

## 50 Days in Space

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“Exploration” at its most basic level is everything that expands the realm of human experience and of human consciousness. I started my professional career as an astronomer, and I have always considered astronomy to be exploration, with telescopes the vessels that carry our minds, and thus at least part of our consciousness, out to the stars. Astronomy may be passive compared to actual physical exploration, but while Columbus with his ships gave us a new continent, Galileo with his telescopes gave us whole new worlds; and he never set foot outside Italy. During our lifetime, we have explored the surfaces of all the worlds Galileo discovered and many others besides.

The Hubble Space Telescope is the flagship of our astronomical exploration fleet, with many powerful colleagues on the ground as well as partners in space observing other electromagnetic wavelengths. Hubble has taken us deep into space and back in time to the youth of our universe. For minds confined to a miniscule volume of space on a single, small planet to have expanded their domain to contemplate a universe as immense as the one we think we live in is an astounding feat of exploration.

I was fortunate to have been selected as a NASA astronaut in 1978, when NASA was preparing to start flying the Space Shuttle. I made five space flights during my 19 years with NASA and became the first astronaut to accumulate 1000 hours of space flight onboard the Shuttle. Of all the missions I flew, the one with the greatest impact was surely the rescue and repair of the initially flawed Hubble telescope. Having been both an astronomer and an astronaut, for me one of the most satisfying aspects of working on Hubble was uniting the world of space astronomy, which normally prefers automated spacecraft, with the world of human spaceflight.

Hubble has been such an extraordinary success since our mission that it is hard to remember the shock and despair when astronomers first discovered that its exquisitely crafted optics suffered from spherical aberration, preventing Hubble from producing the sharply focused images for which it was designed. If NASA could not fix the problem, it was unlikely that the U.S. Congress would authorize the construction of the International Space Station, so in a very real sense when we blasted off for the Hubble rescue repair mission in December 1993, we carried the future of NASA with us.

The results have surpassed everyone’s wildest dreams. Hubble’s discoveries have rewritten astronomy textbooks many times over. We have seen the birth of stars and the death of stars. We have seen planets in the process of formation. We have seen galaxies formed many billions of years ago, when the universe was much younger, and we now understand much more about how galaxies are formed, with massive black holes seemingly present at the center of all galaxies. Most unexpected, we have discovered that the expansion of the universe, first described by Edwin Hubble himself, is actually accelerating, in contrast to all expectations. This has led to the realization that 96% of our universe consists of dark matter and dark energy, whose nature we do not understand. Normal matter and energy, which has been the object of scientific study throughout human history, makes up only ~6% of the content of our universe! Clearly, there is a lot of physics still waiting to be discovered. This is what makes science so exciting – no matter how much you discover, you continually uncover new mysteries of nature demanding further research. We truly live in a golden age of astronomical discovery, and there will be plenty of exciting work for the next generation of physicists and astronomers.