

# MY CAREER AT NASA

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AIChE Manhattan  
College Chapter  
Chemical Engineering  
Virtual Alumni Talk

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

OCTOBER 2020

**Nithin S. Abraham**  
**COATINGS ENGINEER**

**NASA Goddard Space Flight Center**  
Contamination & Coatings Engineering Branch  
Greenbelt, Maryland 20771 USA  
E-mail [nithin.s.abraham@nasa.gov](mailto:nithin.s.abraham@nasa.gov)  
Phone (301) 614-7070



- **2009, Bachelor of Science (B.S.)**
  - **Major:** Chemical Engineering
  - **Minors:** Chemistry and Mathematics
- **2010, Master of Science (M.S.)**
  - **Major:** Chemical Engineering
  - **Thesis Topic:** Sustainable water purification and filtration solutions using activated carbon derived from coconut shells



## National Aeronautics and Space Administration (NASA)

- Agency has 10 centers, its headquarters, and various facilities & laboratories across the US

### NASA Locations



IMAGE CREDIT: NASA

- **Ames Research Center**  
Mountain View, CA
- **Armstrong Flight Research Center**  
Edwards, CA
- **Glenn Research Center**  
Cleveland, OH
- **Goddard Space Flight Center**  
Greenbelt, MD
- **Goddard Institute of Space Studies**  
New York, NY
- **Katherine Johnson Independent Verification and Validation Facility**  
Fairmont, WV
- **Jet Propulsion Laboratory**  
Pasadena, CA
- **Johnson Space Center**  
Houston, TX
- **Kennedy Space Center**  
Cape Canaveral, FL
- **Langley Research Center**  
Hampton, VA
- **Marshall Space Flight Center**  
Huntsville, AL
- **Michoud Assembly Facility**  
New Orleans, LA
- **NASA Engineering and Safety Center**  
Hampton, VA
- **NASA Headquarters**  
Washington, D.C.
- **NASA Safety Center**  
Cleveland, OH
- **NASA Shared Services Center**  
Hancock County, MS
- **Plum Brook Station**  
Sandusky, OH
- **Stennis Space Center**  
Hancock County, MS
- **Wallops Flight Facility**  
Wallops Island, VA
- **White Sands Test Facility**  
Las Cruces, NM



# Goddard Space Flight Center



## NASA Goddard Space Flight Center

- Main campus is located in Greenbelt, Maryland
- Established in 1959 as NASA's first space flight complex
- Builds spacecraft, instruments, and new technology to study Earth, the sun, our solar system and the universe
- Critical in carrying out NASA's missions of space exploration and scientific discovery
- Named after Dr. Robert H. Goddard, an American rocketry pioneer (known as "the father of modern rocket propulsion")
- Goddard installation locations include:

Goddard Institute for Space Studies  
in New York City

Katherine Johnson Independent  
Verification and Validation Facility  
in Western Virginia

Wallops Flight Facility  
in Virginia's Eastern Shore

White Sands Complex  
in New Mexico



IMAGE CREDIT: NASA/GSFC

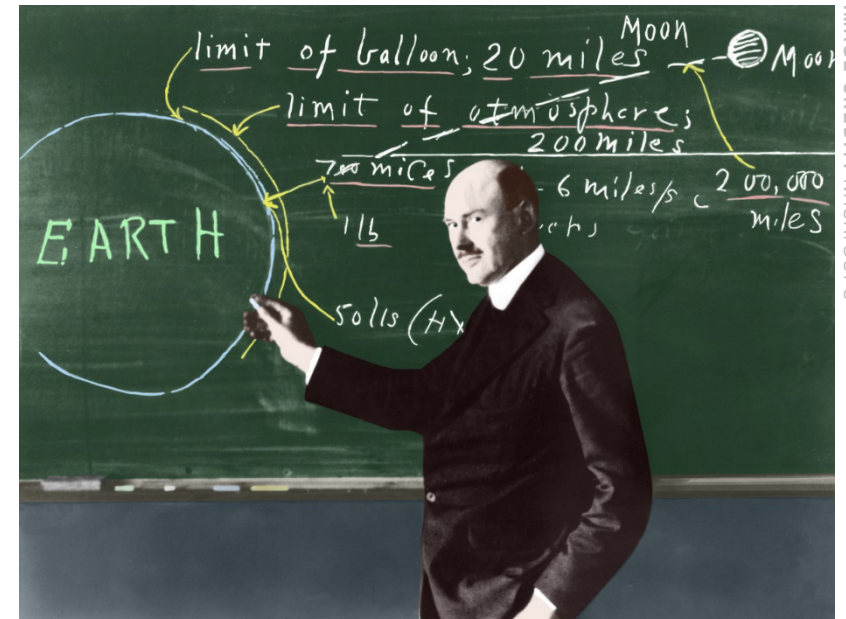


IMAGE CREDIT: NASA/GSFC

## Coatings Engineer

- NASA Goddard Space Flight Center
- Contamination and Coatings Engineering Branch (Code 546)
- Started career in aerospace in 2010
- Provide technical subject matter expertise in:
  - Spaceflight thermal control coatings
  - Spaceflight technology research and development of coatings and materials, e.g. molecular adsorber coatings
- Work on NASA's astrophysics, earth science, heliophysics, and planetary science missions
- Support NASA mission objectives and strategic technology transfer partnership efforts



IMAGE CREDIT: NASA/GSFC/PAT IZZO



# My Career at NASA



## As a Coatings Engineer, I ...

- Consult and make recommendations on coatings-related topics and discussions
- Lead research and development efforts on spaceflight coatings and materials
- Perform thermal/optical property and performance tests on coatings
- Coordinate activities involved with the application of coatings on flight hardware
- Inspect critical thermal coating surfaces through integration and test activities
- Install adsorber coatings in strategic locations to mitigate molecular contamination concerns

