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MONDAY,
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PRESS KIT

PROJECT: SAS-C

Contents

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NEW X-RAY SATELLITE TO BE LAUNCHED FROM AFRICA

The fast-developing science of high-energy astrophysics soon will be provided with an important new instrument for studying major energy transfer mechanisms in the universe.

The instrument is NASA's Small Astronomy Satellite-C, an X-ray explorer scheduled for launch about May 7 from the Italian-operated San Marco Equatorial Range off the coast of Kenya in East Africa.

The satellite will be renamed Explorer ~~52 in~~ 53 orbit.

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April 18, 1975

SAS-C is the third spacecraft in the SAS series developed at NASA's Goddard Space Flight Center, Greenbelt, Md. A unique system designed with a standard control section, SAS can support a variety of scientific instruments for space exploration.

The 195-kilogram (430-pound) satellite carries an instrument package which is a composite of four separate experiments for studying X-ray sources within and beyond our galaxy, the Milky Way. X-rays, gamma-rays and cosmic-rays make up the major areas of investigation in the field of high-energy astrophysics.

In addition to contributing to a better understanding of the birth, evolution and ultimate destiny of our universe, data gathered by astrophysicists may well lead to new theories about energy production and high-density nuclear matter. What man can do here on Earth ultimately is limited by the same laws that govern the production of energy in astronomical sources.

A systematic study of the X-ray sky began in late 1970 with the launch of NASA's SAS-A from San Marco. Listed 42 in NASA's Explorer series, the spacecraft was renamed Uhuru ("freedom" in Swahili) in honor of Kenya's Independence Day, Dec. 12, the date on which SAS-A was launched.

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Results from the mission exceeded expectations: the catalogue of known X-ray sources was increased from 36 to about 200, many of which exhibit unusual characteristics. Many sources within our galaxy were found to have variable emissions. In addition to seemingly random variations, some display periodic changes which are thought to arise from rotation of a compact object, such as a neutron star, or eclipse by a companion star. Scientists believe the interpretation of these temporal variations is crucial to the understanding of energy transfer processes in the emitting objects.

SAS-A not only detected many classes of X-ray objects, but found the first evidence for the possible existence of a black hole companion to a massive luminous star. Theorists had predicted earlier that certain stars could collapse to an extremely dense state whose gravitational field was so powerful that light could not escape -- a so-called black hole.

The presence of a black hole, when part of a binary star system, may be revealed both by the orbital motion of the visible component (which provides information on the mass of the unseen companion) and by the X-rays emitted when matter is transferred from the visible component and accelerated in the strong gravitational force of the compact object.

SAS-C will be launched aboard a four-stage, solid-propellant Scout launch vehicle into a circular, equatorial orbit about 486 kilometers (302 miles) high. The spacecraft will circle the globe once every 96 minutes. Its designed lifetime is one year.

The liftoff will take place at night to minimize heating of the spacecraft before launch.

Orbiting satellites such as the SAS-C provide astrophysicists with an invaluable instrument for studying the high-energy phenomena of the universe inasmuch as X-rays, gamma-rays and cosmic-rays generally cannot be observed from Earth because of the filtering effects of the atmosphere.

The ability of satellites to observe phenomena for prolonged periods compared to the few minutes possible during typical sounding rocket experiments permits scientists to view faintly visible X-ray sources, as well as record the variability of their emissions and obtain more accurate source positions.

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NASA ground controllers can maneuver the X-ray Explorer by energizing an electromagnet in the spacecraft's attitude control system. Electrical energy causes the electromagnet to act like a compass needle and align itself with the north-south lines of the Earth's magnetic field.

Under the terms of the launch contract, signed by NASA and the Universita degli Studi di Roma (University of Rome), NASA provides the launch rocket and the satellite. The University's Centro Ricerche Aerospaziali (Aerospace Research Center) is reimbursed for assembly, checkout of the launch vehicle and launch of the satellite.

The Italian launch team, trained by NASA at its Wallops Flight Center, Wallops Island, Va., successfully launched the San Marco I satellite from Wallops in 1964 and seven other satellites from the San Marco platform since 1967.

Italy's San Marco platform enables NASA to place the X-ray Explorer into an equatorial orbit through use of a small Scout rocket instead of using the larger launch vehicles required for achieving the same orbit from Cape Canaveral, Fla.

An equatorial orbit was selected for this satellite to enable it to bypass the South Atlantic area where the Earth's radiation belts dip close to the surface. This radiation could degrade both the spacecraft's electronic systems and the X-ray instruments.

The SAS spacecraft are unique in that the scientific instruments for each mission are contained in a separately fabricated section which is fitted to a common bus section. This section, intended to be standard for all SAS missions, contains the mission support subsystems such as power, attitude control, communications and data storage.

Goddard Space Flight Center manages the SAS program for NASA's Office of Space Science. The Massachusetts Institute of Technology's Center for Space Research, Cambridge, Mass., principal experimenter for the mission, designed and developed the X-ray experiment. Fabrication of the spacecraft and integration of the experiment were conducted at the Johns Hopkins University's Applied Physics Laboratory in Howard County, Md.

The Scout launch vehicle is managed for NASA by Langley Research Center, Hampton, Va. It was developed by the Vought Systems Division of Ling-Temco-Vought, Aerospace Corp., Arlington, Tex.

(END OF GENERAL RELEASE: BACKGROUND INFORMATION FOLLOWS)

HIGH ENERGY ASTROPHYSICS

High-energy astrophysics -- the study of the most energetic forms of radiation such as X-rays, gamma rays and cosmic rays -- has provided man with many exciting discoveries about our universe.

