LAUNCHING LEARNING

United Launch Alliance

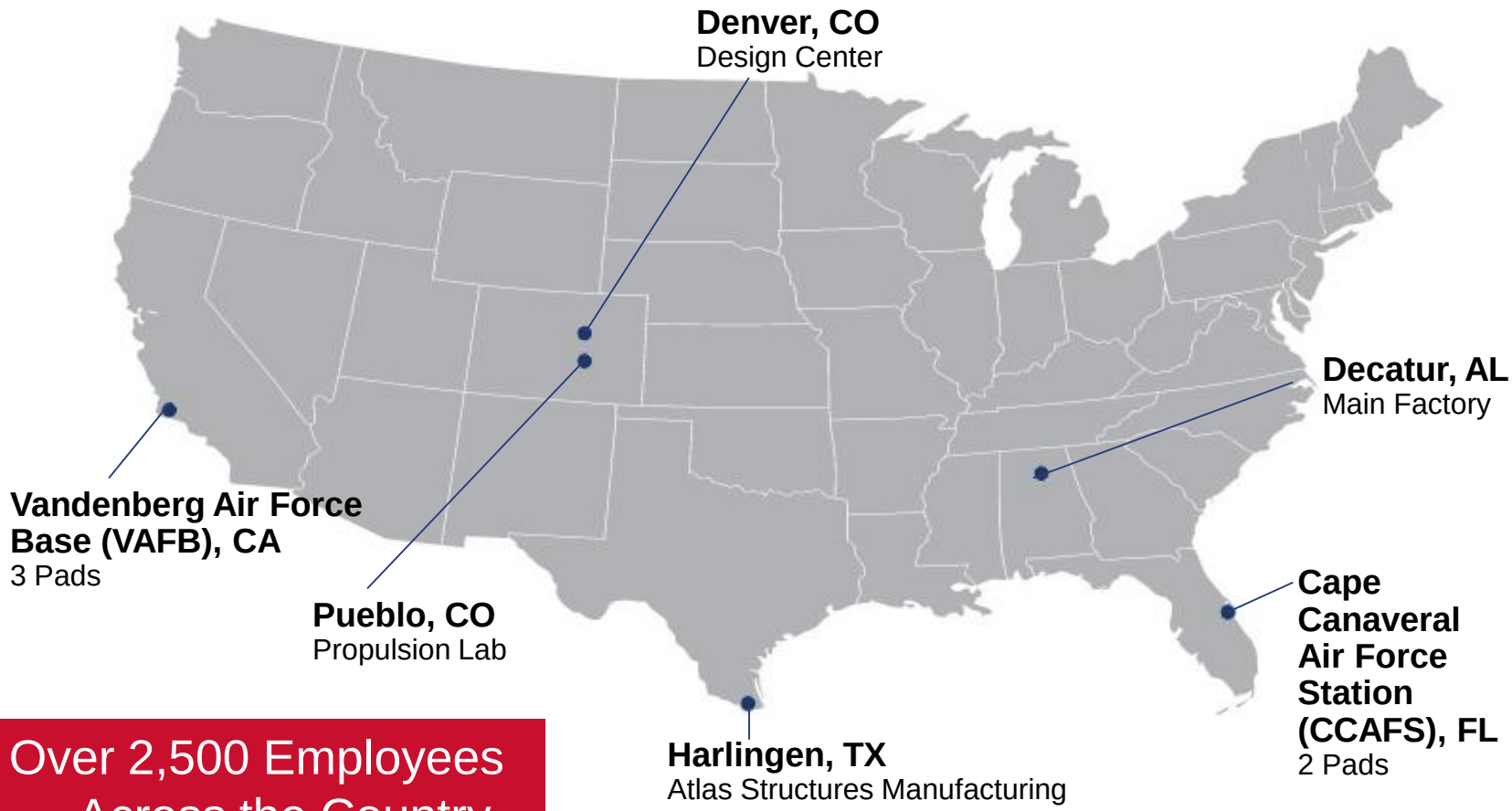
8.25.2018

UNITED LAUNCH ALLIANCE (ULA)

- Two world-class launch systems operating as a single provider to the U.S. Government
- Over 100 years combined experience in Expendable Launch Systems
- 1,300+ launches starting from 1950

The largest, most experienced and reliable launch service provider IN THE NATION!

WHERE CAN YOU FIND US?



Over 2,500 Employees Across the Country

JOBS AT ULA

MISSION MANAGER
PRODUCT DEVELOPMENT ENGINEER
FINANCE & ACCOUNTING
HUMAN RESOURCES
FACILITIES MANAGEMENT
PRODUCTION TECHNICIAN
LAUNCH PROCESSING TECHNICIAN
PROCUREMENT
PRODUCTION/LAUNCH MANAGER
TEST ENGINEER
COMMUNICATIONS

& MANY MORE!

WHERE DO WE BUILD ROCKETS?

Decatur, AL

Plant Fun Facts

- 1/2 Wile Long x 1/4 Mile Wide
- >36 football fields
- Entire Campus is ~300 Acres
- Ceiling From 4 to 12 Stories

The plant can manage 20 rocket builds at one time

Delta IV Space Launch Complex-37 CCAFS, Florida

Delta IV Space Launch Complex-6
VAFB, California

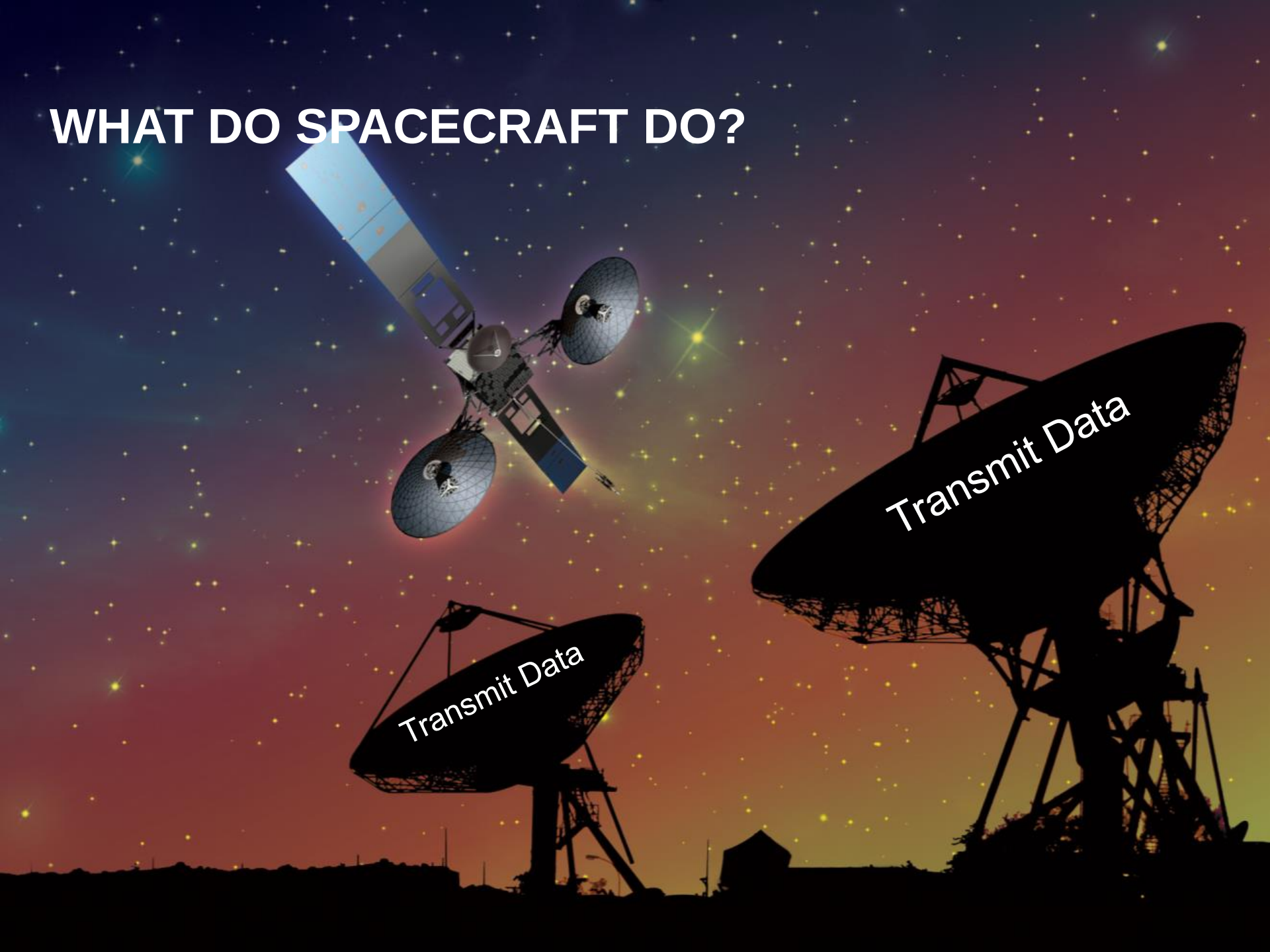
SATELLITE

An Object that Orbits a Planet
or Other Celestial Body

SPACECRAFT

A Machine Designed to Operate in Space (i.e. a Man-made Satellite).