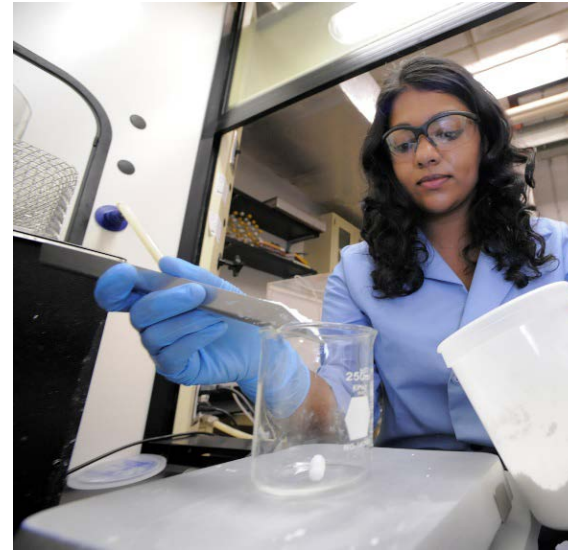


IMAGE CREDIT: NASA/GSFC/PAT IZZO



IMAGE CREDIT: NASA/GSFC/CHRIS GUNN



IMAGE CREDIT: NASA/GSFC/CHRIS GUNN

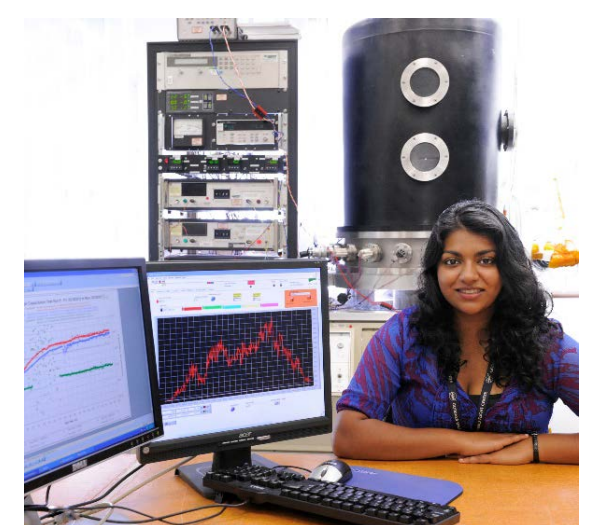


IMAGE CREDIT: NASA/GSFC/PAT IZZO

# Thermal Control Coatings

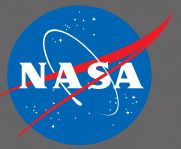


- Thermal coatings are unique spaceflight materials that play an important role in **passive thermal control management** of spacecraft, satellites, instruments, and telescopes
- Thermal coatings allow a spacecraft to survive the **harsh conditions** of space
- Thermal coating systems include:
  - Spray applied coatings and primers
  - Vacuum vapor deposition thin films
  - Space insulation blanket materials
  - Reflective tape materials
  - Thermal control surfaces and materials





# Thermal Control Coatings



## Temperature

- Thermal properties of thermal coatings help **passively control** temperatures within the operational range
  - Radiates heat (*e.g. low solar absorptance, high emittance*)
  - Regulates heat (*e.g. high solar absorptance, high emittance*)

## Electrical Charging

- Electrically dissipative or conductive properties of thermal coatings help mitigate **charge build-up** on the spacecraft

## Straylight

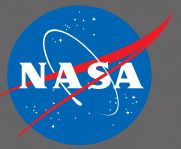
- Optical properties of thermal coatings help **suppress straylight** within instrument cavities



IMAGE CREDIT: NASA/GSFC



# Thermal Control Coatings



## Space Environment

- Durability and degradation properties of thermal coatings are dependent on exposure to **space radiation effects** and **harsh environmental factors**, such as:
  - Atomic Oxygen
  - Ultraviolet Radiation
  - Charged Particles
  - Solar Wind
  - Vacuum Pressures
  - Contamination
  - Launch Acoustics
  - Launch Vibrations
  - Orbit Conditions

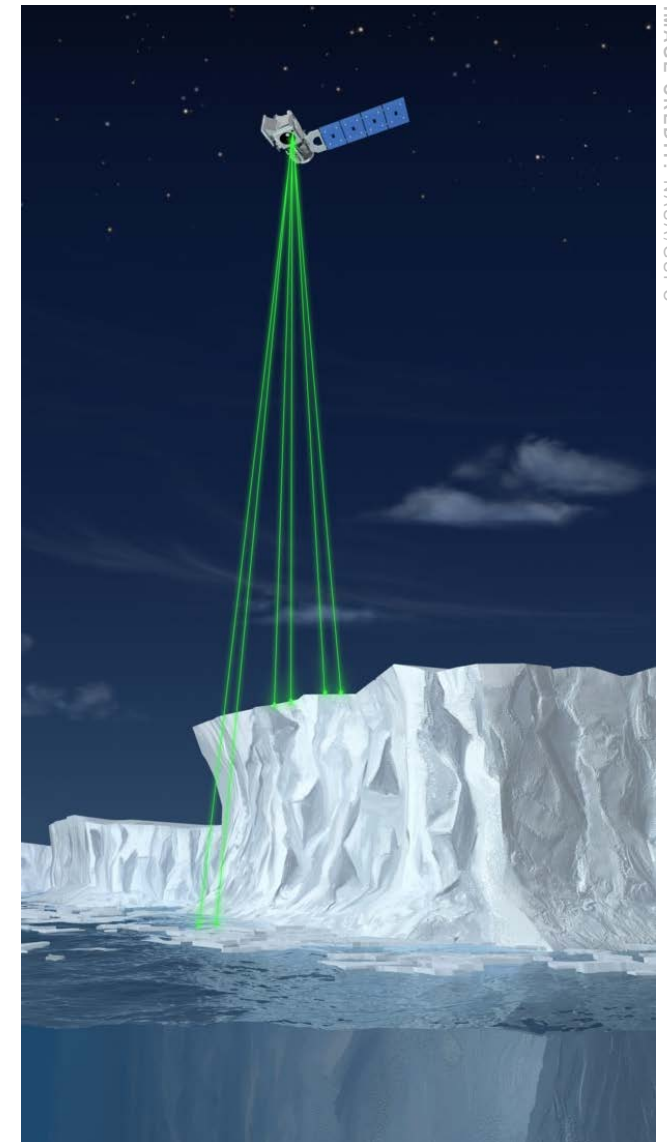


IMAGE CREDIT: NASA/GSFC

# Molecular Adsorber Coatings

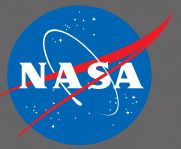


- Presence of **molecular contaminants** can pose a significant threat to NASA science and exploration missions
- Sources originate from commonly used spacecraft materials that **outgas** (or release molecules) during vacuum testing or during spaceflight operations
  - e.g. adhesives, lubricants, epoxies, potting compounds
- Molecular contaminants can **deposit** on critical surfaces
  - e.g. optics, electronics, laser systems, detectors, baffles, solar arrays, thermal coatings, and vacuum chambers
- This can **degrade** the performance and operational lifetime of satellites, telescopes, and instruments

