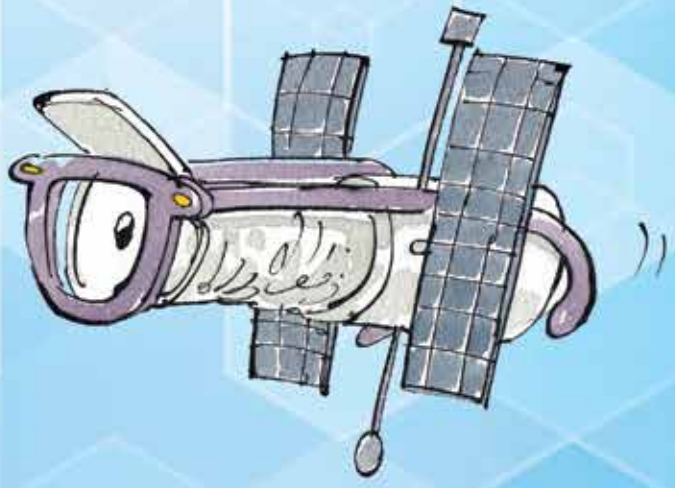
Dr. Dave Astronaut

Mighty Mission Machines

From Rockets to Rovers



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art by Theo Krynauw

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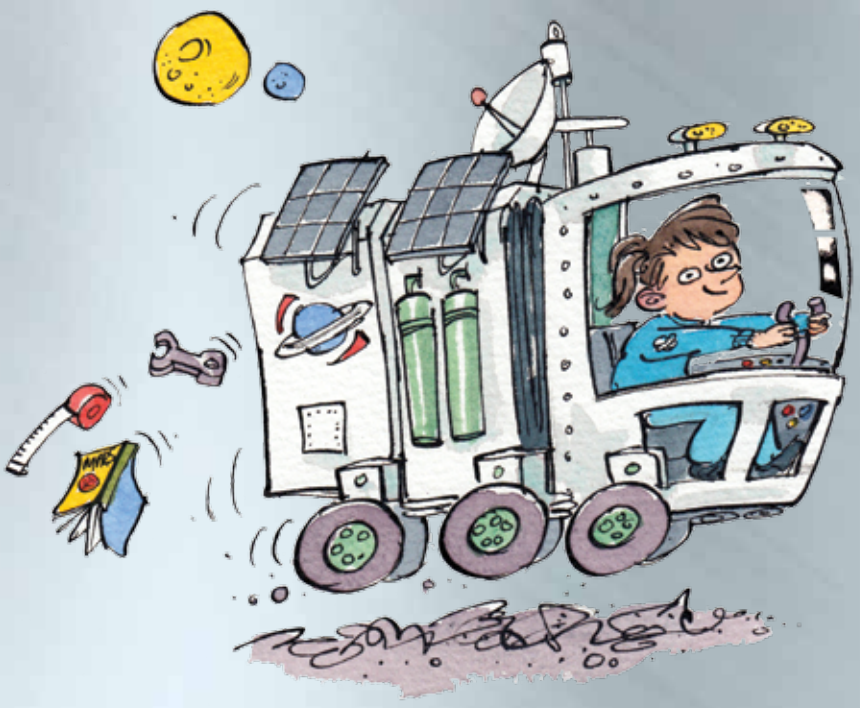


Welcome from Dr. Dave

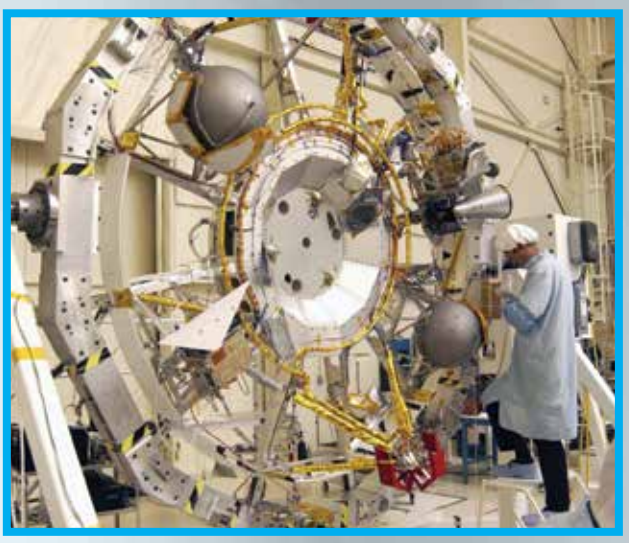
Exploration is all about teams and machines.
Success takes creativity, science, and technology.