WHAT DO SPACECRAFT DO?



WHAT DO SPACECRAFT DO?

TV & Radio Communication

WHAT DO SPACECRAFT DO?

Study the Earth

WHAT DO SPACECRAFT DO?

Map Our Planet


WHAT DO SPACECRAFT DO?
Study Weather
Predict Hurricanes
200 km

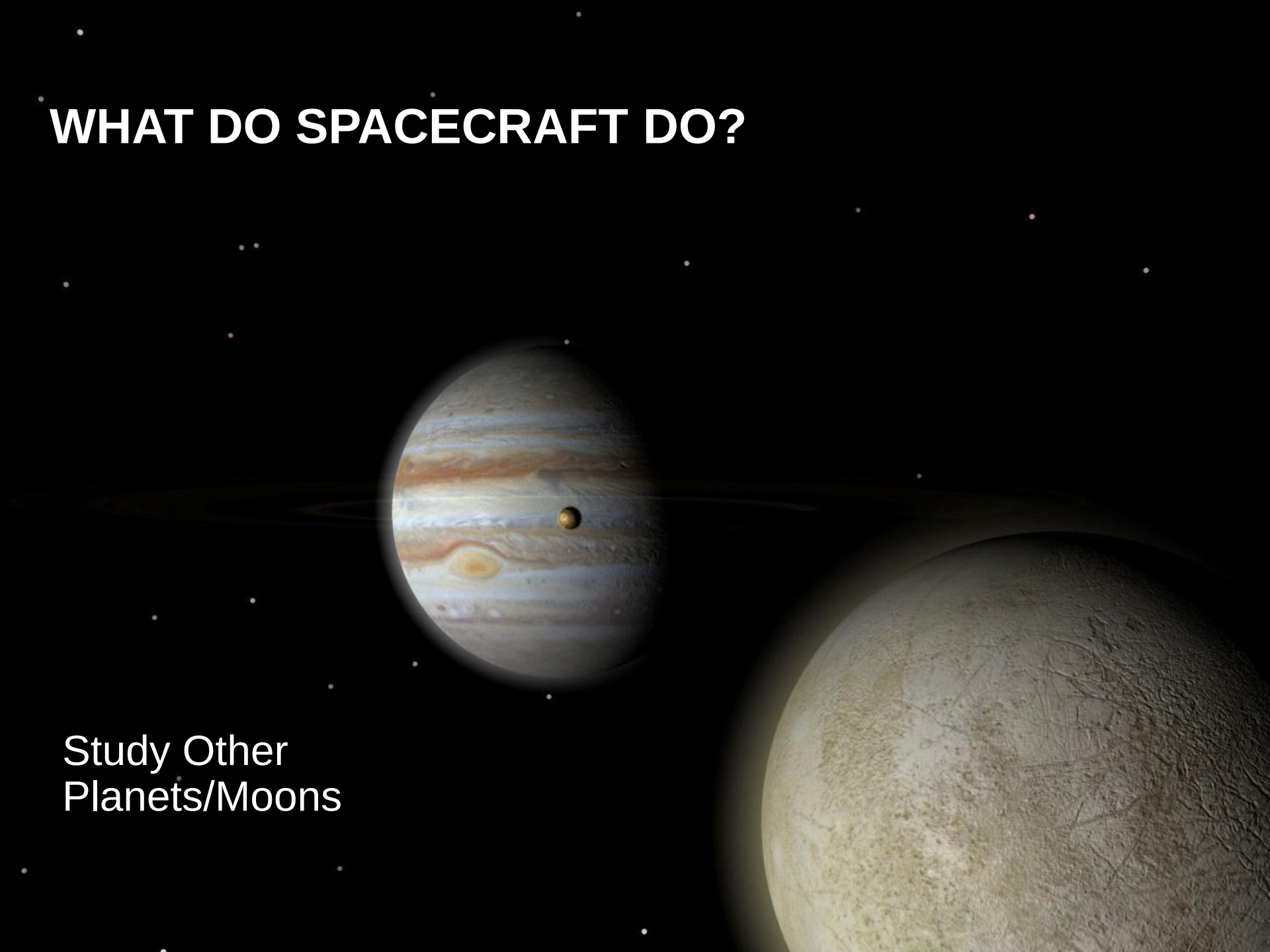
WHAT DO SPACECRAFT DO?

Facilitate Navigation

WHAT DO SPACECRAFT DO?

Track Enemy Missile Launches

WHAT DO SPACECRAFT DO?

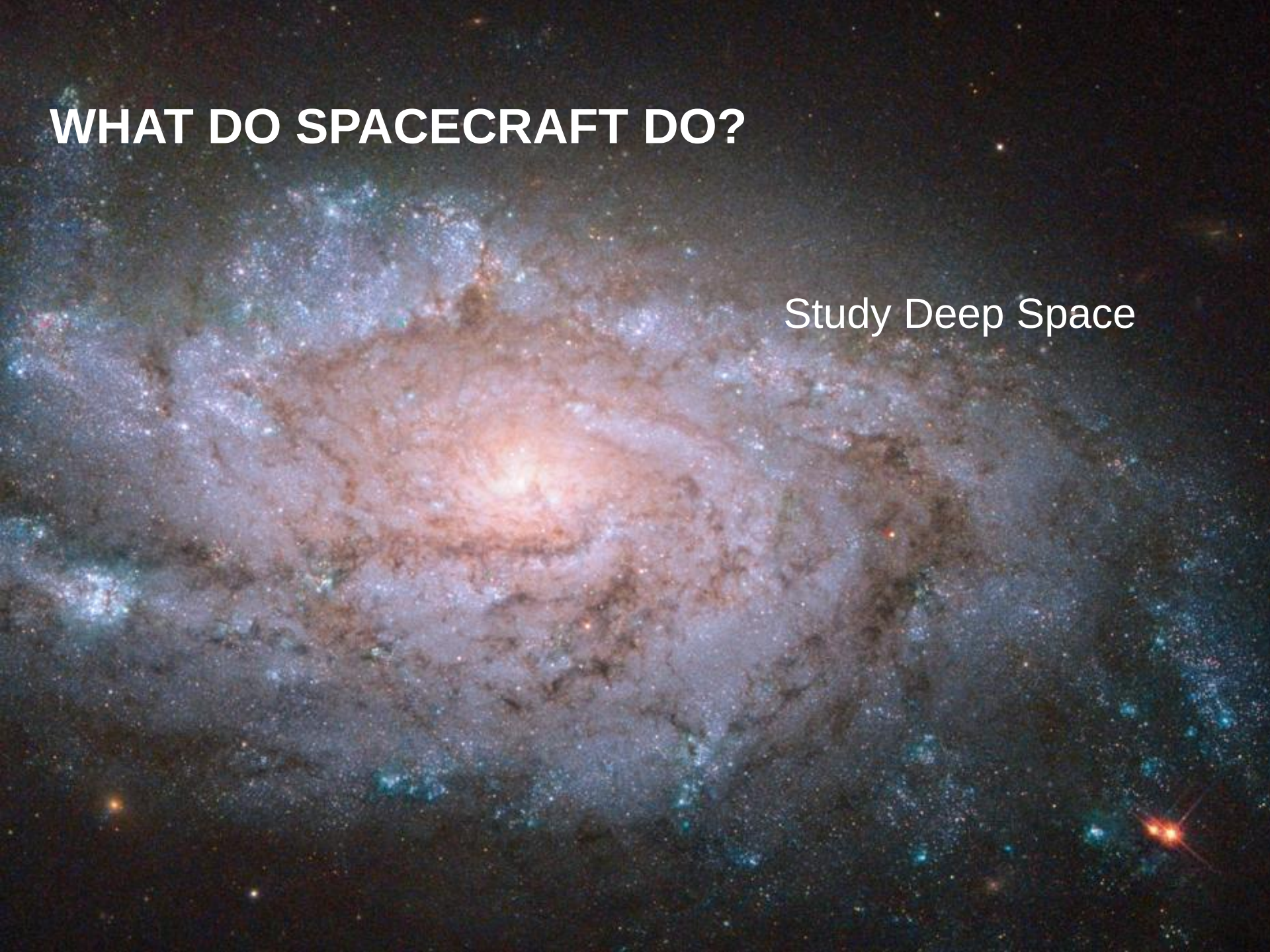


Study Other Planets/Moons

WHAT DO SPACECRAFT DO?