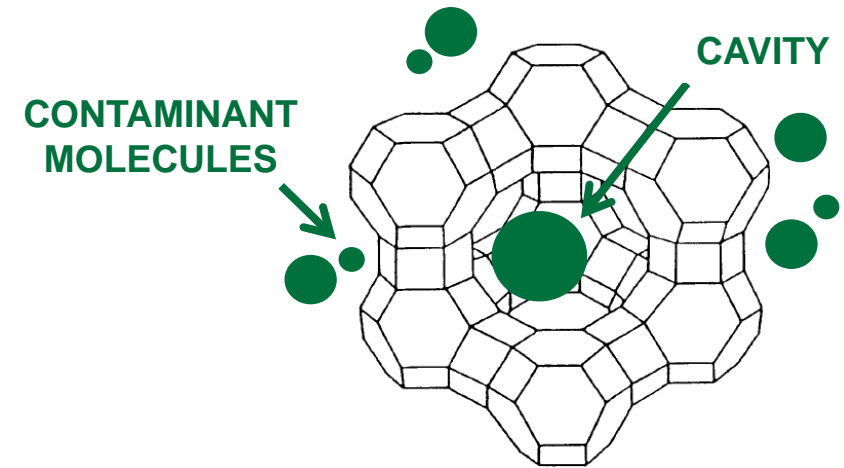




# Molecular Adsorber Coatings



- NASA developed sprayable coatings technology
- Highly porous structure designed to **passively capture** molecular contaminants
- High **surface area** and **surface roughness** properties



SCANNING ELECTRON MICROSCOPE

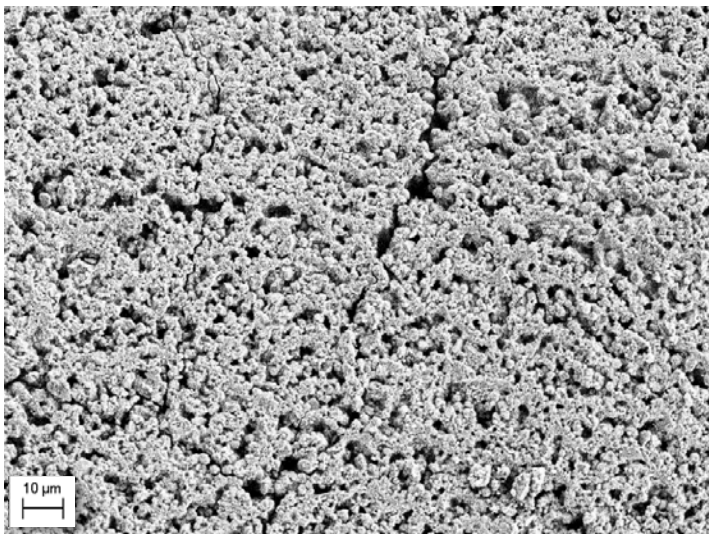


IMAGE CREDIT: NASA/GSFC

MAC TECHNOLOGY VARIATIONS

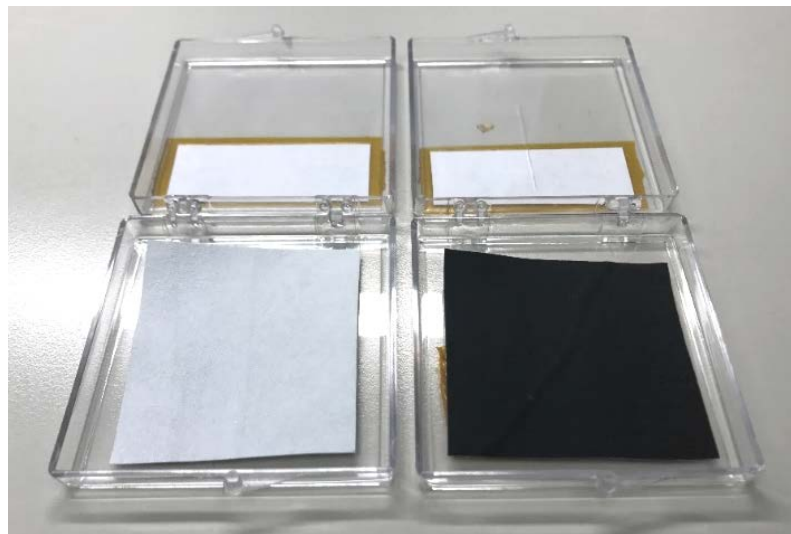


IMAGE CREDIT: NASA/GSFC

CONFOCAL MICROSCOPE IMAGE

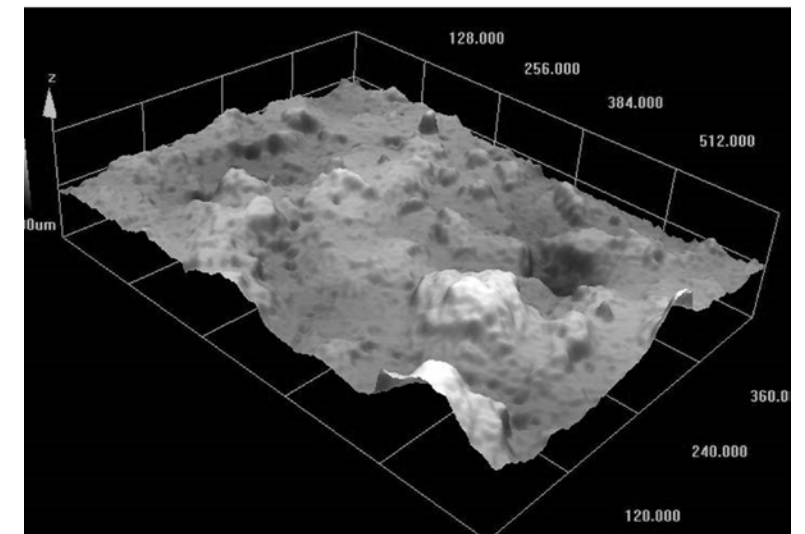
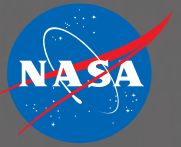


