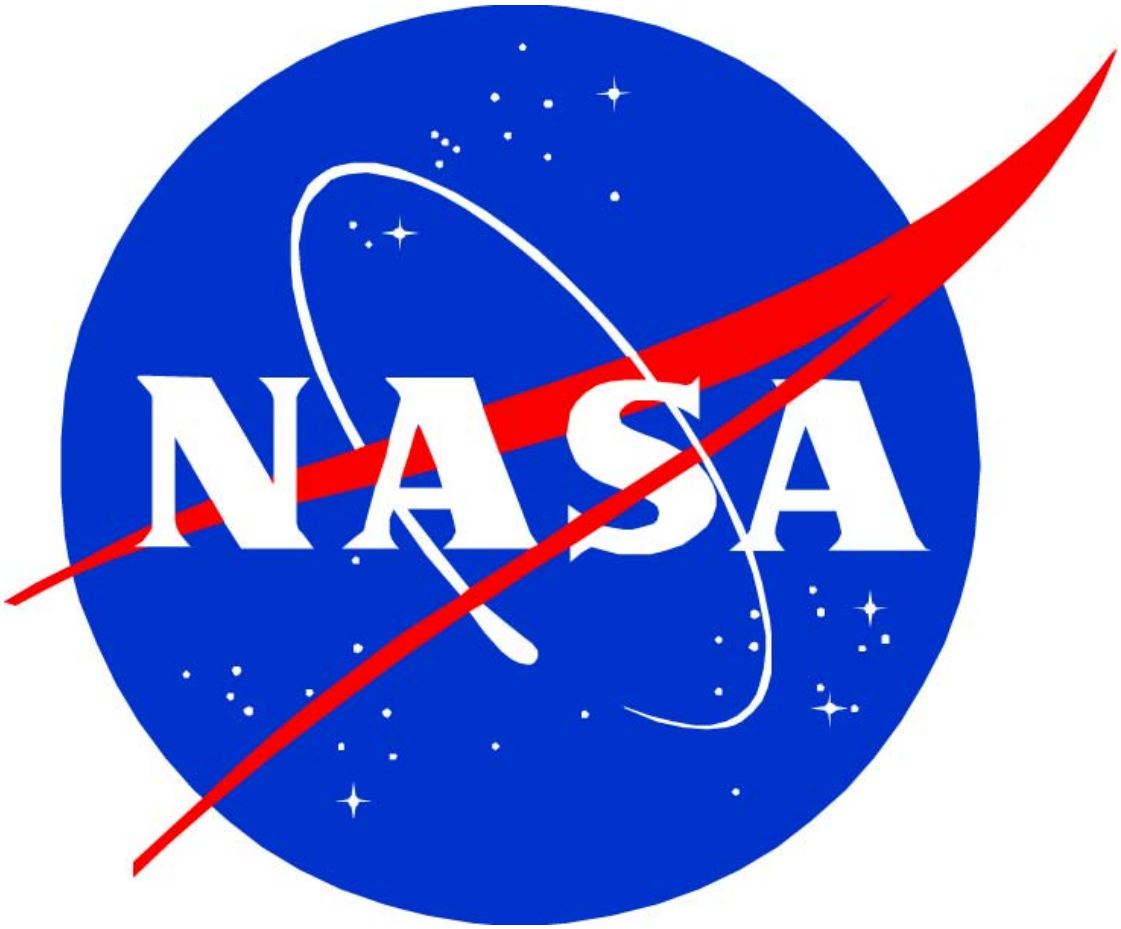
The continuation of NASA´s Apollo Program



