



# DOUBLE TROUBLE FOR THE HUBBLE

If you had a new brand-new camera that took fuzzy pictures, you'd probably bring it back to the store for a refund or return it to the manufacturer for repair. But what if your new gadget was 380 miles above Earth, took almost 10 years to build, and cost \$1.6 billion? This was NASA's (National Aeronautics and Space Administration) dilemma after the Hubble Space Telescope was launched in 1990 from the space shuttle *Discovery*. Images transmitted to Earth from the telescope were blurry, when they should have been 10 times sharper than any Earth-bound telescope.

The cause was a tiny mistake in the main light-gathering mirror: it was too flat—1/50 the width of a human hair too flat. That's a very, very tiny mistake, but one that turned out to be very important. There were other problems on the telescope, too.

For help, NASA turned to a team of engineers and scientists. They made a series of thumbnail-size mirrors that corrected the problem the same way glasses correct a person's vision, and figured out solutions for the other problems.

Then it was up to a crew of seven astronauts to fly

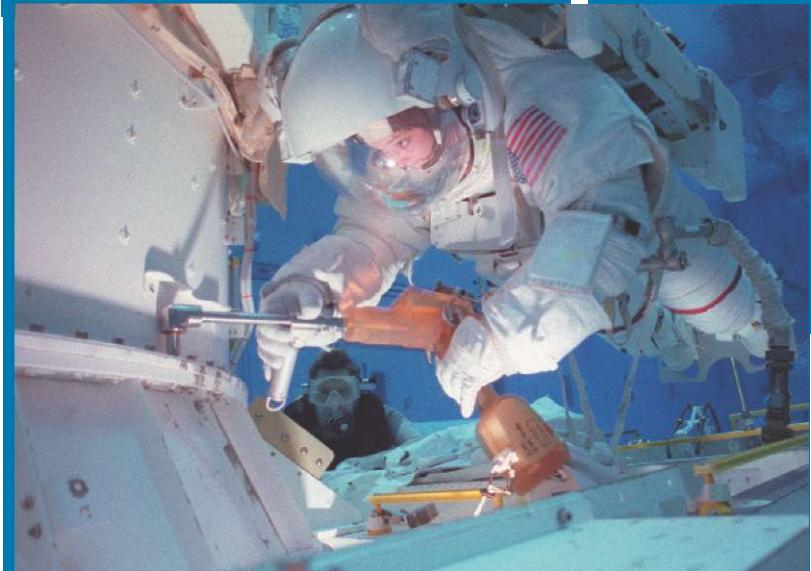
up to the Hubble on a space shuttle and repair the telescope in space. This was one of the toughest jobs ever given to a shuttle team. It would mean completing five space walks, each one six hours long. No one had ever done this before. It would mean moving huge pieces of equipment in space and disconnecting delicate electronic equipment. It would also mean working very carefully and neatly. A loose screw or piece of space trash could damage the telescope while its insides were exposed during the repairs. And the astronauts would have to do this extraordinarily difficult work while braving -300° F (-184° C) temperatures, zero gravity, and wearing bulky gloves and space-suits. Could they do it?

To prepare for the mission, the crew trained hard for 10 months. They spent a total of 400 hours underwater in a weightless-simulation tank—sometimes 7 hours at a time—to condition themselves for the space walks. They also practiced using 100 different kinds of tools. They did three "dress rehearsals" of the mission to make sure they would get it right. It's a good thing they did. During one rehearsal, when the temperature was as cold as it is in space, an astronaut's hand became frostbitten (it healed unharmed). Because of this problem, an extra layer of insulation was added to the astronauts' gloves.

Despite the hard training the astronauts did, NASA believed they would be able to finish only half the repairs. But NASA was in for a big surprise. The astronauts did all the repairs in their 11-day mission. Since then, the Hubble has sent thousands of beautiful images of the universe back to Earth. Further repairs were conducted in late 1999.



# Nearly No Gravity



Movies often show astronauts bouncing around in a zero gravity training center as they practice how to adjust to the weightlessness of space. Unfortunately for anyone who has ever dreamed of floating in a zero gravity chamber, such places don't exist. Zero gravity cannot be created on Earth for long periods of time. Instead, astronauts experience weightlessness using other methods. One way is in a 35-foot deep pool of water called the Weightless Environment Training Facility. The Hubble rescue crew practiced repairing the telescope on a model in this pool. Astronauts wore training versions of their space suits.

Something that looks like a huge air-hockey table helped them practice moving large objects in space. The astronauts were strapped into harnesses and suspended above a floor from which jets of air flowed.

## Hubble's Fantastic Finds

Some top discoveries made by the Hubble:

- ▶ Identified gas whirlpools that can be trapped only by the power of a black hole's gravity—more proof that black holes exist.
- ▶ Detected oxygen in the atmosphere of Europa, one of Jupiter's moons.
- ▶ Found ancient helium between galaxies and calculated the speed at which stars and galaxies are moving. Findings support the Big Bang theory, which says a big burst of energy was released in a single explosion between 12 and 14 billion years ago. It also suggests the universe is expanding and pushing galaxies farther apart.
- ▶ Observed dust clouds that could be newly born solar systems. If they are, there are many more planets out there and many more chances of finding life elsewhere.

## Need For Speed

The Hubble speeds around Earth at 5 miles (8 km) per second. If you could drive a car from New York City to Los Angeles at this speed, you'd arrive in California in just 10 minutes!

## Activity

**HUBBLE'S VISION** Edwin Hubble had a lot of theories about the universe, which the telescope named in his honor later confirmed. Look up and read about Edwin Hubble. Compare his theories with what the telescope has discovered. Write a list of any similarities you find.