IMAGE CREDIT: NASA/GSFC

# Molecular Adsorber Coatings

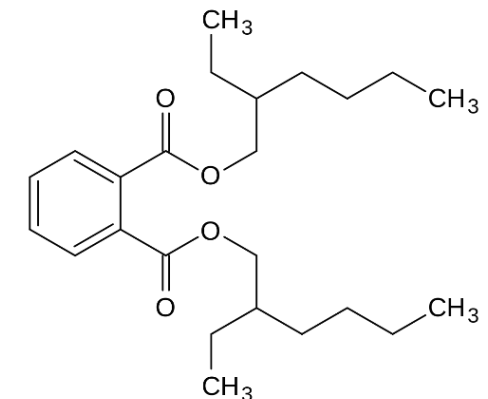
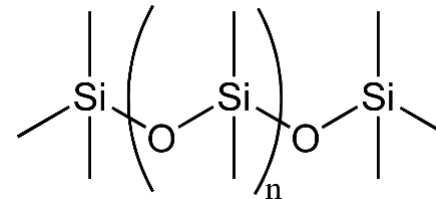
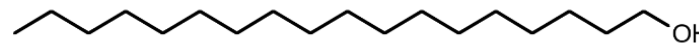


- Ground tested and flight qualified at **representative spaceflight conditions**

<b>CONDITIONS</b>	<ul style="list-style-type: none"><li>Under high vacuum pressures</li><li>At moderate temperature ranges</li></ul>
<b>TESTING</b>	<ul style="list-style-type: none"><li>Adsorptive capabilities, thermal/optical properties, adhesion performance, thermal stability, and particulate characteristics</li></ul>

- Tailorable to meet specific adsorption characteristics
- Effective at trapping **high molecular weight chemical species**

- Long-chained hydrocarbons
- Silicones
- Plasticizers
- Other outgassed constituents from common spaceflight materials





# Molecular Adsorber Coatings

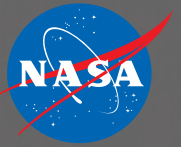
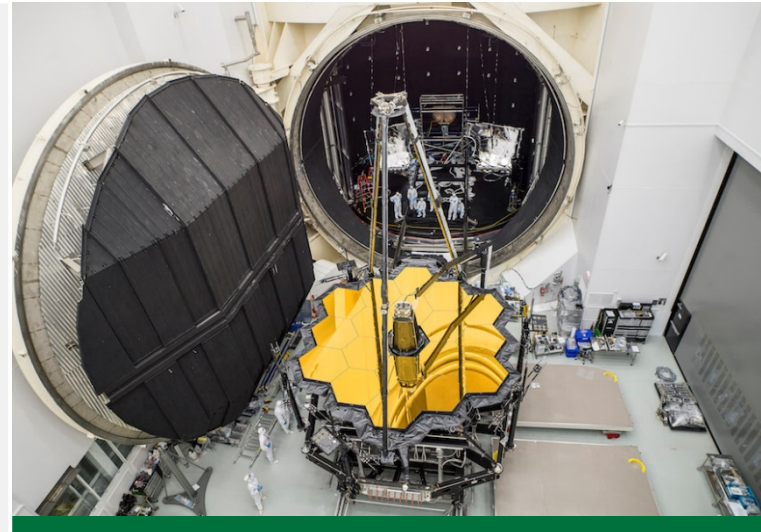


IMAGE CREDIT: NASA/GSFC

## NASA Ground Applications

- Use as “getter material” during vacuum testing of critical hardware and components to mitigate risk of molecular contaminants from chamber environments



## James Webb Space Telescope (JWST)

Implemented during cryogenic thermal vacuum testing of critical flight and optical ground support hardware

## NASA Flight Applications

- Use within internal instrument or laser cavities to address on-orbit material outgassing concerns

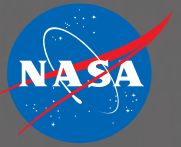


IMAGE CREDIT: NASA/UCB

## Ionospheric Connection Explorer (ICON)

Installed within contamination sensitive far ultraviolet instrument cavity benches of spectrograph and imager

# Molecular Adsorber Coatings



## Strategic Partnerships

- NASA innovations can also benefit us here on Earth through the process of technology transfer and spinoff technologies
  - e.g. hair straighteners, temper foam mattresses, baby formula, heart pumps
- NASA partners with industry on topics of mutual interest to discover endless possibilities

## NASA Space Act Agreement with Smithsonian Institution's National Museum of Natural History

- Collaboration involves a preliminary investigation of the molecular adsorber coating technology for protecting natural science museum collections from molecular contaminants



IMAGE CREDIT: NASA/GSFC/CHRIS GUNN



IMAGE CREDIT: NASA/GSFC/CHRIS GUNN



# Deep Space Climate Observatory (DSCOVR)



A series of still images from EPIC aboard DSCOVR shows fully illuminated “dark side” of the moon that is never visible from Earth as it moves in front of sunlit side of Earth



IMAGE CREDIT: NASA/NOAA

- NOAA space weather, space climate and Earth observation satellite
- Launched February 2015
- Orbits **~1 million miles from Earth** at L1 Lagrange point
- Monitors changes in **solar wind**
- Provides space weather alerts and forecasts for geomagnetic storms that could disrupt power grids, satellites, aviation, telecommunications, and GPS
- Earth Polychromatic Imaging Camera (EPIC)
  - Takes a new picture of Earth every 2 hours
  - Captures images of solar eclipses and the Moon