Carlos González

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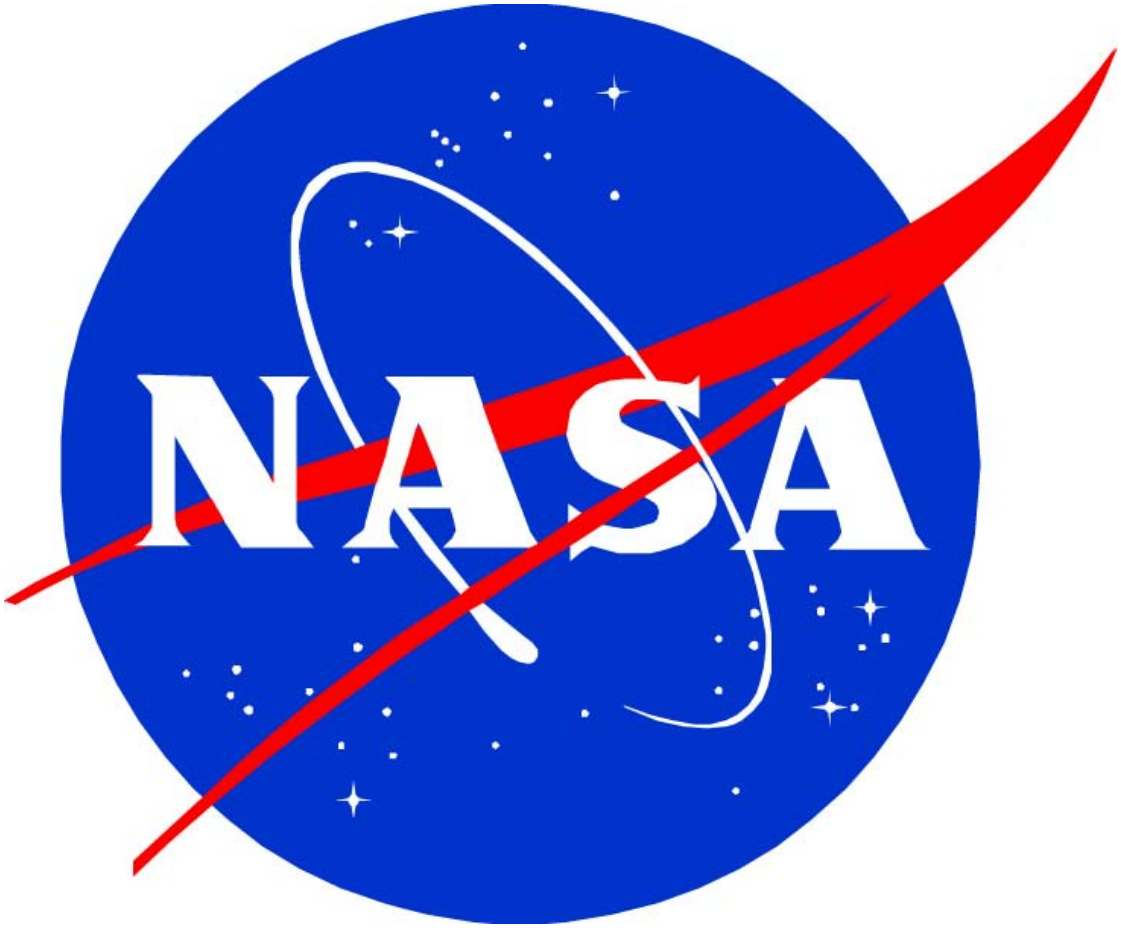


This essay, as all the previous, is dedicated to my wife, Estrella, and daughters, Raquel and Sara, who have seldom seen me in the last months while I was busy with compiling all the available information existing on the subject and mixing it with my own memories.

Carlos González

Brief history of NASA´s SKYLAB Program

(Carlos Gonzalez. Former OPS Manager MDSCC)

Foreword

During the design phase of the Apollo Program, NASA had anticipated the launching of, at least, 20 Saturn vehicles which would include the AAP *(Apollo Applications Program)*. This program was established in 1968 to convey a series of science-based manned space missions using the hardware developed for the Apollo missions and was a subset of the AES *(Apollo Extension Series)*. AES was establishing new technology concepts for missions based on the Saturn IB and Saturn V boosters. These included a *manned lunar base*, an *earth-orbiting space station*, a Project called "*Grand Tour of the Outer Solar System*", and a "*Voyager program*" for Mars Lander probes.