Study the Sun

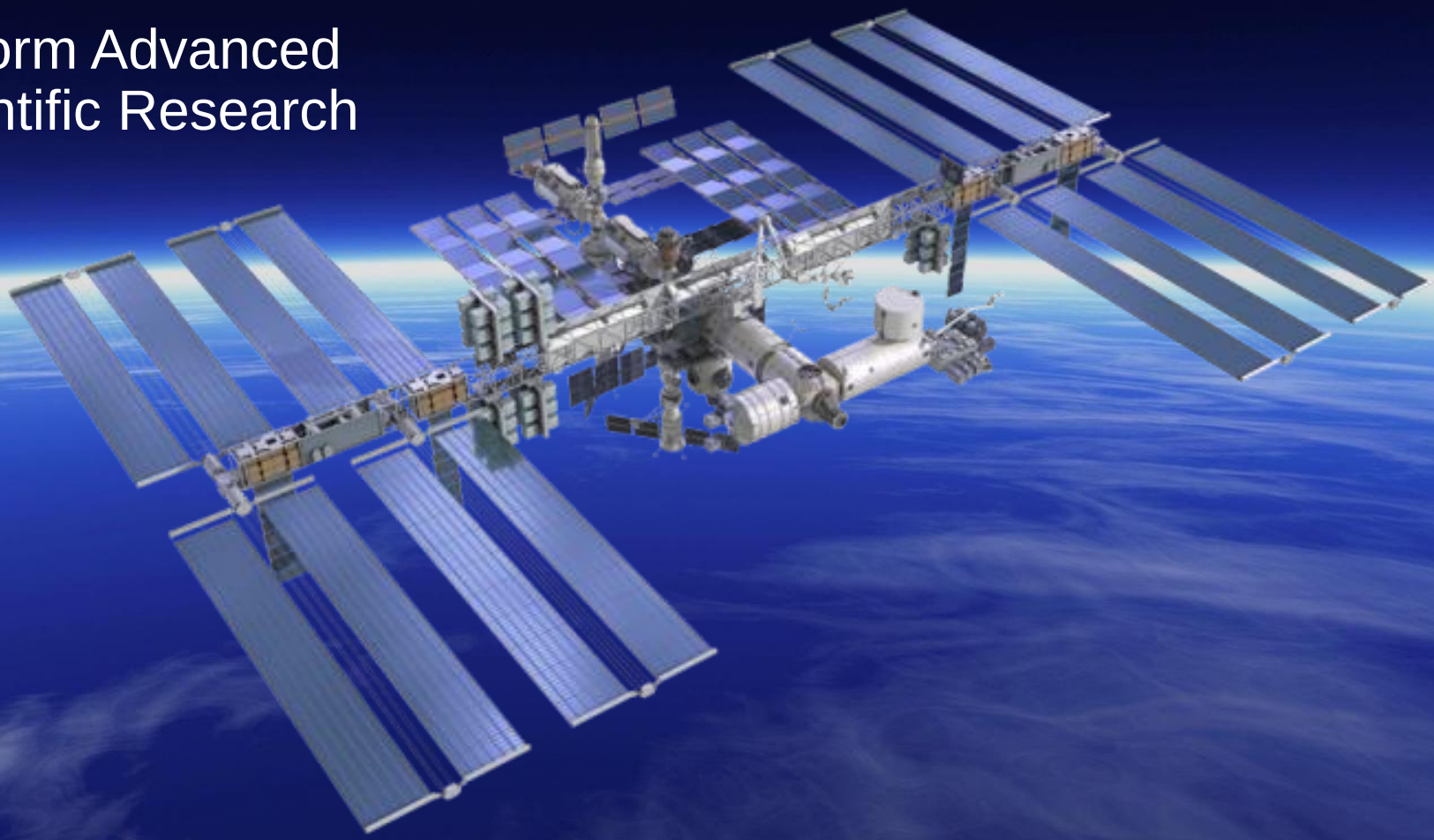
WHAT DO SPACECRAFT DO?



Study Deep Space

WHAT DO SPACECRAFT DO?

Perform Advanced Scientific Research



WHAT DO SPACECRAFT DO?

Space Tourism
…Coming Soon

WHAT DO SPACECRAFT DO?

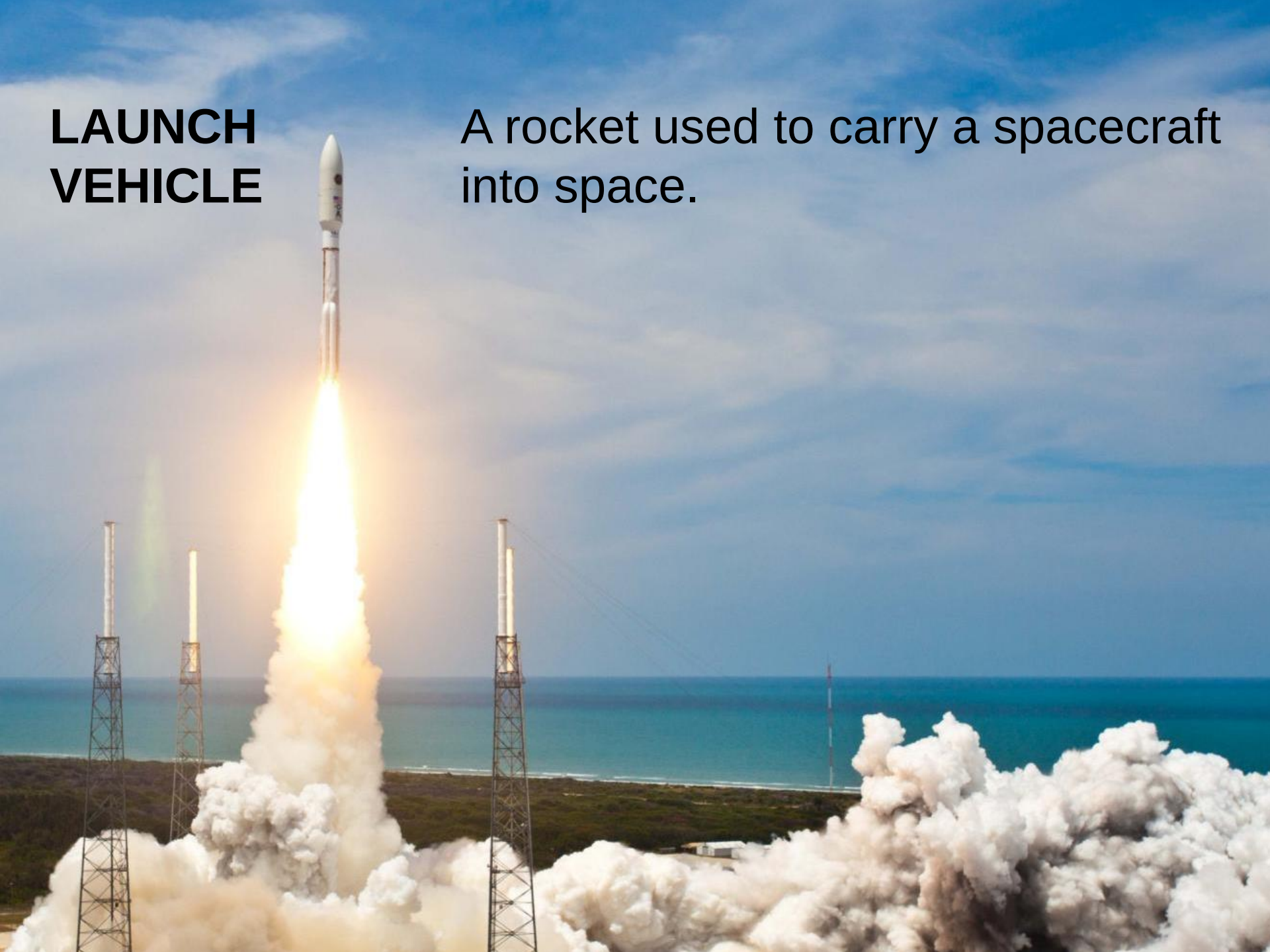
WHAT DO SPACECRAFT DO?

