Space Physics: Introduction

The National Aeronautics and Space Administration (NASA) program was launched by President Dwight D. Eisenhower in 1958, at a time when the United States and Russia were doing more competing than cooperating in their quests for achievements in space exploration. Early Russian achievements included the first artificial satellite (Sputnik 1 [1957]) and the first probe to impact the Moon (Luna 2 [1959]). But American scientists and engineers were hard at work on the Mercury Project, and less than one month after Russian Cosmonaut Yuri Gagarin became the first person launched into space, American Astronaut Alan Shepard became the second human being in space (1961), and the milestones achieved in space exploration and human spaceflight continued in competitive fashion for both nations. In 1962, President John F. Kennedy said “We choose to go to the moon and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills...”

What did President Kennedy mean when he said the goal “would serve to organize and measure the best of our energies and skills”? Likely, he was referring to the consolidation of talented people with brilliant ideas. But, was he also talking about the reorganization and refinement of ideas that so often results from collaboration?

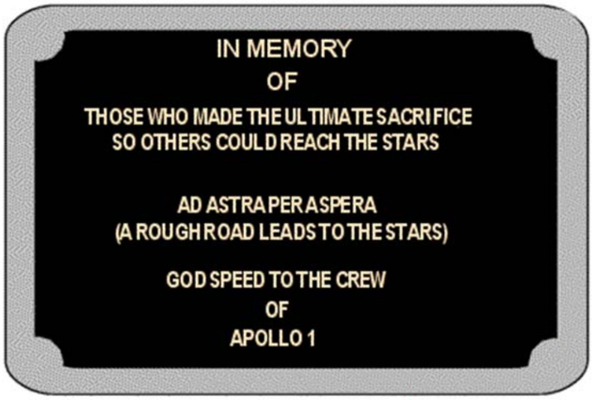
NASA photo.

To consider this question, let's review a few of the many reasons space exploration has been important to us:

- The unifying effect felt by 60s-era Americans as a result of a national objective to see U.S. astronauts explore the moon's surface
- Economically stimulating employment opportunities that have been offered to Americans by NASA, academia, and the thousands of technology startup companies that benefited, and then prospered because of, the NASA space program
- Countless technological advancements in use today that resulted from both achieved and even a few failed NASA goals.

American Astronaut Neil Armstrong, first man to walk on the moon (July 20, 1969.)

These advancements, often called NASA spin-off technologies, include water filtration and purification, clean energy technology, scratch-resistant lenses, CAT scans, and even the cell phone camera. The process that resulted in these amazing advancements went something like this: Everything on a spacecraft must be as small and lightweight as possible, because the heavier a spacecraft, the more difficult it is to launch. Designs developed to meet this very specific need quickly influenced the design of devices outside the space program, such as tools for diagnosing diseases and lightweight devices that help people overcome many types of disabilities.



Similarly, materials and parts that compose a spacecraft must endure incredibly harsh conditions, such as extreme heat and cold. Products designed to meet those goals quickly inspired designs for other materials, and now many new homes and buildings contain fire-resistant materials. Firefighters today wear protective suits made from fabric originally used in space suits.

And finally, to survive their missions, astronauts had to have a safe working environment. Thus, NASA developed systems for purifying air, water, and food, and (you guessed it) these systems now benefit us all.

In the 1950s and early 60s, science that didn't appear to have a practical use was often viewed as a waste of money, so the NASA space program was controversial in its inception. Many people held strong views that, with so many problems to deal with on Earth, we shouldn't use our resources to explore "new frontiers." Many also thought that space flight was extremely risky and that this the risk was unnecessary. On January 27, 1967, three American Astronauts paid the ultimate price. Since then, more brave researchers, scientists, pilots, and even a school teacher have paid that price.

So, how has our culture benefited from the space program? Today, our lives are longer, safer, and even more fun, in part, because of advancements made by the space program and associated research. Nevertheless, a similar controversy continues today over the value of government-funded space exploration.

Regardless of politics, it is difficult to deny that efforts to achieve the early goals of the NASA space program did in fact “organize and measure the best of our energies and skills.” NASA’s Project Mercury, Project Gemini, and of course the Apollo Program, which was responsible for landing the first humans on Earth’s Moon in 1969, are evidence of that.

German V-2 rocket.

Today’s article is the first in a series that will discuss objects in space and achievements in rocketry and space exploration, including those of NASA and other space agencies. Phenomenal Physics articles are not intended to support either side of a debate regarding the space program. Rather, the intent is to illustrate space flight from a scientific and historical perspective.

The coming articles will not only provide an exciting history of rocketry (beginning with Goddard’s liquid fueled rocket and the German V-2), they will demonstrate the progression of related research and development. We’ll talk about escape velocity, propulsion, orbits, planets, comets, suns, solar systems, galaxies, and other universes.

We’ll learn about satellites, the Space Shuttle, and NASA probes that are presently in interstellar space. Through the articles, we hope to convey the concept that collaboration—a dynamic, exponential-like exchange of ideas—is a key element in solving problems and achieving great things. Collaboration reveals what President Kennedy called the “best of our energies and skills.” As contemporary author Steven Johnson explains in his book *Where Good Ideas Come From: The Natural History of Innovation*, “Good ideas may not want to be free, but they do want to connect, fuse, recombine. They want to reinvent themselves by crossing conceptual borders. They want to complete each other as much as they want to compete.”

Launch of NASA’s Space Shuttle Atlantis.

NASA photo.

Space: The Beginning

As with all things in science, we begin with a question: How far is it from the Earth to space?

Commercial airliners climb to around 30,000 ft or about 6 mi (9 km) off the ground. Military planes can reach heights over 100,000 ft, or about 19 mi (30 km) above the ground surface. That distance, however, isn't even half way to space. In the continental United States, space begins at 50 mi (80.4 km) above the ground. International consensus about where space begins is at 62 mi (100 km) or 380,000 ft.

The first official definition of space came from the National Advisory Committee for Aeronautics, who determined that the area where atmospheric pressure is less than 1 pound per square foot is where space begins. At that altitude, aircraft control surfaces can no longer be used. Control surfaces are the moveable surfaces on an airplane's wings and tail that allow a pilot to maneuver an airplane and control its attitude or orientation. Any NASA test pilot or astronaut who surpasses an altitude of 50 mi is awarded his or her astronaut wings.

Fun Facts:

- The first animal in space was a Russian dog named Laika, aboard Sputnik 2, in 1957.
- In 2012, Austrian sky diver Felix Baumgartner ascended to a height of 128,100 ft (39 km) aboard a capsule attached to a 55-story-tall helium balloon. He was less than half way up to what we consider space. Baumgartner jumped and shot to earth at a speed of 833.9 mph (1,343 km/h), reaching Mach 1.24, and became the first person to break the sound barrier without vehicular power on his descent. It took 9 minutes for Baumgartner to reach the ground.