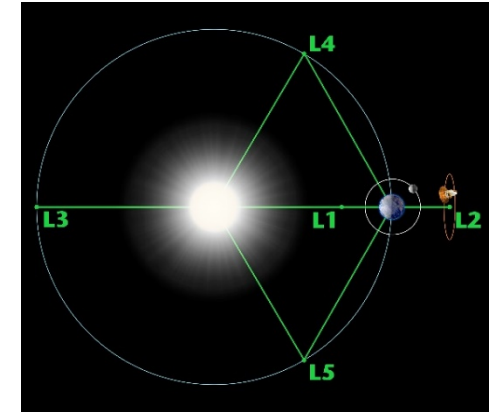
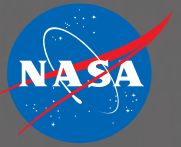


IMAGE CREDIT: NASA

# Ice, Cloud and land Elevation Satellite (ICESat-2)



- Studies the **cryosphere** to investigate changes in Earth's frozen and icy regions due to the warming climate
- Launched September 2018 to low earth orbit
- Advanced Topographic Laser Altimeter System (ATLAS)
  - Instrument measures height of **glaciers, ice sheets, sea ice**
- Scientists have measured thickness of Arctic sea ice and depth of snow on ice
- ICESat-2 will gather enough data to estimate annual height change of Greenland and Antarctic ice sheets to within 4 millimeters – the width of a No. 2 pencil!

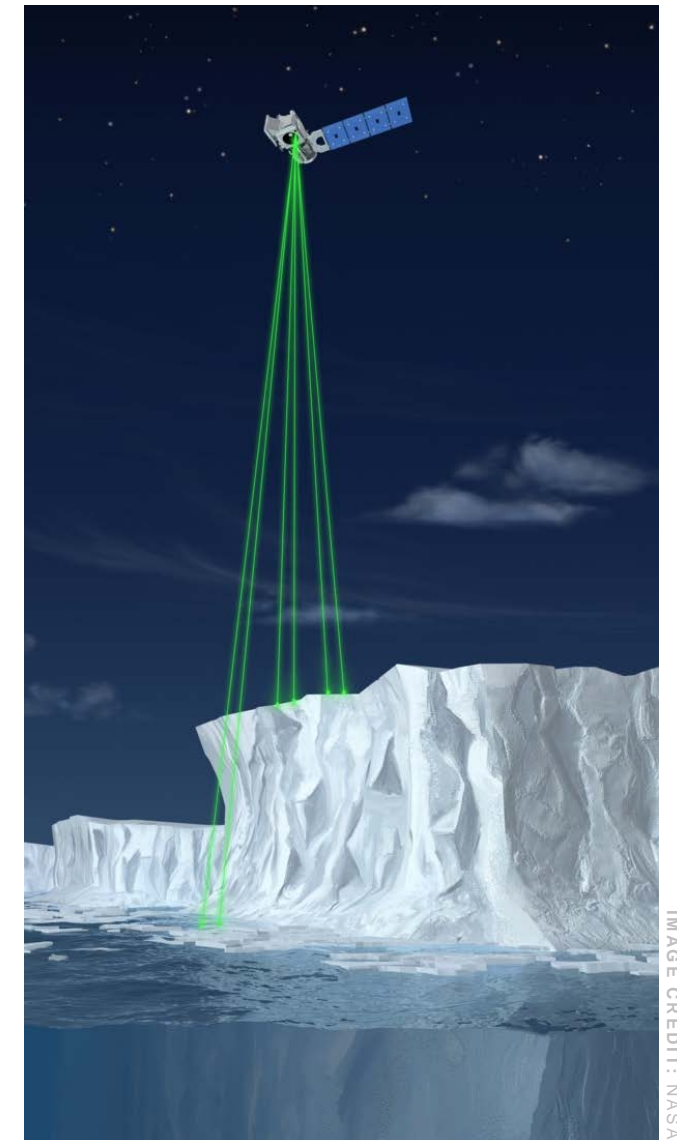
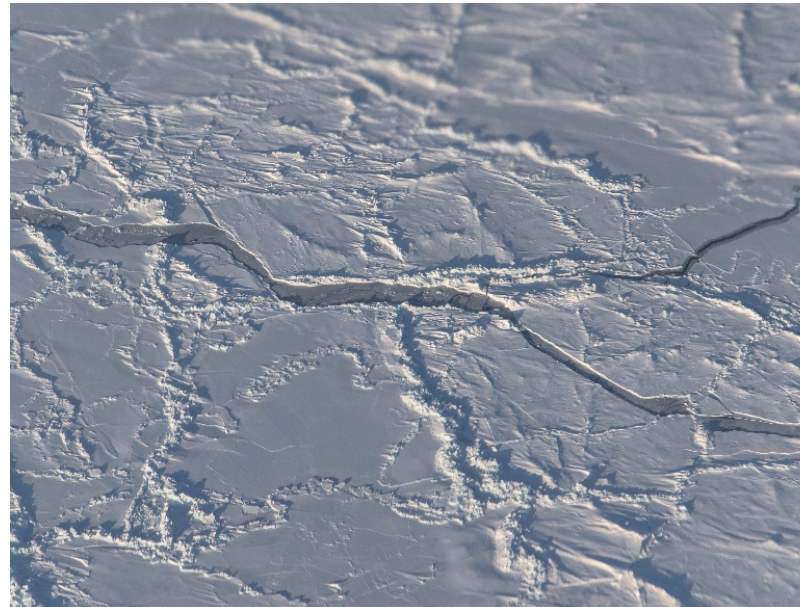


IMAGE CREDIT: NASA



# Global Ecosystem Dynamics Investigation (GEDI)



- Advanced laser technology will create first 3-dimensional map of **forest ecosystems** around the world
- Will measure height of **foliage, branches, trees** and **shrubs** to yield new insights into how forests are storing or releasing **carbon**
- Launched December 2018 to International Space Station
- Highest resolution and densest sampling of any lidar ever put in orbit!