Roam Around
Other Planets

ROCKET BASICS

ROCKET

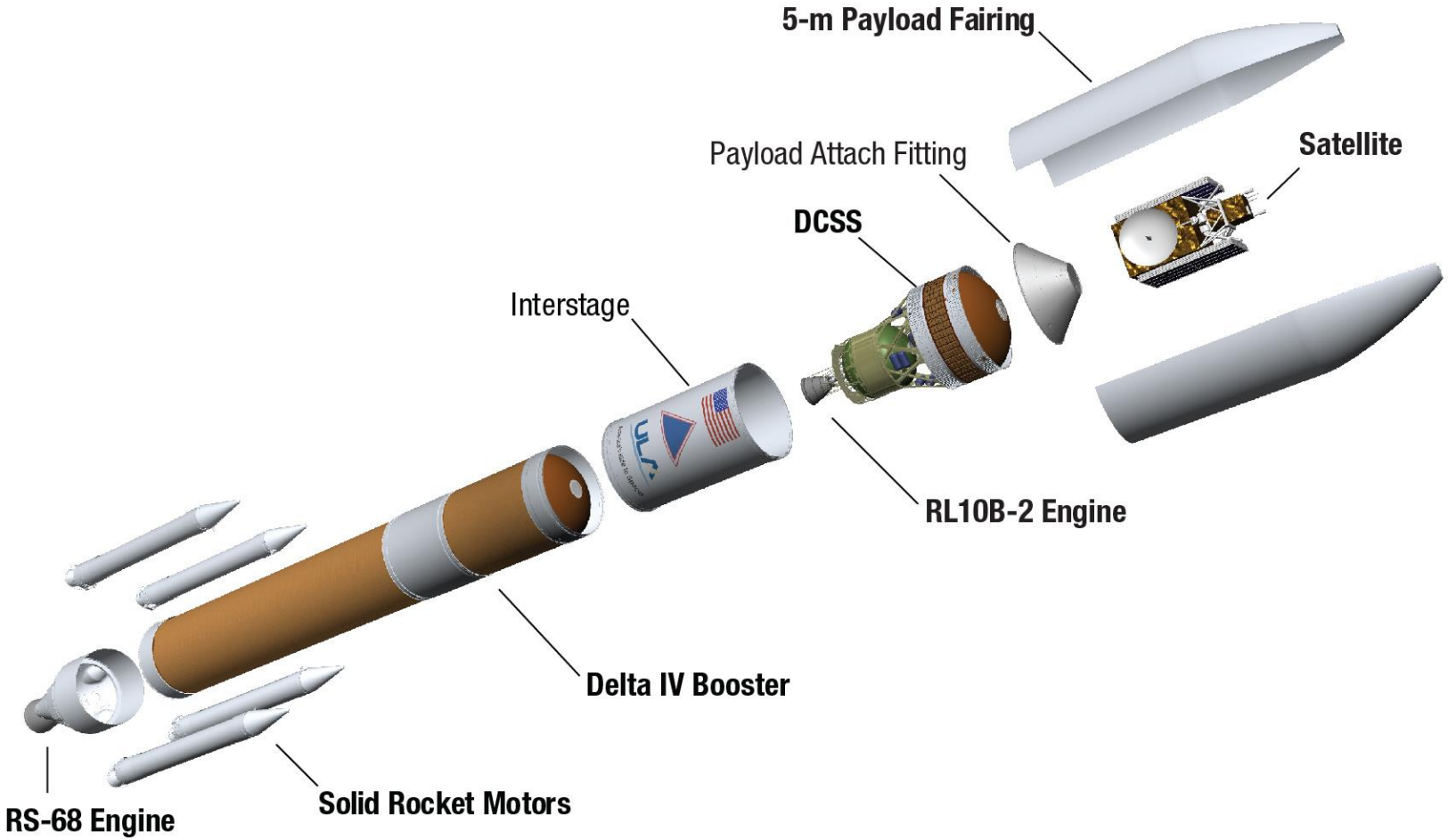
A machine designed to propel objects at very high speeds or into space using an engine whose thrust is derived by the combustion of propellants carried within the rocket.



LAUNCH VEHICLE

A rocket used to carry a spacecraft into space.

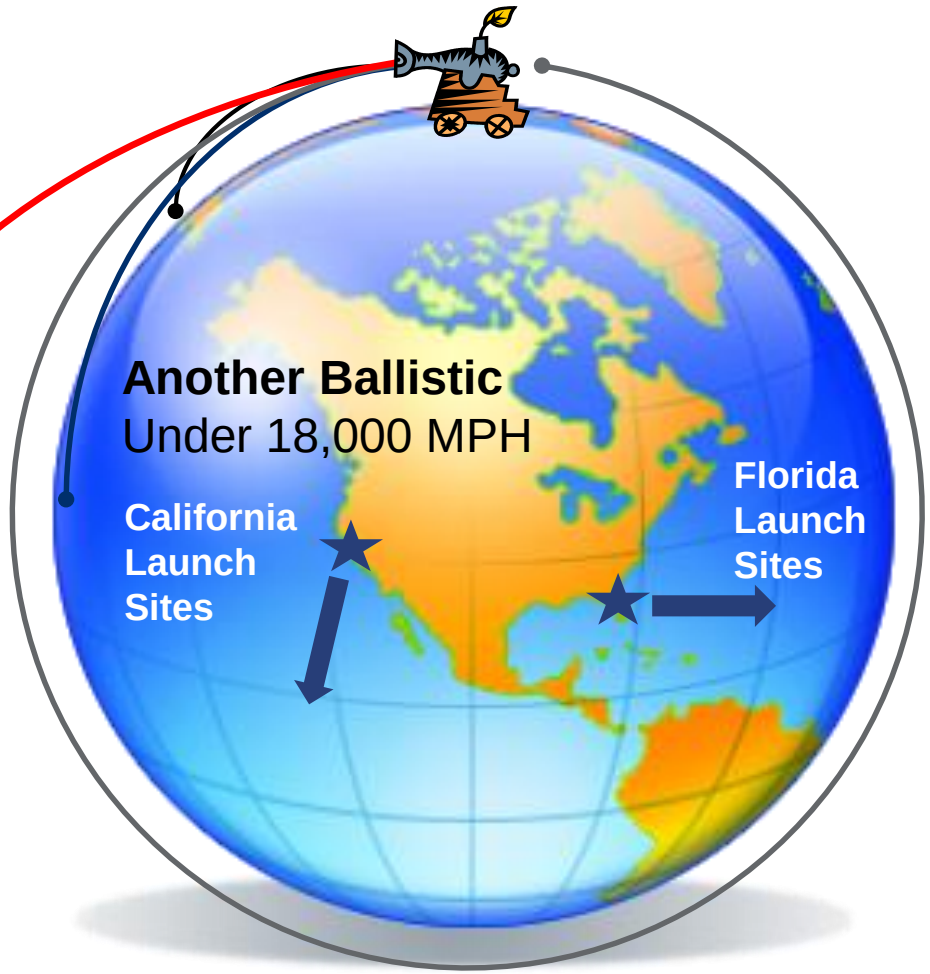
PARTS OF A ROCKET
DELTA IV LAUNCH VEHICLE



PHYSICS OF A ROCKET LAUNCH

Ballistic returns to earth (SRBs)

