EXPLORATIONS IN SPACE: ASTRONOMY IN THE SPACE AGE

Erik Tandberg
Sondreveien 4 K, 0378 Oslo, Norway

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Summary

The classic instrument of the astronomer since the 16th and 17th centuries has been the optical telescope. Together with the spectroscope, the radio telescope and other instruments on the ground, this powerful tool has given later astronomers a good insight into the fantastic universe around us – and will continue to do so through technical improvements such as larger, better mirrors and adaptive optics. A new window to the universe was opened with the launching of Sputnik 1, the first artificial satellite, on October 4, 1957. In the Space Age we could place optical telescopes and other tools in orbit around the Earth, send instruments to other celestial bodies and put manned spacecraft on the surface of the Moon. Above the Earth's atmosphere it is possible to see further out with greater detail and study the universe in all wavelengths of the electromagnetic spectrum. And the space probes will, like a stretched hand, put instruments close to or in direct contact with the planets, moons, asteroids and comets of our solar system. This is a revolution, and it is only starting. The purpose of this

chapter to give a coarse outline of what the Space Age has contributed to astronomy through unmanned and manned spacecraft so far. Astronomical benefits through the use of scientific satellites and space observatories in low Earth orbits are not included.

1. The First Satellites

The Space Age did not "just happen". Unexpected to most people around the world, the October 4, 1957 launch of the Soviet Sputnik 1, the first artificial satellite, was the result of circumstances such as the missile race, the brilliant Soviet engineer Sergey P. Korolyov and the ICSU (International Council of Scientific Union) 1952 initiative on IGY (The International Geophysical Year).

The missile race appeared as an intense rivalry between the United States and the Soviet Union to develop military rockets with enough payload capability to carry nuclear payloads, even thermonuclear warheads, over so-called intercontinental ranges.

Figure 1. With Sputnik 1, launched on October 4, 1957, the Soviet Union initiated the Space Age. (NASA)

The two superpowers started work on the basis of the German V-2 ballistic missile, which was designed by a group of scientists under the leadership of Dr. Wernher von Braun and used against Antwerp and London from September 1944. Both the USA and the USSR captured a lot of V-2 parts and equipment in Germany at the end of World War II, but USA gained an added advantage with the surrender of Dr. Wernher von Braun and 117 of his foremost scientists and engineers in May 1945.

Sergey P. Korolyov (1906-1966) was an aeronautical engineer with a special interest in rocket propulsion and space flight. This interest cost him seven years as a badly treated Stalin prisoner, but when freed in June 1944 he resumed work on rocket propulsion for military purposes. In the fall of 1945 he was appointed as a colonel in the Red Army and sent to Germany with the specific task of obtaining more V-2 related equipment and information.

Korolyov had to wait until Stalin's death in 1953 to be fully rehabilitated, but was

shortly after given the responsibility for the development of the Soviet long range missile, the R-7, nicknamed Semyorka.

Korolyov and his OKB-1 design bureau knew that the R-7 would develop enough thrust to place a simple satellite in a low Earth orbit, but was told that no R-7 would be available before it had demonstrated its ability to carry a two ton nuclear warhead in a ballistic orbit with a range of 7000 km. After three unsuccessful tests in the period May-July 1957, the R-7 achieved an almost full ballistic range capability in August 1957.

The ICSU 1952 IGY initiative specified the need for geophysical data collected from the ground, from airplanes and from balloons. In October 1954 the Council adopted a resolution promoting the use of satellites to map the surface of the Earth.

On July 29, 1955 the Eisenhower administration announced that the USA intended to launch small satellites as part of the IGY contribution. Three days later the Soviet Union also declared satellite plans. This and later reports from the superpower in the east were registered by the media, but rarely made headlines. A race to be the first nation to launch a satellite was on, but in the mind of almost everybody the winner would be USA, the technologically most advanced nation in the world.

The IGY was stated to last from July 1, 1957 to December 31, 1958, and there are indications that Korolyov had in mind to launch Sputnik 1 on September 17, 1957, the 100th anniversary of the birth of the Russian space pioneer Konstantin E. Tsiolkovky. The time available for preparations was too short, however, and the satellite was not orbited until October 4, 1957.