IMAGE CREDIT: NASA/JSC

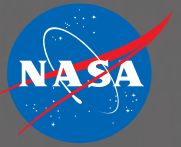


IMAGE CREDIT: NASA/GSFC

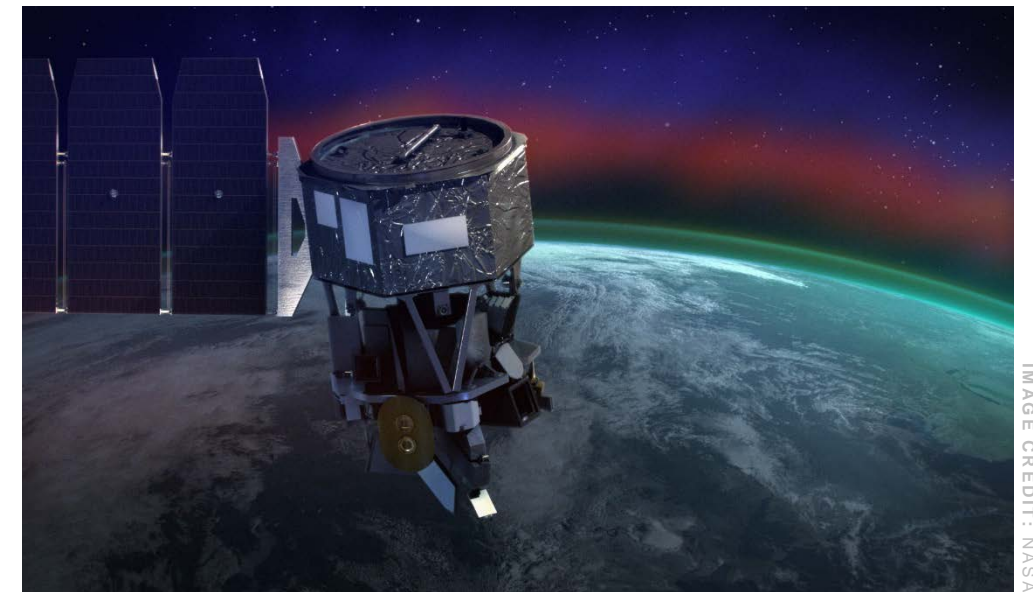
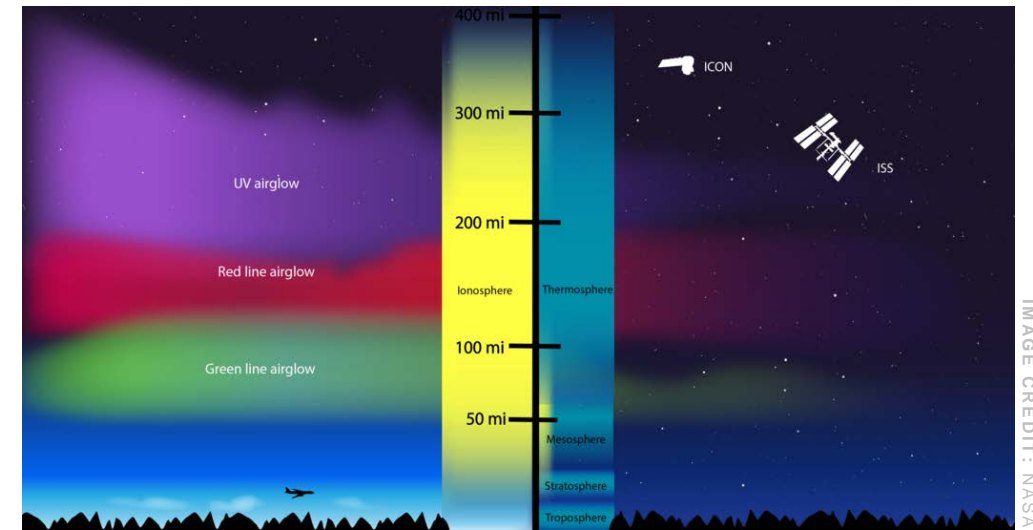


IMAGE CREDIT: NASA/GSFC

# Ionospheric Connection Explorer (ICON)



- Will investigate interactions of space weather and Earth weather and sources of **ionospheric variations**
- Launched October 2019 to low earth orbit
- Charged particles from solar radiation create colorful bands of plasma known as **airglow** above the Earth's surface
- Will better understand disturbances that are responsible for signal interferences to space based technologies, such as communication and navigation systems





# Thermal Infrared Sensor 2 (TIRS-2)



- Instrument is a 2-channel thermal imager
- Will fly aboard **Landsat 9** satellite
  - Landsat mission series has taken Earth imagery since 1972
- Will measure **land surface temperatures** across the globe
- Track wild fires, volcanos, clouds
- Detect amount of water and irrigation used in agriculture fields
- Planned for launch in mid-2021



IMAGE CREDIT: NASA/GSFC

# James Webb Space Telescope (JWST)



[YouTube](#)