Escape Velocity
25,000 MPH

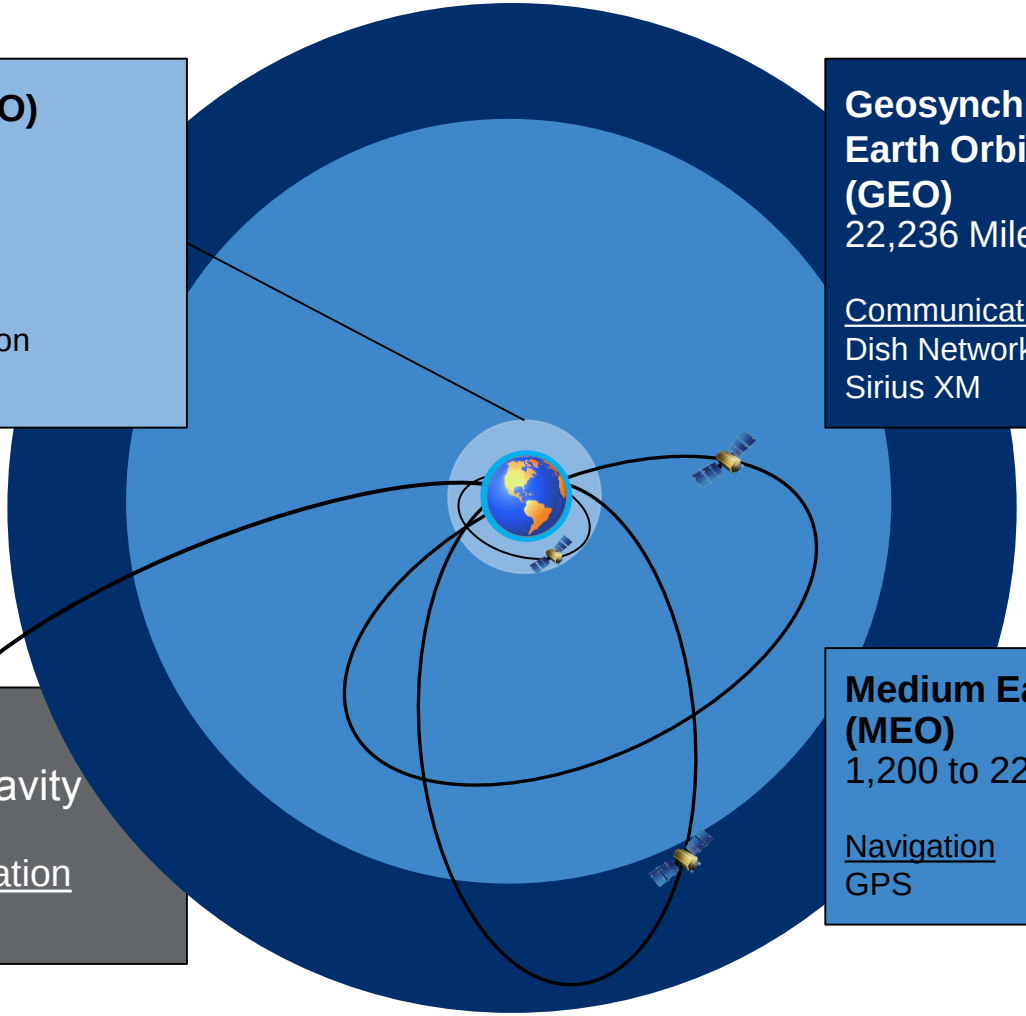


Orbital Velocity
Over 18,000 MPH

WHAT ARE THE TYPES OF ORBITS?

Low Earth Orbit (LEO)
99 to 1200 Miles

Earth Observation
Weather surveillance,
Earth imaging
International Space Station
= 260 miles



Geosynchronous Earth Orbit (GEO)
22,236 Miles

Communications
Dish Network,
Sirius XM

Inter-Planetary
Beyond Earth's Gravity

Interplanetary Exploration
Mar's Rovers

Medium Earth Orbit (MEO)
1,200 to 22,236 Miles

Navigation
GPS

HOW HEAVY ARE SATELLITES

Block IIR GPS: ~4,500 lbs.

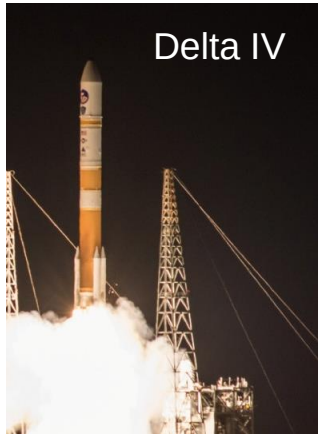
ICO: ~6,100 lbs.

Milstar: ~10,500 lbs.

Family Sedan: ~4,500 lbs.

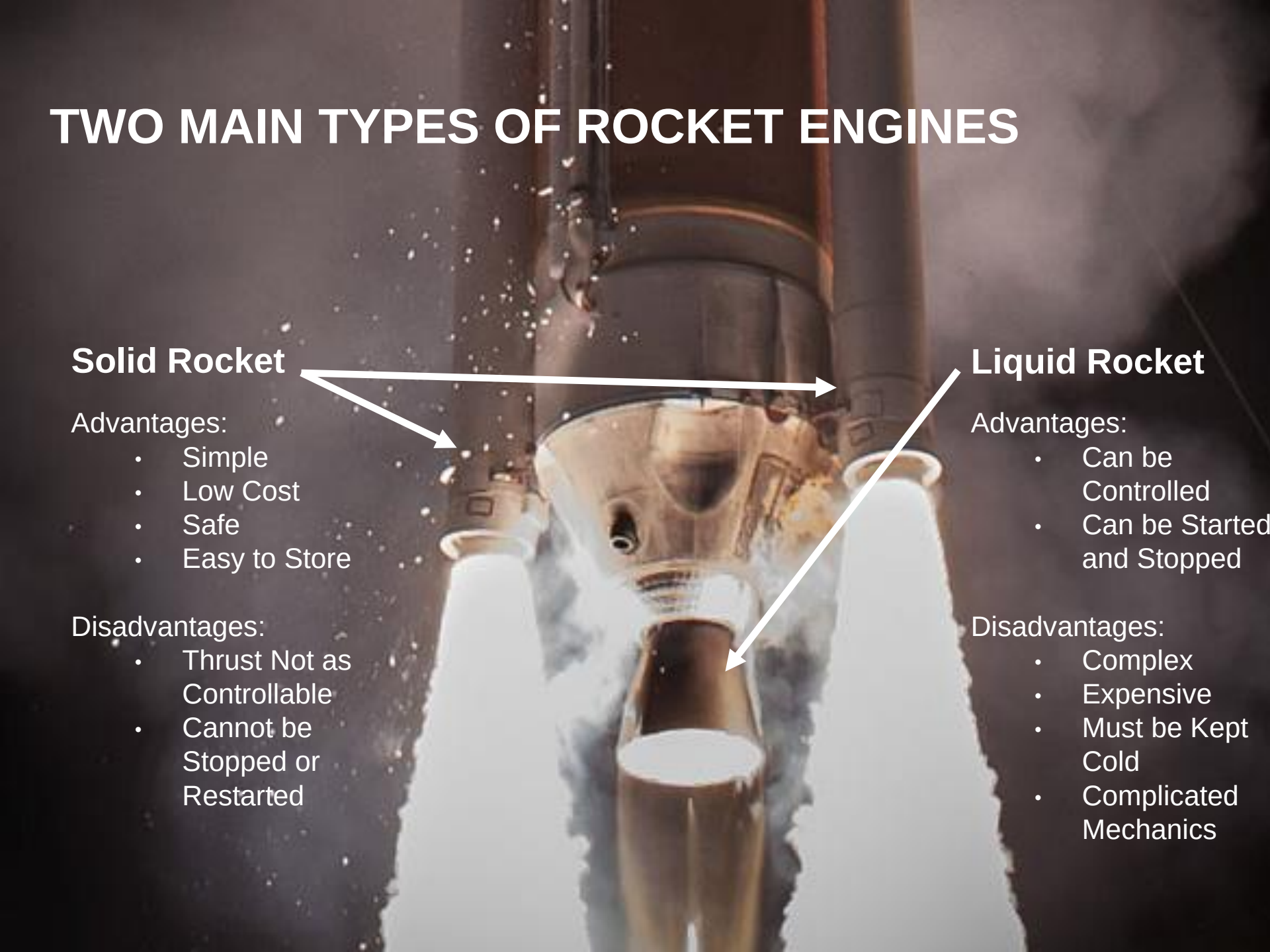
Truck ~4,500 lbs.

School Bus: ~23,000 lbs.



ROCKET ENGINES (101)

TWO MAIN TYPES OF ROCKET ENGINES



Solid Rocket

Advantages:

- Simple
- Low Cost
- Safe
- Easy to Store

Disadvantages:

- Thrust Not as Controllable
- Cannot be Stopped or Restarted

Liquid Rocket

Advantages:

- Can be Controlled
- Can be Started and Stopped

Disadvantages:

- Complex
- Expensive
- Must be Kept Cold
- Complicated Mechanics

ATLAS V BOOSTER ENGINE

RD-180

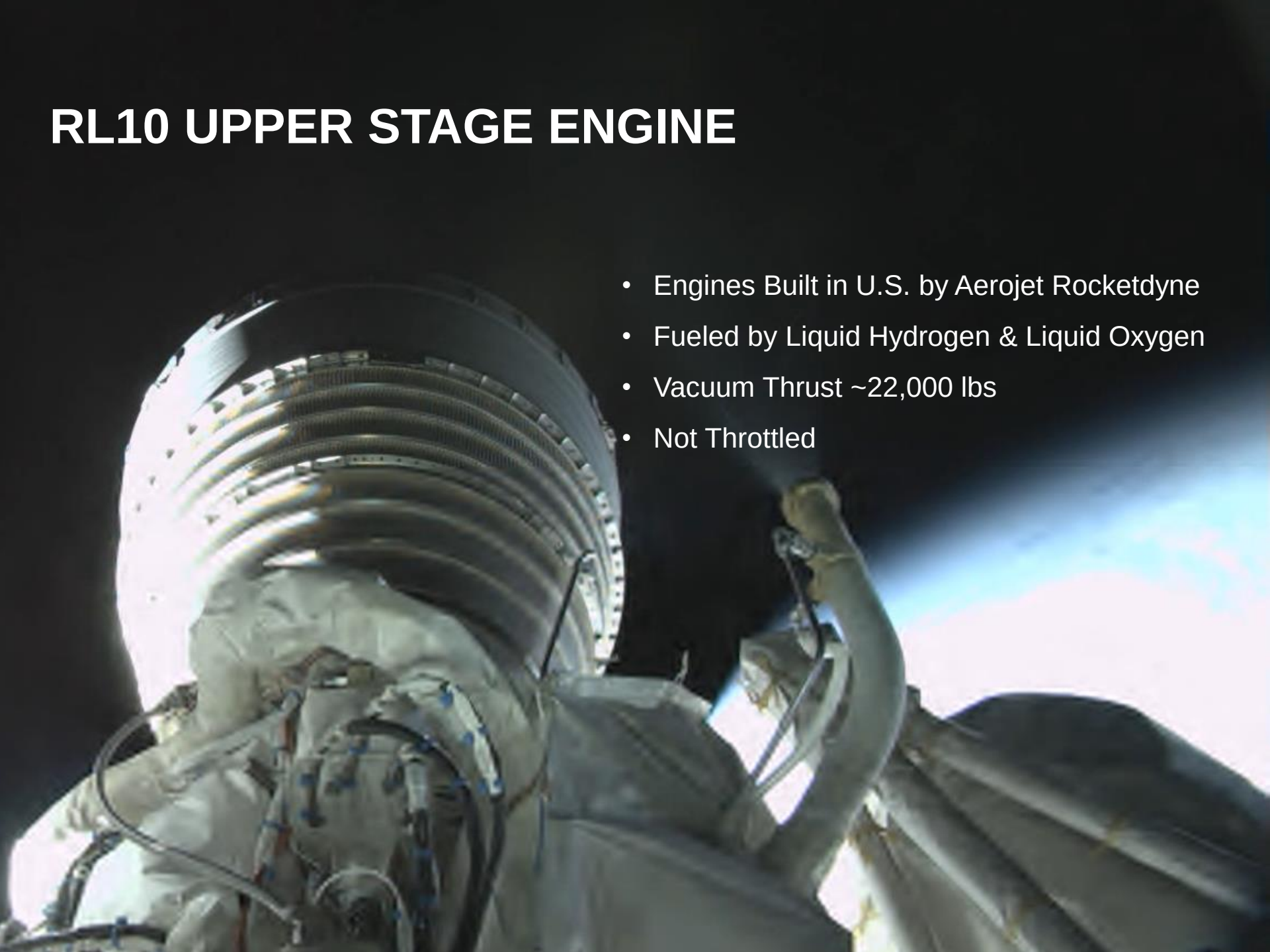
- Engines Built In Russia
- Fueled by Kerosene & Liquid Oxygen
- Vacuum Thrust ~1,000,000 lbs
- Throttle From 40% to 100%

DELTA IV BOOSTER ENGINE

RS-68

- Engines Built in U.S. by Aerojet Rocketdyne
- Fueled by Liquid Hydrogen & Liquid Oxygen
- Vacuum Thrust ~758,000 lbs
- Two Throttle Settings: Full and Half

RL10 UPPER STAGE ENGINE



- Engines Built in U.S. by Aerojet Rocketdyne
- Fueled by Liquid Hydrogen & Liquid Oxygen
- Vacuum Thrust ~22,000 lbs
- Not Throttled

BLUE ORIGIN BOOSTER ENGINE

- American Made
- Commercial Partnership
- Affordable
- Re-usable

BE-4 Characteristics	
Fuel	Liquefied Natural Gas (LNG)
Oxidizer	Liquid Oxygen (LOx)
Cycle	Oxygen-Rich Staged Combustion (ORSC)
Flight	Engine ready for flight in 2017

MAY THE FORCE BE WITH YOU: THRUST

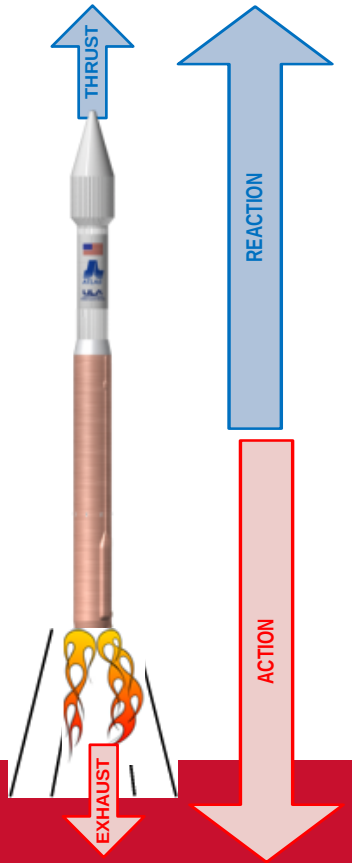
What Is Thrust?

- The Amount of Push the Rocket Engine Provides

How Does a Rocket Create Thrust?

- The Engine Creates Thrust by Burning Rocket Fuel in the Opposite Direction the Rocket is Heading

Isaac Newton



Force = Mass x Acceleration

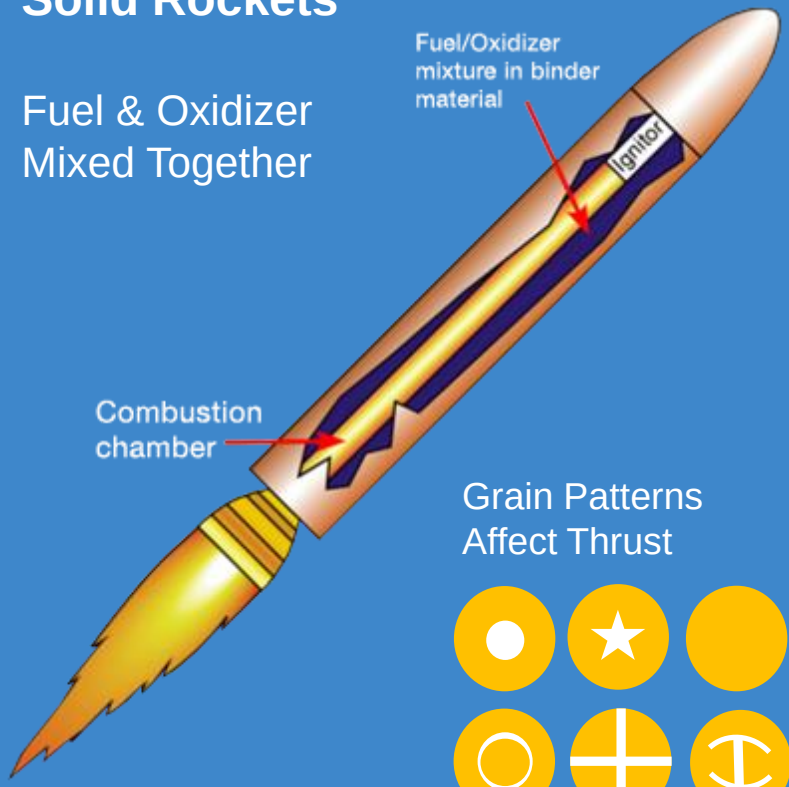
NEWTON'S THIRD LAW

"For every **ACTION**, there is an equal and opposite **REACTION**"