The launch came as a big surprise to most people, and was a media sensation where newspapers and radio commentators gave factual information and expressed admiration. In the US some editorials and politicians also reflected disappointment and even fear. Disappointment because it was expected that the Americans would take the lead in this high-technology endeavor, fear because the Soviets had demonstrated a powerful rocket with long-range capabilities.

Sputnik 1 carried instruments and equipment, including two radio transmitters broadcasting on 20 and 40 MHz. The signals could be received by radios around the world, and analysis was used to obtain information on electron density of the ionosphere, while temperature and pressure data were encoded in the duration of the radio beeps. The pressure data indicated that Sputnik 1 was not punctured by micrometeoroids.

The information about near-Earth space did not reveal any surprises, but were more comprehensive than what instrument-equipped rockets had collected in ballistic flights up to that point.

Sputnik 1 had the shape of a sphere with a diameter of 58 cm and with four whip antennas. The on-orbit mass was 84 kg.

The Soviet premier, Nikita S. Khruschev, impressed by the national and international

reactions to Sputnik 1, requested from Korolyov a new spectacular event to celebrate the 40th anniversary of the 1917 Revolution. Time was extremely short, and Korolyov knew it could not be spent on a thorough development. Nevertheless Sputnik 2 was a new sensation when the launch was announced on November 3, 1957: Not only did the satellite carry Laika, a mongrel dog and the first living being in orbit around the Earth, but the mass was an impressive 508 kg. Laika survived only 5-7 hours in space due to stress and high temperatures, but instruments to observe solar and cosmic radiation carried out some space exploration.

The initial US plan for IGY satellite participation came to involve a launch vehicle called Vanguard, but met with technical problems. The first attempt to launch a satellite by the same name on December 6, 1957, was a complete failure right before the eyes of the invited world press, but at that time President Eisenhower had already turned to Dr. Wernher von Braun. The German rocket engineer, now an American citizen working for the US Army Ballistic Missile Agency at Redstone Arsenal in Huntsville, Alabama, led the assembly of a four-stage Jupiter C variant. The three-stage Jupiter C with a Redstone first stage was developed mainly for military re-entry testing, and the new four-stage variant, sometimes called Juno 1, was used to launch the first US satellite. The name was Explorer 1, the date January 31, 1958.

Explorer 1 was built by California Institute of Technology's Jet Propulsion Laboratory and equipped with instruments delivered by Dr. James Van Allen, professor of geophysics at the University of Iowa. The instruments collected data on cosmic radiation, temperatures and micrometeoroid-hits. The discovery of the Earth's inner radiation belt, the so-called inner Van Allen belt, was made by Explorer 1.

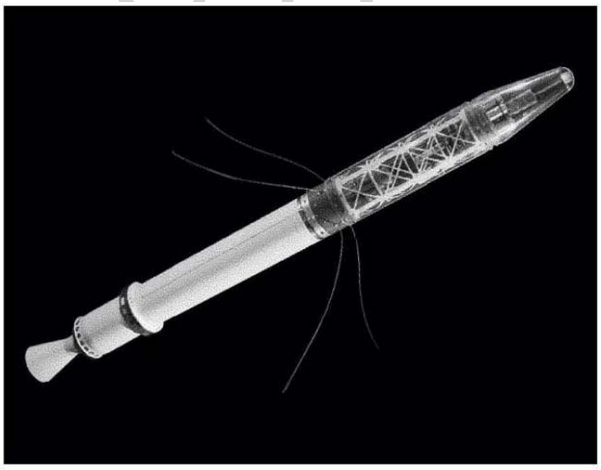

Figure 2. Explorer 1, the first US satellite, was launched on January 31, 1958. It's on orbit mass was 14 kg, not much compared to Sputnik 1's 84 kg. But Explorer 1 discovered the Earth's inner radiation belt, later called the inner Van Allen belt. (NASA)

The successful launch of the first US satellite was widely applauded, and for the Americans it created a sense of relief – they were at least participating in what was now referred to as the space race. It is important to note, however, that the Explorer 1 on orbit mass of 14 kg was only one sixth the mass of Sputnik 1 and roughly one hundredth

the mass of the next Soviet sensation, Sputnik 3.

