.7	315.6	-	348.1
Environmental Compliance and Restoration	58.1	74.7	-	76.2

SSMS and CECR: \$3.6 Billion

- Safety, Security, and Mission Services - \$3.2 Billion
  - Maintenance of all NASA centers - \$2.1 Billion
  - Strategic cybersecurity risk management
  - Enables mission success across all programs and projects
- Construction and Environmental Compliance & Restoration - \$424 Million
  - Support Exploration mission work (SLS, Orion, Exploration Ground Systems programs)
  - "Construct, repair, or revitalize institutional infrastructure that supports capabilities across all centers"

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Thanks everyone!!




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