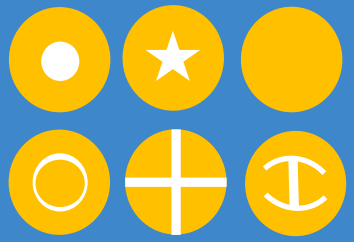
HOW ROCKET ENGINES MAKE THRUST

Solid Rockets

Fuel & Oxidizer
Mixed Together



Grain Patterns
Affect Thrust

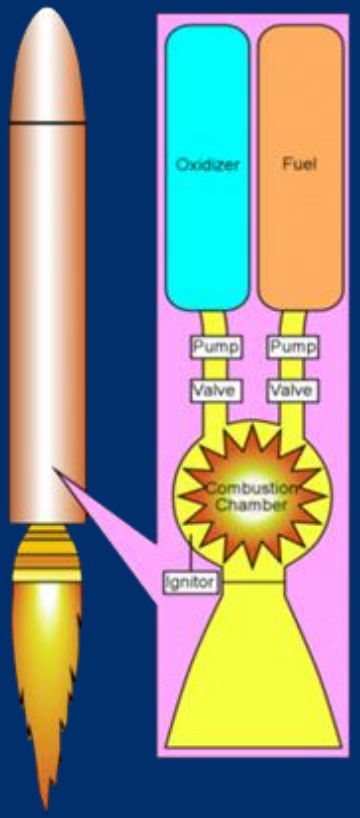


Liquid Rockets

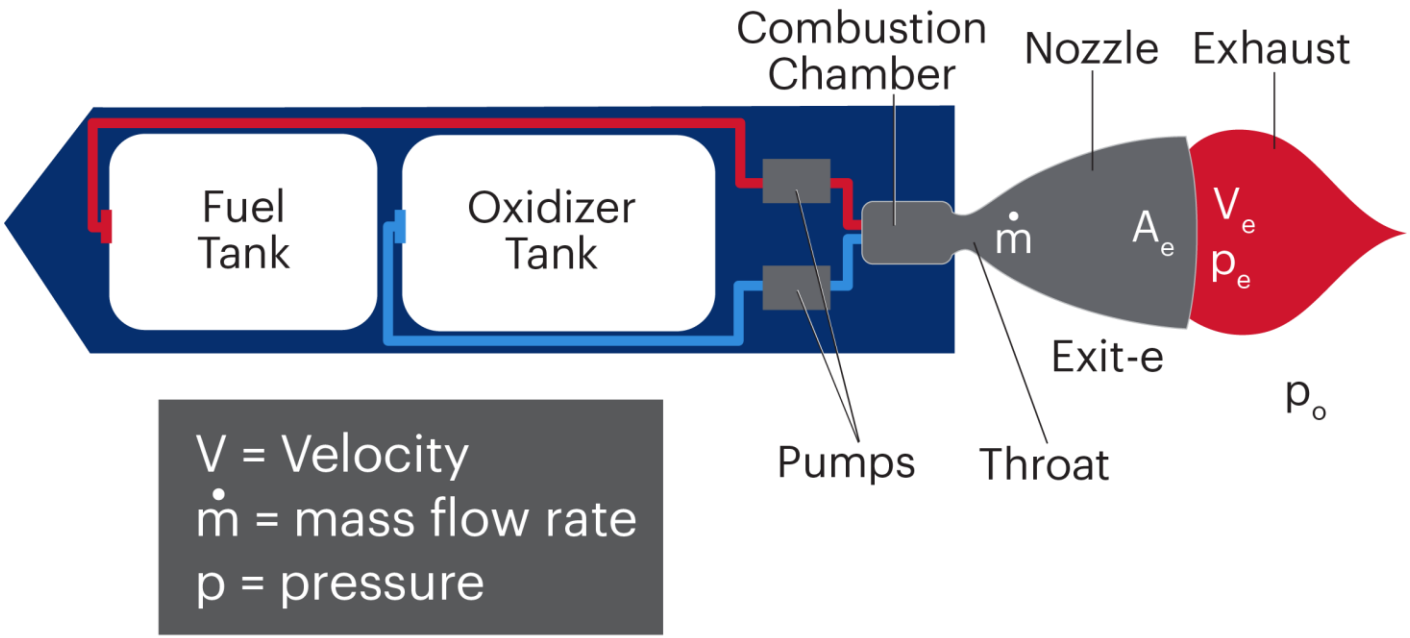
Fuel And Oxidizer
Stored Separate

Combust When Mixed
Together in Engine

Pump Speed Used to
Control Thrust



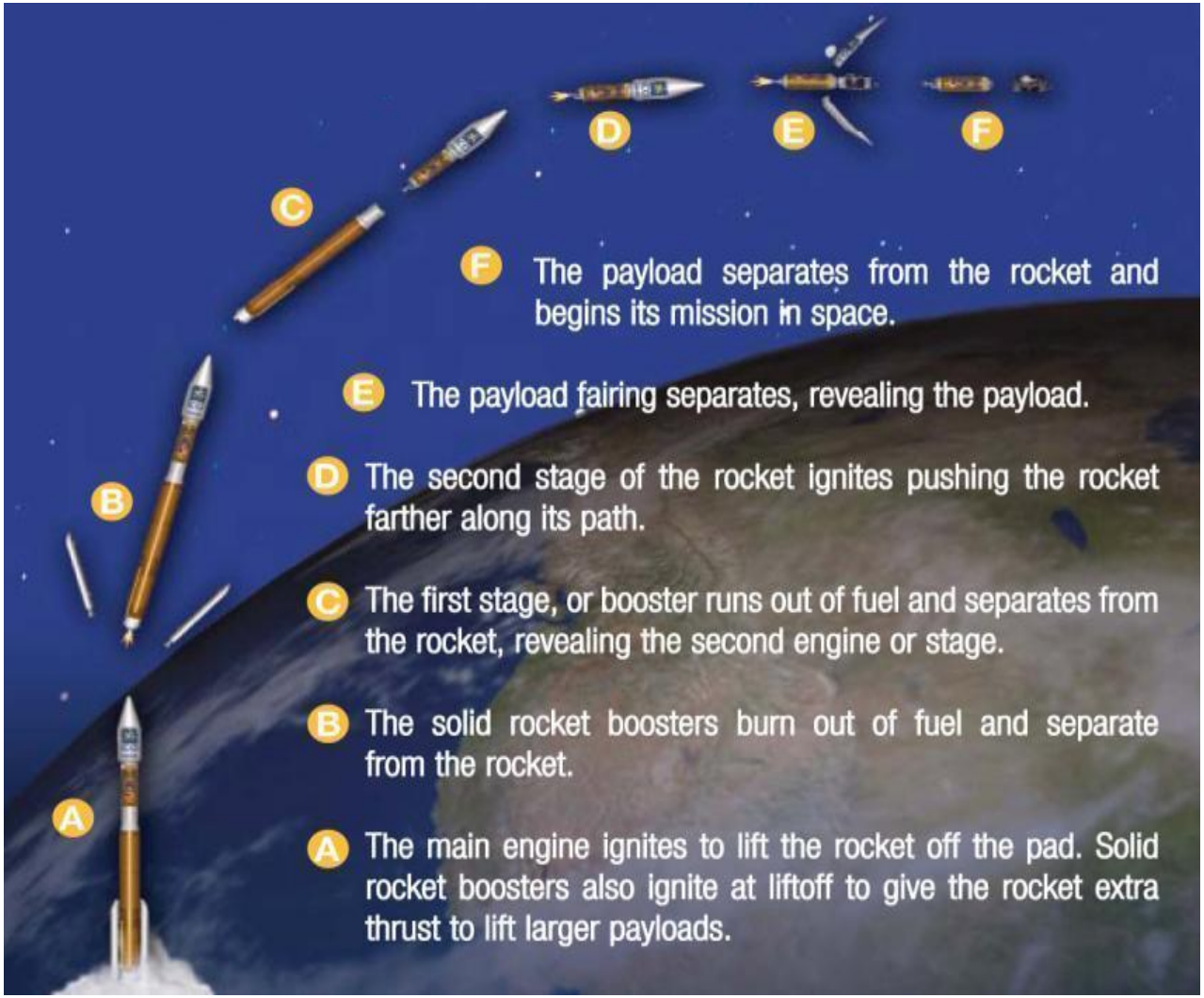
LIQUID ROCKET ENGINE EQUATION



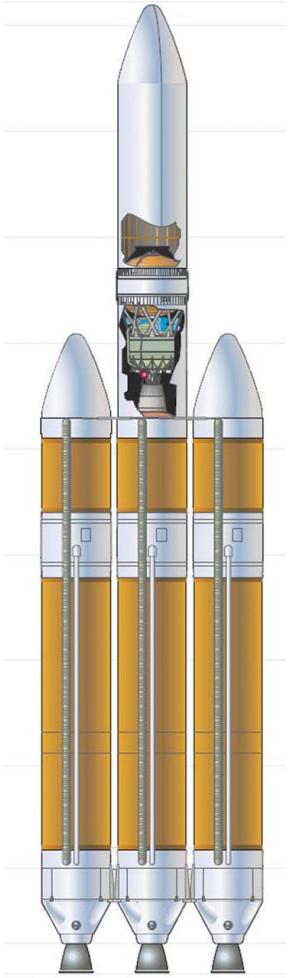
$$\text{Thrust: } F = \dot{m} V_e + (p_e - p_o) A_e$$

Force = mass flow*exit velocity + area of the exit *(pressure at the exit – ambient pressure)