This satellite was launched on May 15, 1958, after an unsuccessful attempt on April 27. Sputnik 3 was actually a Sputnik 1 proposal, and an on orbit mass of 1327 kg included instruments to measure high-energy particles, radiation, solar radiation, upper atmosphere density, and micrometeoroid-hits. Unfortunately a failed tape recorder severely limited the volume of data transmitted to the ground.

The first successful Vanguard-satellite was launched on March 17, 1958. This relatively small satellite, still in orbit, was in operation until May 1964. It's most important scientific contribution was tracking data indicating that the Earth was somewhat pear-shaped.

2. Towards the Moon

The early Soviet ambitions in the space race extended considerably further than low Earth orbits – the first lunar probe, Luna 1, also known as Mechta (Dream), was launched on January 2, 1959. The mission was to hit our celestial neighbor, but it missed by about 6000 km and instead became the first manmade object in a solar orbit. Position measurements were made 113 000 km from the Earth on the way to the Moon, when 1 kg sodium-gas was released. The gas formed an orange-colored cloud visible for a short moment from the Indian Ocean.

The almost identical Luna 2 was launched on September 12, 1959 and hit the Moon at the end of a 33.5 hours flight. Radiation and magnetic field measurements were made on the way, in addition to a recording of micrometeoroid hits. In the collision, small Soviet emblems were spread out locally on the lunar surface.

Luna 3 was an Earth satellite in a highly elliptical orbit that took it around the Moon. Launched on October 4, 1959 it gave us the first view of the up till then unknown rear side of our celestial neighbor. 29 photographs, covering about 70 percent of the rear side area, were taken in 40 minutes on October 7 from an altitude of 63 500-66 700 km. The film was developed on board the satellite, and 17 were transmitted to Earth by telephoto-technology. Six were publicized. The quality was of course not comparable to the present standard, but in 1959 the photographs were sensational.

Also the US had a lunar program in 1958-1959, but it did not achieve much. The impressive Luna-results emphasized the Soviet lead in the space race. So did other space projects, and the American frustration grew. Impatient with efforts to catch up was expressed by politicians, the media and the general public.

The frustration level reached a new high with the Soviet launching of Yuri A. Gagarin, the first human in space, in Vostok 1 on April 12, 1961, and after the failed, CIA-supported invasion on Cuba on April 17, 1961, the young, newly inaugurated US president John F. Kennedy on April 20 sent a note to vice president Lyndon B. Johnson asking what could be done to beat the Soviets. The note suggested several alternatives.

The vice president was also the head of what was then known as the National

Aeronautics and Space Council, a high level advisory board, and went to work immediately with a group of hand-picked, competent people within and outside NASA, among them Dr. Wernher von Braun and Dr. Jerome B. Wiesner. Von Braun was now the director of George C. Marshall Space Flight Centre in Huntsville, Alabama, one of the most important NASA field centers; Dr. Wiesner was President Kennedy's scientific advisor.

NASA had already started preliminary planning of a manned lunar mission, which could include a landing provided von Braun's giant Saturn V launch vehicle would perform as specified. The manned lunar landing mission, called Apollo, was not the only project considered by vice president Johnson's task group, but was the first priority alternative in the recommendation decided upon May 3, 1961.

On May 5, 1961, NASA-astronaut Alan B. Shepard became the first American in space with a 15 minutes suborbital mission in the Mercury-capsule Freedom 7, and on May 25, 1961, president Kennedy delivered to the Congress his famous speech in which he challenged the US to send a man to the Moon and return him safely to Earth – before the end of the decade.

Based on what was known in May 1961 about the Moon and the possibilities to reach it with a manned spacecraft, the challenge must have been one of the toughest ever presented by a politician. But obviously the speech was the right message given by the right person at the right time.

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Biographical Sketch

Erik Tandberg received his engineering education at the University of Santa Clara (BS, 1957) and Stanford University (MS, 1959) in California, and carried out postgraduate studies in Rocket Propulsion at Princeton University in New Jersey (1965). He has served 17 years with the Royal Norwegian Air Force, and has held positions in private companies. Tandberg has written several books and numerous

articles on space related matters, and has been a space science/technology consultant to the Norwegian Broadcasting Corporation (radio/TV), covering many space events. At the time of writing this chapter he was running his own consultancy company, mainly working for the Norwegian Space Center in Oslo, Norway.