In order to fulfill these requirements, NASA approved the appropriation of enough money from its budget to build the 20 vehicles and signed the designing and development contract with the different companies involved with this project.

The problem was that the taxpayers' interest in Space exploration decayed as soon as the Moon was reached. If we´ve been there the first, why keeping these Moon trips at such a big cost? Apollo XII was already questioned more than NASA expected but the accident with the Apollo XIII brought back the expectations.

NASA managed to keep, somehow, the interest of the people by designing and building a rover that would increase the total exploration surface around the LM much further. This solution gave way to Apollo´s XV, XVI and XVII but that was it.

So, they had four Saturn V vehicles in their back yard for which there was no apparent use. Resurfacing back the initiative of AES, they thought of remodeling the third stage of one of these vehicles into a laboratory and astronauts´ quarters and include a telescope called ATM *(Apollo Telescope Mount)* to observe Sun, Earth and Solar System in general, and place it into Earth´s orbit. This was the Skylab.

The purpose was to work on a myriad of experiments related to physics applications, chemistry, biology, pharmacology, etc. taking advantage of micro gravity, and use it also, as a permanent observatory for Earth, Sun, the planets and the new and still unknown comet Kohoutek (discovered March 1973) thanks to the ATM.

After the last manned flight to the station, plans were made to use the new STS to refurbish the vehicle and to place it into a higher more stable orbit but the delay in the delivery of *Columbia* was crucial in the decay of the station due to atmosphere drag. All efforts to maintain Skylab in orbit were unsuccessful and it re-entered Earth's atmosphere on 11th July 1979. Debris from the station fell over the Indian Ocean and parts of Australia.

1. SKYLAB I

This new NASA´s spatial kin started May 14th 1973 when *Skylab* was launched as part of a Saturn S-II.

But the trip didn´t start as smooth as expected however. Shortly after liftoff, the vibrations supported by the vehicle during launch, structurally damaged a large micrometeorite shield, designed to protect the orbital workshop. Within seconds, aerodynamic forces stripped the shield completely free from the station.

As the shield tore off, one of the solar panels partially deployed. After second stage shutdown, exhaust from the retro rockets used to separate both, the second stage and the workshop, impacted the partially deployed solar panel and ripped it off.

The future of the whole *Skylab Program* was in danger.

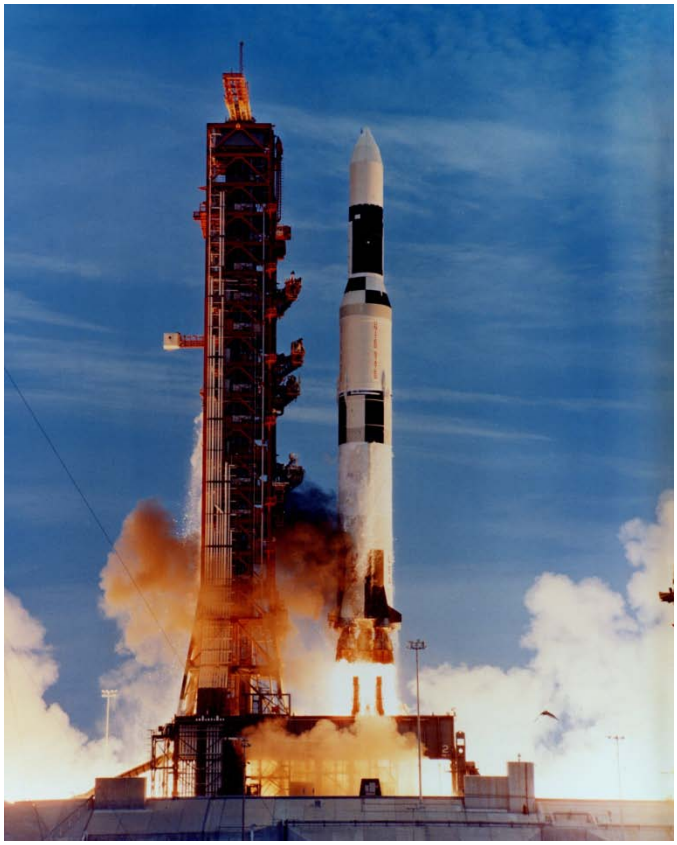
Once in orbit, it was found that the other solar panel had also been damaged and could only be opened half of its total span tangled in a mess of cables and so, enough electricity could not be produced to power the environmental system or to control the station from the ground. This, plus the absence of the micrometeorite shield, caused the temperature inside the dwelling to rise to 52º C, rendering it definitely inhabitable and endangering all of the experiments that were planned.