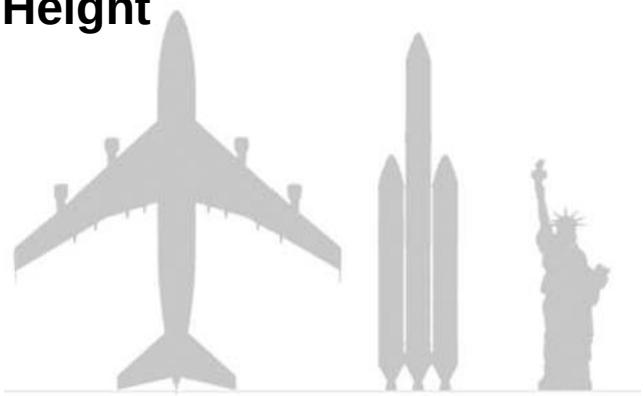
LAUNCHING A ROCKET



DELTA IV HEAVY FUN FACTS



Height



Boeing 747-8	ULA Delta IV	Statue of Liberty
250 ft	**235 ft**	**151 ft**

Performance

Thrust Generated
by **Delta IV Heavy**
Equivalent to
Ten 747 Airplanes

Speed

	DELTA IV HEAVY
0 TO 60 MPH	15 SECONDS
0 TO 100 MPH	25 SECONDS
0 TO 700 MPH	80 SECONDS
0 TO 17,500 MPH	5 MINUTES

Fuel

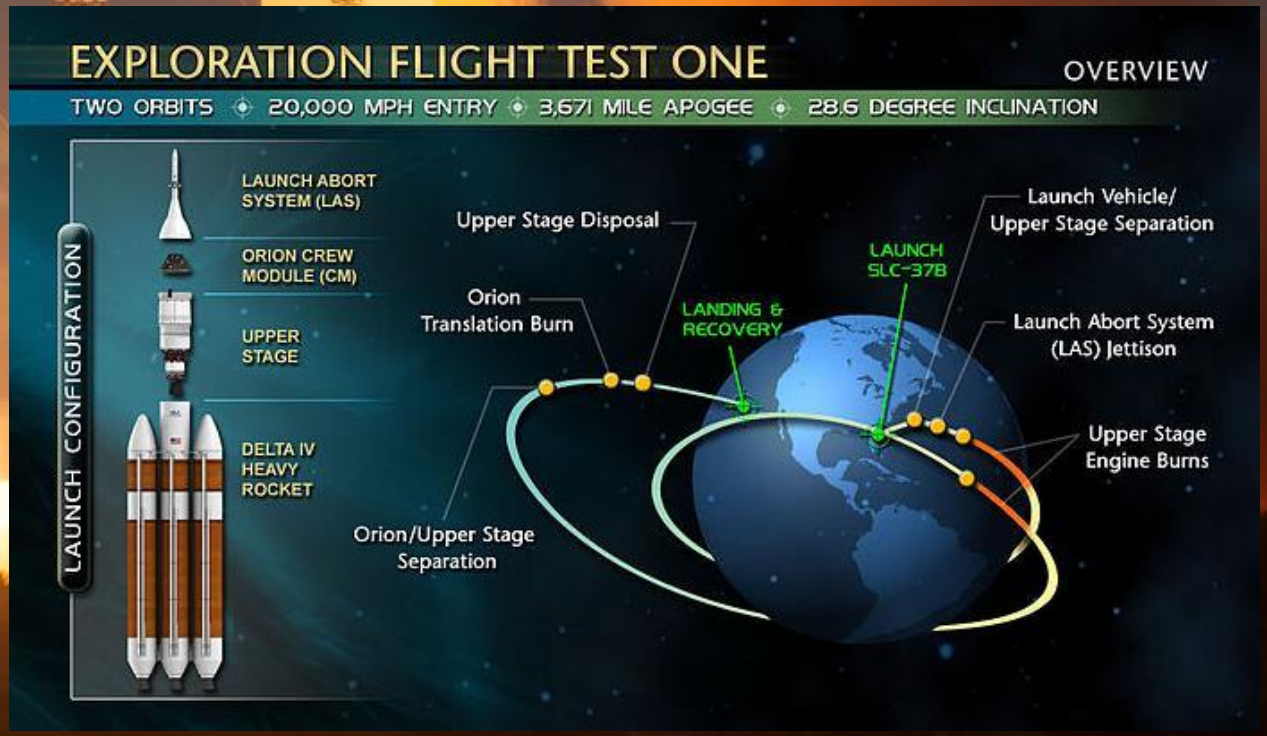
DELTA IV HEAVY

483,500 GALLONS

Stage 1
132,000 Gallons LOX
330,000 Gallons LH2
Stage 2
5,000 Gallons LOX
16,500 Gallons LH2

COST TO FILL UP	$600,000
MILES PER GALLON	0.00087 MPG**

EXPLORATION FLIGHT TEST ONE



OPPORTUNITIES FOR YOU!

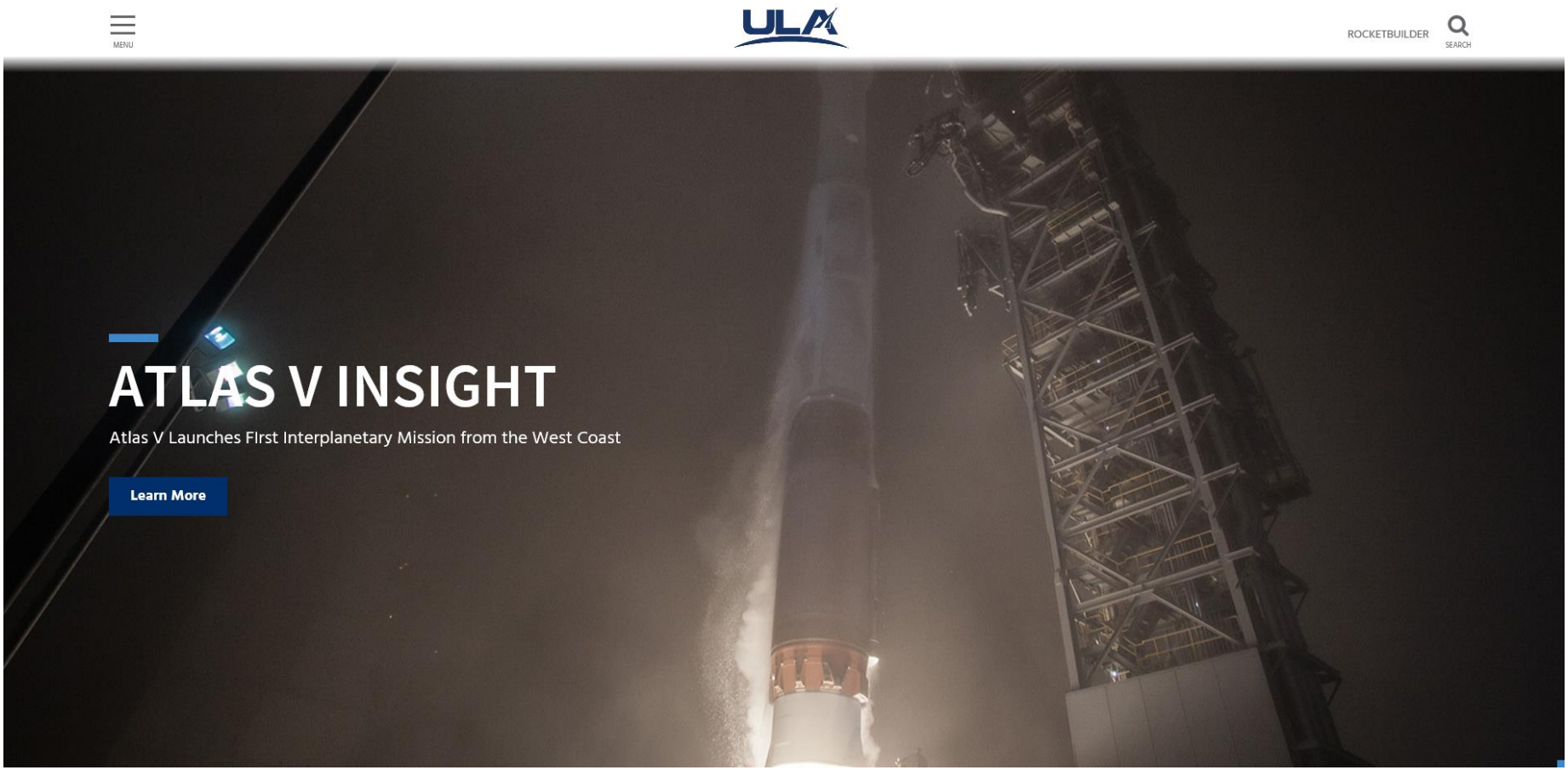
ULA Hires More Than 70 Interns per Year Across All Sites

- Paid Summer Internships!
- Internships Are Available After Your First Year in College
- Job Training in a Business Career or as a Rocket Scientist
- Hands on Experience

Look For Job Postings at **Ulalaunch.Com**
in the Fall Semester of College

ULA WEBSITE – INTERN PROGRAM

WWW.ULALAUNCH.COM



QUESTIONS?