Dr. Dave Williams

NASA engineers with test models of three different Mars rovers: *Sojourner*, *MER*, and *Curiosity*

Every day, thousands of people around the world—scientists, engineers, mathematicians, technicians, and others—work hard to support space programs and exploration. But even with all of that support, there are certain things you just can't do without the right equipment. In this book, we'll explore the rockets, rovers, robots, computers, and gadgets that help astronauts travel, live, and work in space.

—Dr. Dave

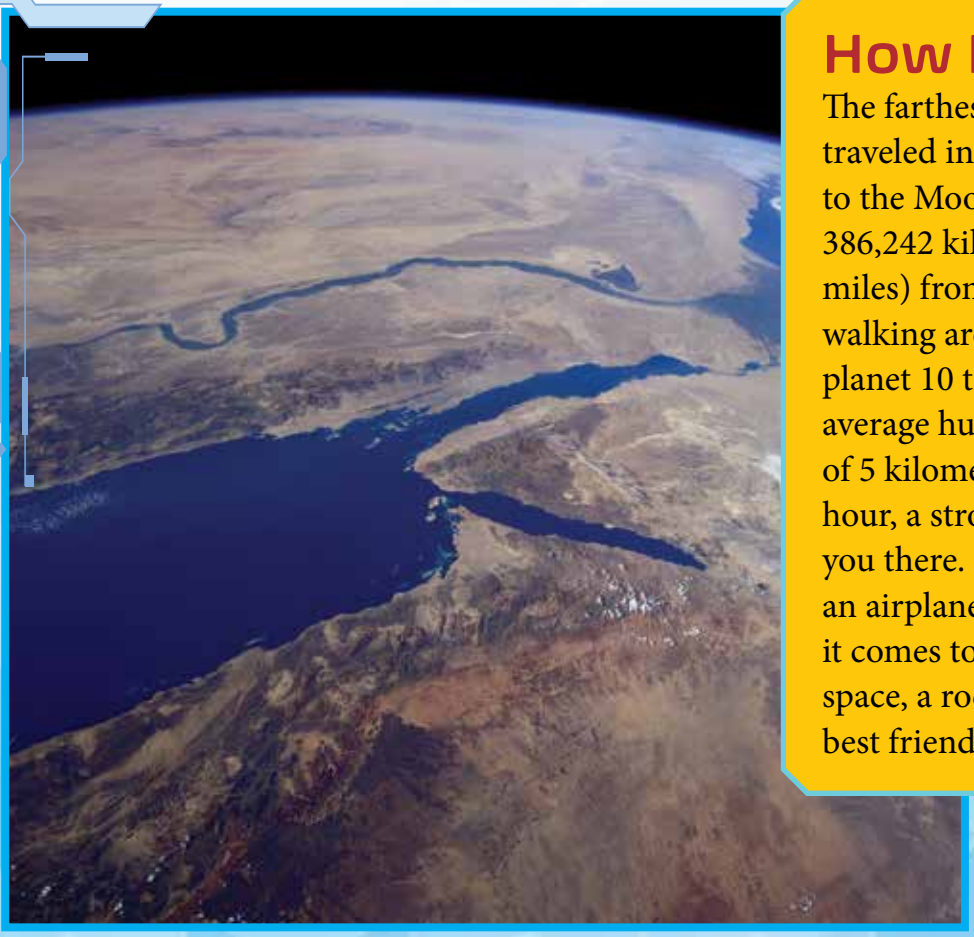


Mars Exploration Rover 1 in the lab

Astronaut Tracy Caldwell Dyson gets help suiting up for launch.

Mighty Machines

Astronauts have a super-cool job—exploring outer space. But they can't do it on their own. It's dangerous for humans in space, and the moons and planets we want to visit are farther away than we can even imagine. Without a lot of mighty machines, amazing technology, and powerful equipment—along with a few basic tools, like good old hammers and wrenches—space missions would never get off the ground.



A view of Earth from Space Shuttle *Columbia*

How Far Is Far?