As it was, the mission was a total failure but NASA was not in the pose to give up. Fortunately, the four solar panels of the ATM deployed as planned and that produced enough power to operate the station, at a minimum level, until repairs could be attempted.

A crisis team was created to analyze and try to minimize the problems and, after studying all the possibilities, they found a partial solution that could "save" some of the list of experiments and observations they had planned.

Left, an artist conception of the space vehicle as it would have looked had the launch problem not occurred.

2. SKYLAB II



I know, the title is Skylab II and the patch says Skylab I but this was due to a NASA management error whereby mission patches were designed in conflict with the official mission numbering scheme.

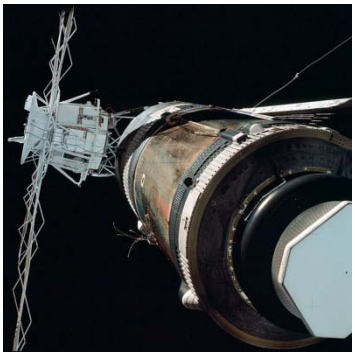
Urgency was a must. Three astronauts were trained in "do-it-yourself" repairs and, only eleven days after the first launch, on May 25th 1973, Skylab II was launched on a Saturn IB in an effort to give a twist to the mission expectancies after the failures of its predecessor.

When they arrived to their new home, they found that the medical and biological experiments were almost ruined due to the high ambient temperature. The environment was so aggressive that they didn´t remove the thermal clothes for several days and had to sleep inside the *Apollo* ship that had taken them up.

The prime crew for this flight was:

Position	**Astronaut**
Commander	Charles "Pete" Conrad, Jr.
Pilot	Paul J. Weitz
Science Pilot	Joseph P. Kerwin

First things first. Upon arrival, the CSM pilot, Conrad, flew around the station to assess the damage and then soft-docked with it. This avoided the necessity of station keeping while the crew ate and flight controllers planned the first repair attempt.



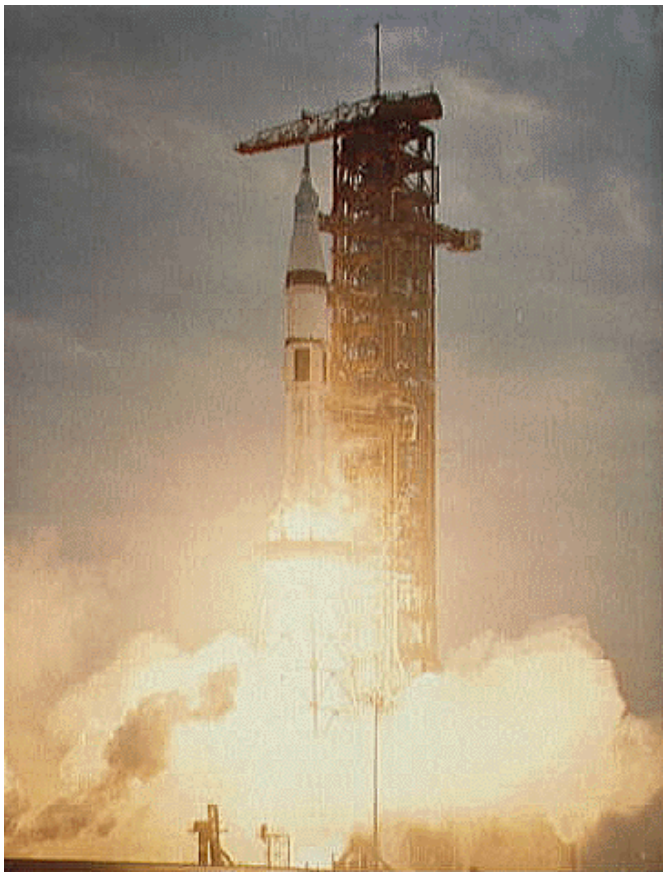
They first tried to free the tangled solar panel by tugging at it with a 10-foot hooked pole. This failed after a few attempts and consumed a significant amount of the Skylab's nitrogen maneuvering fuel while keeping it steady in the process. Then, they maneuvered to hard-dock with the station but latches failed to operate so they, again, donned their space suits and partially disassembled the docking probe after which they were able to lock.