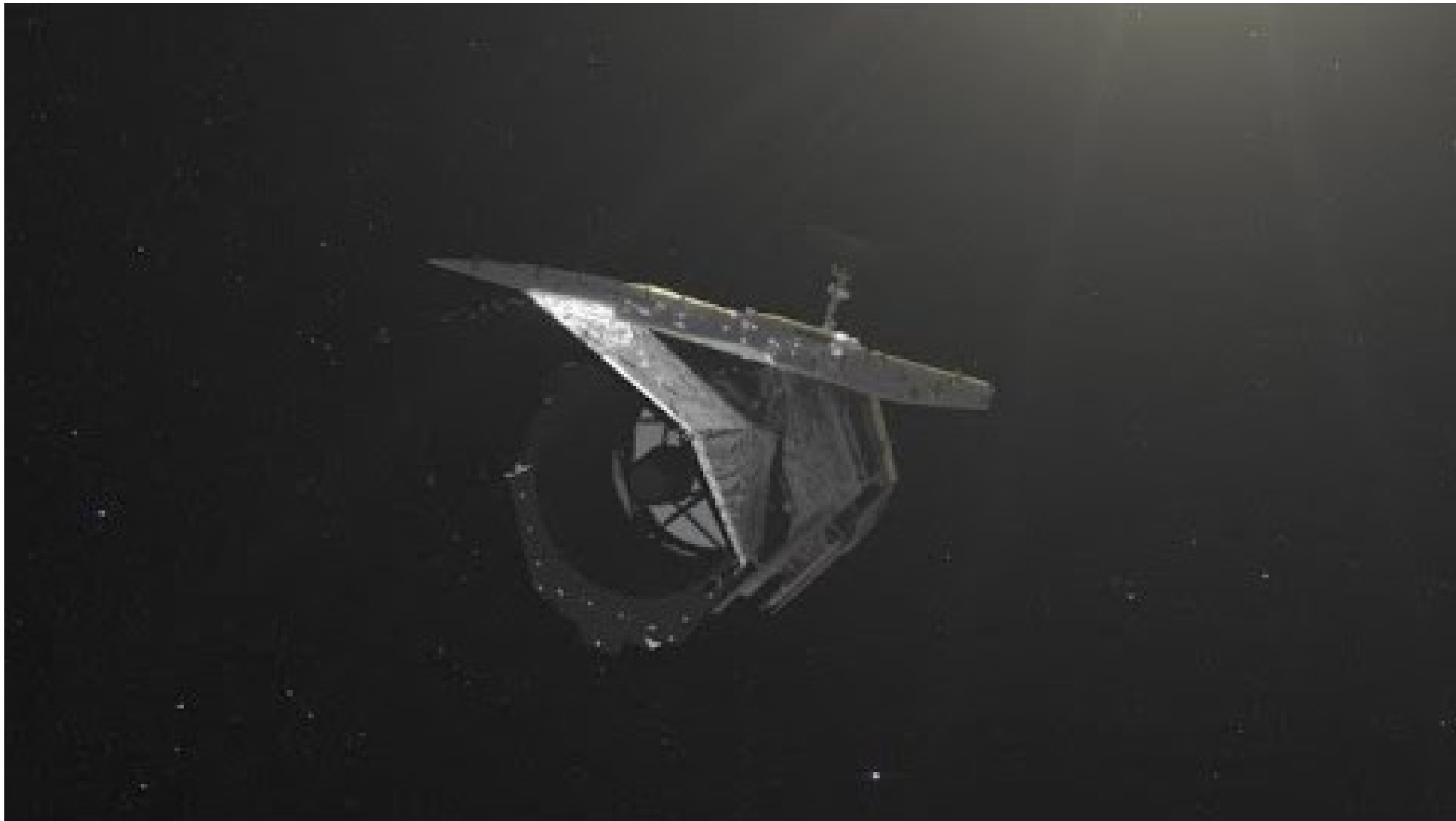
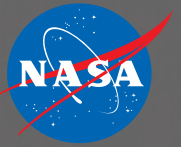
Video Credit: NASA/GSFC

An Introduction to the  
James Webb Space  
Telescope Mission





# Nancy Grace Roman Space Telescope (RST)



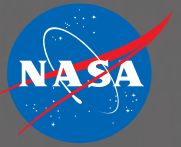
[YouTube](#)

Video Credit: NASA/GSFC

NASA's Nancy Grace  
Roman Space Telescope:  
Broadening Our Cosmic  
Horizons



# My Advice to Students



- **Apply for internship opportunities**

- Explore diverse career paths and gain valuable experiences
- Figure out what you like to do (or don't like to do)
- As an intern, ask a lot of questions and learn as much as you can
- Remember to network with career professionals

- **Build your support network**

- Don't be afraid to ask for help
- Find mentors who will guide you and sponsors who will advocate for you
- Surround yourself with people who will encourage and support your growth

- **Be a team player**

- Collaborate in teams to meet shared project goals or objectives
- Play to your strengths and interests; support and respect your team



# NASA Internship Opportunities



IMAGE CREDIT: NASA

## NASA Locations



Opportunities are available **agency-wide** across the US at 10 centers and other locations. For more information, visit: <https://www.nasa.gov/careers/where-we-work>

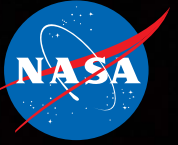
## STEM Engagement Internships

- For high school, undergraduate, and graduate students
- Offered in spring, summer, and fall sessions
- Visit: <https://www.intern.nasa.gov>

## Pathways Internship Program

- For current students and recent graduates
- Offers path for permanent employment at the agency
- Visit: <https://www.nasa.gov/careers/pathways-program>