The farthest humans have traveled in outer space is to the Moon. The Moon is 386,242 kilometers (240,000 miles) from Earth—that's like walking around the entire planet 10 times. Since the average human walks at a pace of 5 kilometers (3.1 miles) per hour, a stroll isn't going to get you there. In fact, not even an airplane can help! When it comes to getting to outer space, a rocket is your new best friend.

Outer space is far! My first mission was on the Space Shuttle *Columbia*. We traveled 10 million kilometers (6.214 million miles), orbiting as high as 274 kilometers (170 miles) above Earth.

Danger Zone!

Imagine trying to live where there is no air to breathe and the temperature outside can be as hot as 121°C (250°F) or as cold as –157°C (–250°F). Oh, and did we mention the flying meteors, stellar explosions, and cosmic radiation? Well, that's space—and that's why astronauts must be protected to survive. Spacecraft, space suits, and planetary rovers all get the job done.

Astronaut Peggy Whitson on a space walk

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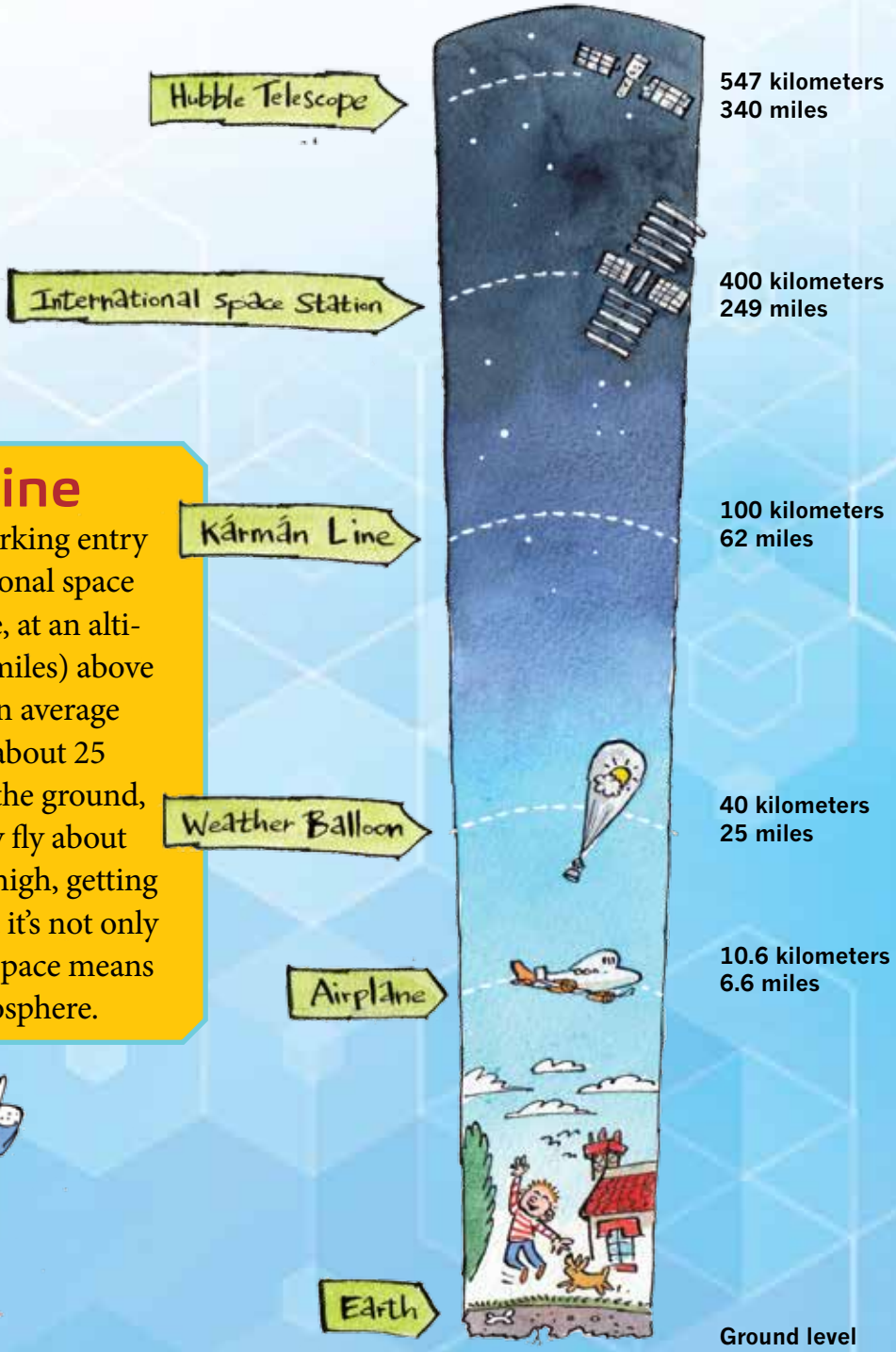
Here We Come!