They entered into the lab, the atmosphere of which had been previously purged with pure nitrogen four times and refilled with the nitrogen/oxygen needed for the crew, and continued with the repairs. Next, through the small scientific airlock, they deployed a double thermal blanket over the lab to act as a parasol to protect it from the heat of the Sun and, by doing so, the temperature inside went down to 28º C, thus making living acceptable.

It was now time to recover the electricity generation by making the remaining solar panel operative and, two weeks later, they performed a second EVA and finally succeeded.

For nearly a month they made further repairs, conducted experiments, gathered science data, and performed a total of 392 hours of experiments. Spent 28 days in space and splashed down in the Pacific Ocean on June 22, 1973 near the recovery ship USS *Ticonderoga*. Skylab II set the records for the longest duration manned spaceflight, greatest distance traveled and greatest mass docked in space. Conrad set the record for most time in space for an astronaut.

3. SKYLAB III



This was the second manned mission to Skylab. It began July 28th, 1973, with the launch of three astronauts on a Saturn IB, and lasted 59 d, 11 h and 9 m.

The time dedicated to scientific experiments, medical activities, solar observations, Earth resources, and other experiments totaled 1,084.7 hours.

During the approach phase, a propellant leak appeared in one of the SM´s reaction control system thruster quads. This was not an impending failure to dock with the station but troubleshooting continued. Six days later, another thruster quad developed a leak, creating concern amongst Mission Control. For the first time, an Apollo spacecraft would be rolled out for a rescue mission, thanks to the ability of having two CSMs docked at the same time. It was eventually determined that the CSM could be safely maneuvered using only two working thruster quads, and the rescue mission was never launched.

The prime crew for this flight was:

Position	Astronaut
Commander	Alan L. Bean
Pilot	Jack R. Lousma
Science Pilot	Owen K. Garriott

During the first EVA, they deployed the twin-pole sunshade, the second of the two solutions to cope with the destruction of the micrometeoroid shield during Skylab's launch, which would help to keep the space station cool. It was installed over the parasol that was originally deployed through a porthole airlock during the previous mission. This sunshade had been brought to the station by Skylab II´s crew but could not be deployed.

During this mission they continued the medical research program that extended the data on human physiological adaptation and re-adaptation to space flight that was collected on Skylab II. In addition, the astronauts' stay in space was extended from almost one month to two months.

The medical investigations that were performed on Skylab II were supplemented during this mission based on lessons learned. For example, only leg volume measurements, pre-flight and post-flight stereophotogrammetry, and in-flight maximum calf girth measurements were originally scheduled for all three Skylab missions.

One of the additions was the in-flight torso and limb girth measurements to gather more data on the apparent head-ward fluid shift commonly known as the "puffy face syndrome" observed during Skylab II. Other additional tests included arterial blood flow measurements, facial photographs, venous compliance, hemoglobin, urine specific gravity, and urine mass measurements. All of these gave additional information about fluid distribution and fluid balance.