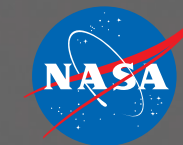




**THANK YOU!**  
*Any Questions?*



# References



#	REFERENCE TITLE	WEBSITE   ACCESSED 4 SEPTEMBER 2020
1	What is NASA?	<a href="https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-nasa-58.html">https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-nasa-58.html</a>
2	NASA Centers and Facilities	<a href="https://www.nasa.gov/about/sites/index.html">https://www.nasa.gov/about/sites/index.html</a>
3	Where We Work	<a href="https://www.nasa.gov/careers/where-we-work">https://www.nasa.gov/careers/where-we-work</a>
4	Goddard Space Flight Center	<a href="https://www.nasa.gov/centers/goddard/about/index.html">https://www.nasa.gov/centers/goddard/about/index.html</a>
5	Dr. Robert H. Goddard, American Rocketry Pioneer	<a href="https://www.nasa.gov/centers/goddard/about/history/dr_goddard.html">https://www.nasa.gov/centers/goddard/about/history/dr_goddard.html</a>
6	Ah, That New Car Smell: NASA Technology Protects Spacecraft from Outgassed Molecular Contaminants	<a href="https://www.nasa.gov/topics/technology/features/outgas-tech.html">https://www.nasa.gov/topics/technology/features/outgas-tech.html</a>
7	NASA Technology Protects Webb Telescope from Contamination	<a href="https://www.nasa.gov/feature/goddard/nasa-technology-protects-webb-telescope-from-contamination">https://www.nasa.gov/feature/goddard/nasa-technology-protects-webb-telescope-from-contamination</a>
8	What Lurks Beneath NASA's Chamber A	<a href="https://www.nasa.gov/feature/goddard/2017/what-lurks-below-nasas-chamber-a">https://www.nasa.gov/feature/goddard/2017/what-lurks-below-nasas-chamber-a</a>
9	NASA Developed Coating Investigated for Protecting Smithsonian Specimens	<a href="https://www.nasa.gov/feature/goddard/2018/nasa-developed-coating-investigated-for-protecting-smithsonian-specimens">https://www.nasa.gov/feature/goddard/2018/nasa-developed-coating-investigated-for-protecting-smithsonian-specimens</a>
10	NASA Goddard Strategic Partnership Office	<a href="https://partnerships.gsfc.nasa.gov/index.html">https://partnerships.gsfc.nasa.gov/index.html</a>
11	NASA Solar System DSCOVR Mission In Depth	<a href="https://solarsystem.nasa.gov/missions/DSCOVR/in-depth/">https://solarsystem.nasa.gov/missions/DSCOVR/in-depth/</a>
12	From a Million Miles Away, NASA Camera Shows Moon Crossing Face of Earth	<a href="https://www.nasa.gov/feature/goddard/from-a-million-miles-away-nasa-camera-shows-moon-crossing-face-of-earth">https://www.nasa.gov/feature/goddard/from-a-million-miles-away-nasa-camera-shows-moon-crossing-face-of-earth</a>
13	NOAA DSCOVR: Deep Space Climate Observatory	<a href="https://www.nesdis.noaa.gov/content/dscovr-deep-space-climate-observatory">https://www.nesdis.noaa.gov/content/dscovr-deep-space-climate-observatory</a>
14	YouTube: One Year on Earth – Seen From 1 Million Miles	<a href="https://youtu.be/CFrP6QfbC2g">https://youtu.be/CFrP6QfbC2g</a>
15	Goddard ICESat-2	<a href="https://icesat-2.gsfc.nasa.gov/">https://icesat-2.gsfc.nasa.gov/</a>
16	NASA ICESat-2	<a href="https://www.nasa.gov/content/goddard/icesat-2">https://www.nasa.gov/content/goddard/icesat-2</a>

#	REFERENCE TITLE	WEBSITE   ACCESSED 4 SEPTEMBER 2020
17	YouTube: Countdown to ICESat-2 Launch	<a href="https://youtu.be/ybt5Qy4XaNU">https://youtu.be/ybt5Qy4XaNU</a>
18	GEDI Ecosystem Lidar	<a href="https://gedi.umd.edu/">https://gedi.umd.edu/</a>
19	Return of GEDI's First Data Reveals the Third Dimension of Forests	<a href="https://www.nasa.gov/feature/goddard/2019/return-of-gedi-first-data-shows-forests-topography">https://www.nasa.gov/feature/goddard/2019/return-of-gedi-first-data-shows-forests-topography</a>
20	YouTube: NASA's Laser Mission to Measure Trees	<a href="https://youtu.be/qpzFn5bqhI4">https://youtu.be/qpzFn5bqhI4</a>
21	YouTube: May the Forest Be with You: GEDI Moves Toward Launch To Space Station	<a href="https://youtu.be/XjieZ9iZHWs">https://youtu.be/XjieZ9iZHWs</a>
22	NASA ICON	<a href="https://www.nasa.gov/icon">https://www.nasa.gov/icon</a>
23	UC Berkeley ICON	<a href="https://icon.ssl.berkeley.edu/">https://icon.ssl.berkeley.edu/</a>
24	YouTube: Meet ICON: NASA's Airglow Explorer	<a href="https://youtu.be/b94PaWleG9Q">https://youtu.be/b94PaWleG9Q</a>
25	New Landsat Infrared Instrument Ships from NASA	<a href="https://www.nasa.gov/feature/goddard/2019/new-landsat-infrared-instrument-ships-from-nasa">https://www.nasa.gov/feature/goddard/2019/new-landsat-infrared-instrument-ships-from-nasa</a>
26	TIRS-2 Testing: A Landsat 9 Instrument Takes Shape	<a href="https://landsat.gsfc.nasa.gov/tirs-2-testing-a-landsat-9-instrument-takes-shape/">https://landsat.gsfc.nasa.gov/tirs-2-testing-a-landsat-9-instrument-takes-shape/</a>
27	YouTube: TIRS-2 Ships From Goddard	<a href="https://youtu.be/qd8CZctgXBM">https://youtu.be/qd8CZctgXBM</a>
28	NASA Landsat 9 Science Instrument Details	<a href="https://landsat.gsfc.nasa.gov/landsat-9/instruments/landsat-9-science-instrument-details/">https://landsat.gsfc.nasa.gov/landsat-9/instruments/landsat-9-science-instrument-details/</a>
29	NASA James Webb Space Telescope	<a href="https://www.jwst.nasa.gov/">https://www.jwst.nasa.gov/</a>
30	YouTube: An Introduction to the James Webb Space Telescope Mission	<a href="https://youtu.be/6VqG3Jazrfs">https://youtu.be/6VqG3Jazrfs</a>
31	NASA Nancy Grace Roman Space Telescope	<a href="https://roman.gsfc.nasa.gov/">https://roman.gsfc.nasa.gov/</a>
32	YouTube: NASA's Nancy Grace Roman Space Telescope: Broadening Our Cosmic Horizons	<a href="https://youtu.be/jPq2VVpjk_U">https://youtu.be/jPq2VVpjk_U</a>
33	NASA STEM Engagement Internships	<a href="https://www.intern.nasa.gov">https://www.intern.nasa.gov</a>
34	NASA Pathways Program	<a href="https://www.nasa.gov/careers/pathways-program">https://www.nasa.gov/careers/pathways-program</a>
35	NASA Internship Programs	<a href="https://www.nasa.gov/sites/default/files/atoms/files/internship_opportunities_brochure_web.pdf">https://www.nasa.gov/sites/default/files/atoms/files/internship_opportunities_brochure_web.pdf</a>