Where *Exactly* Is Space?

Ready to lift off? Great! But where exactly are you lifting off *to*? What do we mean when we talk about space?



The Kármán Line

There's no actual border marking entry to outer space, but international space treaties use the Kármán line, at an altitude of 100 kilometers (62 miles) above sea level, as its start. Since an average 10-year-old can only jump about 25 centimeters (10 inches) off the ground, and most airplanes can only fly about 10.6 kilometers (6.6 miles) high, getting to outer space isn't easy. But it's not only about going up. Getting to space means getting *through* Earth's atmosphere.

Space Shuttle *Endeavour* backdropped by the layers of Earth's atmosphere

Outta My Way, Atmosphere

The atmosphere is a layer of gases that surrounds Earth and is kept in place by the force of gravity. It warms the surface of the planet, reduces temperature swings between night and day, and absorbs the sun's ultraviolet radiation. That's all good news for the life-forms that call Earth home, but it's not so great when it comes to space travel. That's because astronauts need a machine that can fly fast enough to overcome gravity, push through the atmosphere, and get to orbit. Flying at almost 8 kilometers (5 miles) per second, rocket engines and spacecraft come in handy.

All Aboard!

A spacecraft is one incredible vehicle! In it, an astronaut can travel to outer space, orbit Earth, go to the Moon, or, in the future, visit other planets. Some, like the *Soyuz*, look like a capsule. Others, like the space shuttle, resemble an airplane. Whatever they look like, they have to be strong, but also light enough to fly fast and far. And they all have some basic parts in common.

BASIC STRUCTURE:
Spacecraft carrying humans have a flight deck with all the equipment necessary to navigate, communicate, and operate the onboard systems. Spacecraft are usually small, so everyone shares a living room, bathroom, and sleeping area.

The Boeing 777 airplane engine produces a lot of thrust. It would take at least 75 of these engines to get the Space Shuttle to lift off.

The *Soyuz* capsule attached to its rocket

HEAT SHIELD:
As a spacecraft moves through Earth's atmosphere, the friction created generates a lot of heat. Without the heat shield, the spacecraft would burn up.