The biological experiments included the study of the effects of microgravity on mice, fruit flies, single cells and tests on human lung cells to examine the biochemical characteristics of cell cultures in microgravity. The two animal experiments were entitled

Chronobiology of Pocket Mice and Circadian Rhythm in Vinegar Gnats but they were both unsuccessful due to a power failure 30 hours after launch which killed the animals.

A call was made to High school students across the United States to participate as scientific and primary investigators of experiments in the Skylab missions which included, but were not limited to, studies on astronomy, physics, and fundamental biology. Some of the student experiments performed on Skylab III were: The study of libration clouds, X-rays from Jupiter, in-vitro immunology, spider web formation, cytoplasm streaming, mass measurement, and neutron analysis.

Other studies took place on the astronaut maneuvering equipment, the habitability of the crew quarters, and the living and working aspects of life in space.

Mission ended with a splashdown into the Pacific Ocean on September 25th 1973 and with the recovery operation performed by the USS *New Orleans.*

4. SKYLAB IV

The mission started on November 16th, 1973 with the launch of three astronauts on a Saturn IB rocket from the Kennedy Space Center, Florida and lasted 84 days, one hour and 16 minutes. A total of 6,051 hours were dedicated to scientific experiments in the areas of medical activities, solar observations, Earth resources, observation of the Comet Kohoutek and other experiments.

When the crew arrived aboard Skylab, they found they had company – three figures dressed in flight suits. Upon closer inspection, they found their companions were three dummies with Skylab 4 mission emblems and name tags which had been left there by the crew of Skylab 3.

The prime crew for this flight was:

Position	Astronaut
Commander	Gerald Carr
Pilot	William Pogue
Science Pilot	Edward Gibson

This was an all-rookie crew and thus, had problems adjusting to the same workload level as their predecessors especially after the crew attempted to hide Pogue's early space sickness from flight surgeons. This, however, was discovered by mission controllers after downloading onboard voice recordings.

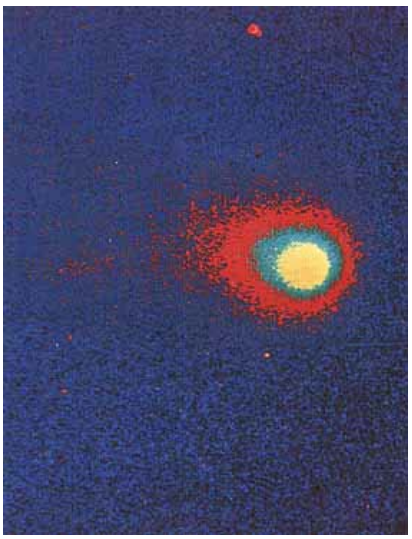
First thing was to unload and stow the thousands of items needed for their lengthy mission and the task proved to be overwhelming. The work plan for the activation sequence dictated lengthy work periods and the crew soon got tired and behind schedule.

As activation progressed, the astronauts complained of being pushed too hard. Ground crews disagreed; they felt that they were not working long or hard enough. Finally, the workload schedule was modified, and by the end of their mission the crew had completed even more work than had been planned before launch.

On Thanksgiving Day, Gibson and Pogue accomplished a 6½ hour spacewalk. The first part was spent replacing film in the solar observatory while the remainder of the time was used to repair a malfunctioning antenna.

The crew reported that the food was good, but slightly bland and that they would have preferred to use more condiments to enhance the taste.

In mission day seven, a problem developed in the Skylab attitude control gyroscope system, which threatened to bring an early end to the mission. This failure was attributed to insufficient lubrication. Later in the mission, a second gyroscope showed similar problems, but special temperature control and load reduction procedures kept the second one operating, and no further problems occurred.

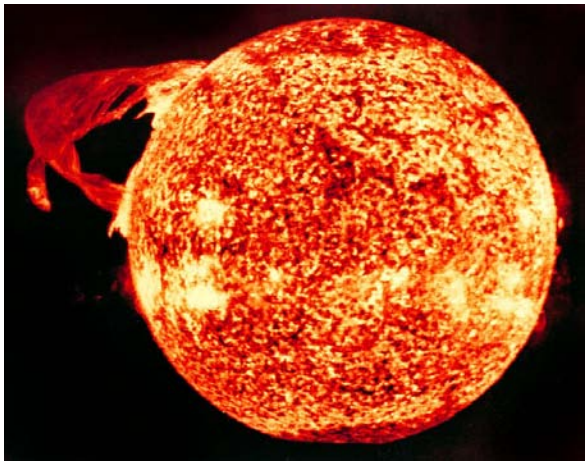


The crew spent many hours studying the Earth and the Sun. Images were taken in the X-ray, ultraviolet, and visible portions of the spectrum.

On December 13th, the crew sighted Comet Kohoutek and focused the solar observatory and hand-held cameras on it. They gathered spectra using the Far Ultraviolet Camera/Spectrograph.

Observation continued as it approached the Sun. On December 30th, as it swept out from behind the Sun,

Carr and Gibson spotted it as they were performing a spacewalk.



On January 21st, 1974, an active region on the Sun's surface formed a bright spot which intensified and grew. This sequence was filmed and was listed as the first recording from space of the birth of a solar flare.

The crew also photographed the Earth and, despite instructions not to do so, and perhaps inadvertently, Area 51, causing a minor dispute between various government agencies. In the end, the picture was published along with all others in NASA's Skylab image archive, but remained unnoticed for years.

The Skylab 4 astronauts completed 1,214 Earth orbits and four EVAs totaling 22 hours, 13 minutes. They traveled 55,500,000 km in 84 days, 1 hour and 16 minutes in space.

The three astronauts had joined NASA in the mid-1960s during the Apollo program and Pogue and Carr had been assigned for the cancelled Apollo 19. Ultimately, none of the crew of Skylab 4 flew in space again, as they all retired from NASA before the first STS launch. Gibson, who had trained as a scientist-astronaut, resigned from NASA in December 1974 to do research on Skylab solar physics data.

The mission ended with splashdown into the Pacific Ocean on February 8th, 1974 and with the recovery operation performed by the USS *New Orleans*.

5. ACKNOWLEDGEMENTS

a. All photographs depicted in this essay are from public Internet publications and, in no way, they will be used to collect any income.
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k. A special mention to my Friend José Araujo. His enthusiasm for all the NASA projects and, in particular, for the Space Race, is so contagious that made me consider seriously that such a part of History couldn't just go unnoticed. We must take into consideration that this is part of the History of Humanity, not just of a specific Country.

6. BIBLIOGRAPHY

- **Skylab:** America's Space Station **by David Shayler.**
- Leland F. Belew, **Skylab:** Our First Space Station, NASA SP-400. 1977.
- W. David Compton and Charles D. Benson, **Living and Working in Space:** A History of Skylab, NASA SP-4208. 1983.
- Living and Working in Space: A History of Skylab - The 1983 NASA history of Skylab
  MSFC Skylab Crew Systems Mission Evaluation (PDF). NASA TM X-64825. August, 1974.
- Skylab, Classroom in Space - A post-mission (1977) review of student research on Skylab.
- Gilles Clement, *Fundamentals of Space Medicine,* Microcosm Press, 2003. pp. 212.
- Lattimer, Dick (1985). *All We Did was Fly to the Moon*. Whispering Eagle Press. ISBN 0-9611228-0-3.
- Skylab: A Guidebook - A pre-launch (1973) overview of the program.
- Skylab Illustrated Chronology - A pre-launch (1973) listing of major calendar milestones of Skylab from 1962-1973.
- Skylab, Our First Space Station - An illustrated post-mission (1977) review of the program.

7. GLOSSARY OF TERMS

AAP **Apollo Applications Program**

AES **Apollo Extension Series**

ATM **Apollo Telescope Mount**

CSM **Command and Service Module**

EVA **Extra Vehicular Activity**