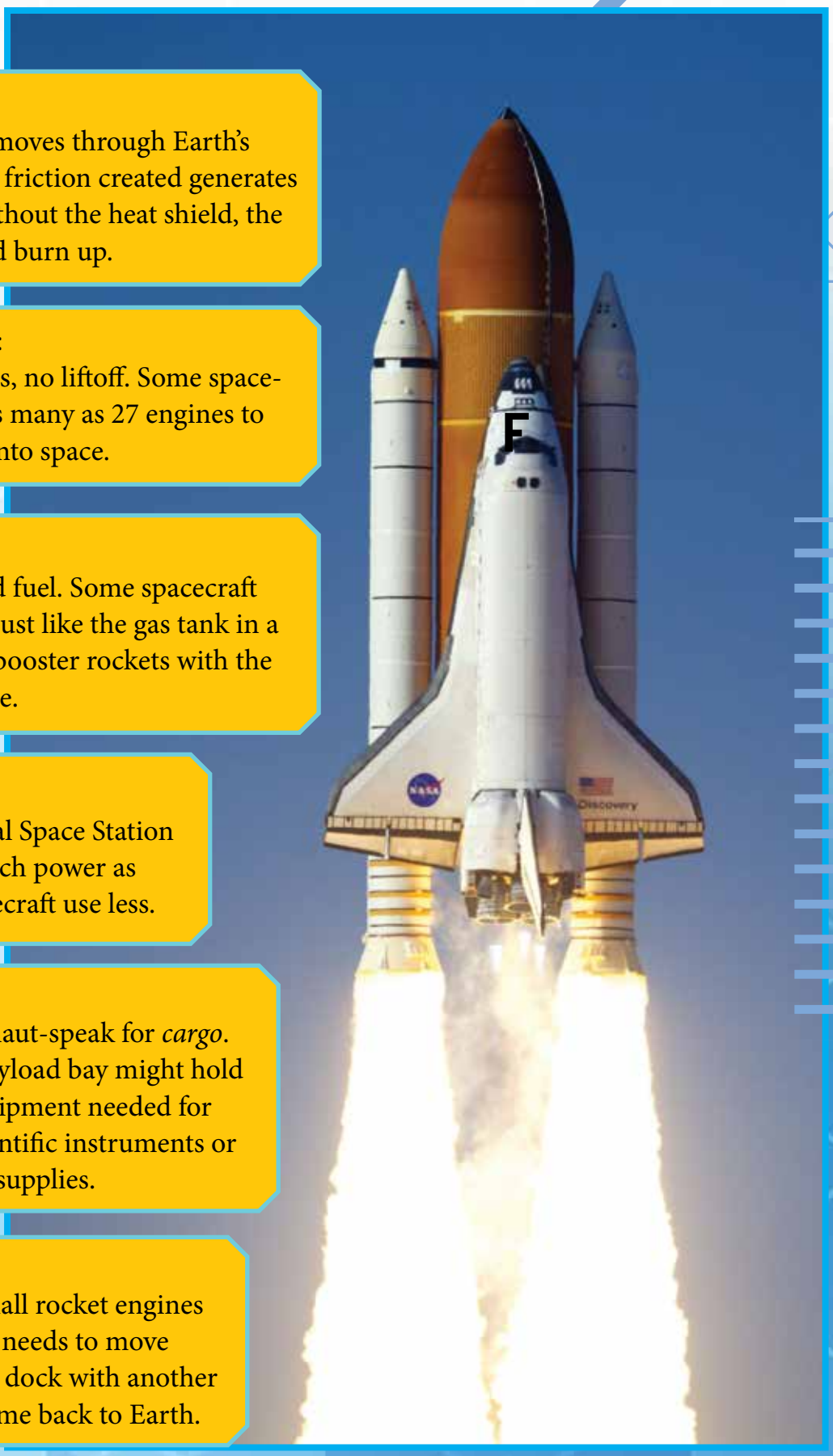
MAIN ENGINES:
No main engines, no liftoff. Some spacecraft can have as many as 27 engines to get their cargo into space.

FUEL TANKS:
All engines need fuel. Some spacecraft have fuel tanks just like the gas tank in a car. Others use booster rockets with the fuel stored inside.

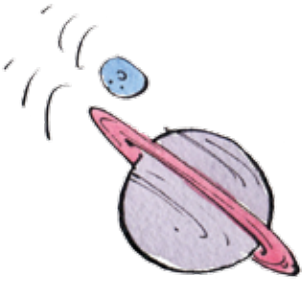
POWER SUPPLY:
The International Space Station (ISS) uses as much power as 55 houses. Spacecraft use less.

PAYLOAD:
Payload is astronaut-speak for *cargo*. A spacecraft's payload bay might hold machines or equipment needed for the mission, scientific instruments or experiments, or supplies.

THRUSTERS:
Thrusters are small rocket engines that a spacecraft needs to move around in space, dock with another spacecraft, or come back to Earth.



Space Shuttle *Discovery* launches



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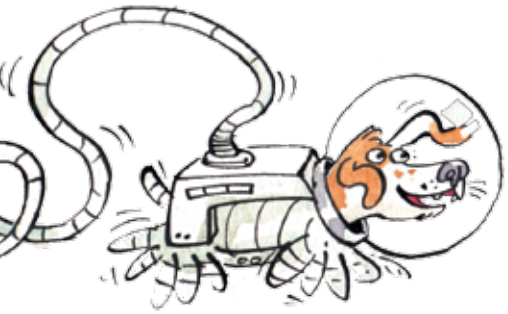

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To all readers, may this book stimulate your curiosity to imagine and build the next generation of mighty machines that will help us explore farther, stay longer, and learn more about our solar system, our planet, and the future of human space exploration. —D.W.

To my brothers John and Claudio, for sharing with me their love of things that go fast. —L.C.