Until the 1940s, all knowledge of the universe beyond the solar system came to us through studies in visible light. Although the telescope was not invented until the 16th century, systematic optical observations have been carried out for at least 3,000 years. Optical picture usage has been expanded in the recent past by the development of radio astronomy, followed by the development of X-ray astronomy starting in the 1960s. Since 1970, a number of X-ray studies have been conducted from spacecraft.

A systematic study of the X-ray sky began in 1970 with the launch of NASA's Small Astronomy Satellite-A (Explorer 42). Also known as Uhuru, it was the first satellite wholly devoted to X-ray astronomy. Results from the mission exceeded expectations, and extended the number of known X-ray sources from 36 to about 200.

Most galactic X-ray sources still have not been identified with visible or radio counterparts. Strong evidence suggests that some of them are associated with pulsars resulting from supernovae explosions. Manny are associated with binary stellar systems which include one compact member such as a neutron star or possibly a black hole.

In addition to the many different classes of X-ray objects catalogued, Uhuru found evidence for the possible existence of a black hole companion to an intrinsically luminous star, Cygnus X-1. Theorists had predicted earlier that certain stars could collapse to an extremely dense state and exhibit an extraordinarily powerful gravitational field -- a so-called black hole. This field has been described as being so powerful that no object, not even light, could be emitted from the star. When it is part of a binary star system, the black hole's presence may be revealed indirectly by the emission of X-rays from the energetic processes occurring in the matter that flows from the one star to the black hole. It also may be revealed by the gravitational influence of the black hole on its visible companion.

Other instruments that have further confirmed the possible identification of Cygnus X-1 as the visible companion to a black hole include sounding rocket instruments, the soft X-ray Telescope on the Orbiting Astronomical Observatory-3 and ground based optical and radio observations.

Galactic X-ray sources are characterized by a high degree of variability. Almost all vary, but some have distinct periodic emissions arising from binary eclipsing or stellar rotation. One example of an X-ray source with periodic emissions is the Crab Nebula, the remnant of a star which exploded nine centuries ago. X-rays have been observed emanating from this source at the rate of 30 pulses per second -- each pulse equaling the entire electrical output of man over a 10-million year period.

The X-ray source, Her X-1, located in the constellation Hercules, has exhibited emissions of at least three different periodicities ranging from about one second to about one month.

RESULTS OF THE SMALL ASTRONOMY SATELLITES

NASA's first two satellites devoted to high-energy astrophysics, Explorer 42 and Explorer 48, are providing the necessary groundwork and guides for large-scale studies by the High Energy Astronomical Observatory (HEAO), which NASA plans for launch in the late 1970s.

Summarizing results from Uhuru, the first spacecraft devoted to the exclusive study of X-rays in space, SAS Project Scientist Dr. Carl Fichtel reports: "Uhuru represents a giant step forward in astronomy by providing the first complete and sensitive picture of the sky in X-rays. These results confirm the expectation that not only significant, but some unexpected, phenomena would be discovered relating directly to the fundamental high-energy processes which govern the evolution of stars and galaxies."

Thus far, a catalogue of 161 X-ray sources have been prepared from Uhuru data. The revised updated catalogue in preparation will list almost 200 sources. In addition, the satellite's important findings include:

- Discovery of rapidly varying X-ray sources whose properties differ in many respects from those of the more common radio pulsars.

- The detection of X-ray emission from Seyfert galaxies.
- Discovery of X-ray emissions from peculiar sources such as quasars.
- Discovery of binary star systems identified solely on the basis of X-ray data.
- The first measurements indicating that black holes may exist and be detectable in binary star systems.
- The detection of extended X-ray emissions from regions near the center of clusters of galaxies.

Results from Explorer 48, which carried a gamma-ray telescope, are already beginning to change the current picture of our galaxy. Dr. Fichtel reports: "It now seems clear that the hot high-energy cosmic ray gas is not uniformly distributed throughout the galaxy, but is tied to major galactic features whose character is now becoming better understood through the high-energy gamma-ray results. The general spiral structure of the galaxy and the high concentrations of cosmic ray gas both support the concept that our galaxy is not a calm pool, but is continually being remolded by the forces of nature."

Most high-energy gamma rays observed in the region of our solar system result from the interaction of cosmic rays with matter throughout the galaxy. The galaxy appears quite dense when viewed optically, but there is only about a one per cent chance that one of the highly energetic gamma rays would be absorbed by matter during its journey from one part of the galaxy to another. Therefore, the large-scale structures of the galaxy can be mapped using X-rays.

Explorer 48 also has made an important contribution to the question of the origin of the hot cosmic ray gas in our galaxy. Although supernovas had long been considered the original sources of cosmic rays, direct experimental evidence was lacking. Explorer 48 has now observed gamma rays, with the energy and intensity expected from cosmic rays interacting with interstellar gas emanating from the direction of the close relatively recent supernova remnant in Vela. The observation provides the first direct experimental evidence which links the origin of cosmic rays to supernovas.

THE SPACECRAFT

The spin-stabilized SAS-C spacecraft consists of the experiment package and a standardized control section designed to support custom experiments. Measuring 66 centimeters (26 inches) in diameter by 61 cm (24 in.) high, it houses subsystems such as redundant tape recorders for data storage, a rechargeable battery with charge control and regulation systems, redundant command receivers and decoders with a stored command capability, a programmable telemetry system, redundant VHF transmitters, a spacecraft aspect sensing system consisting of Sun sensors, Earth horizon sensor and a star sensor, and a magnetically-torqued control system which can point the spacecraft to any point in the sky or vary its spin rate upon command. Stability is provided by a reaction wheel and a passive nutation damper.

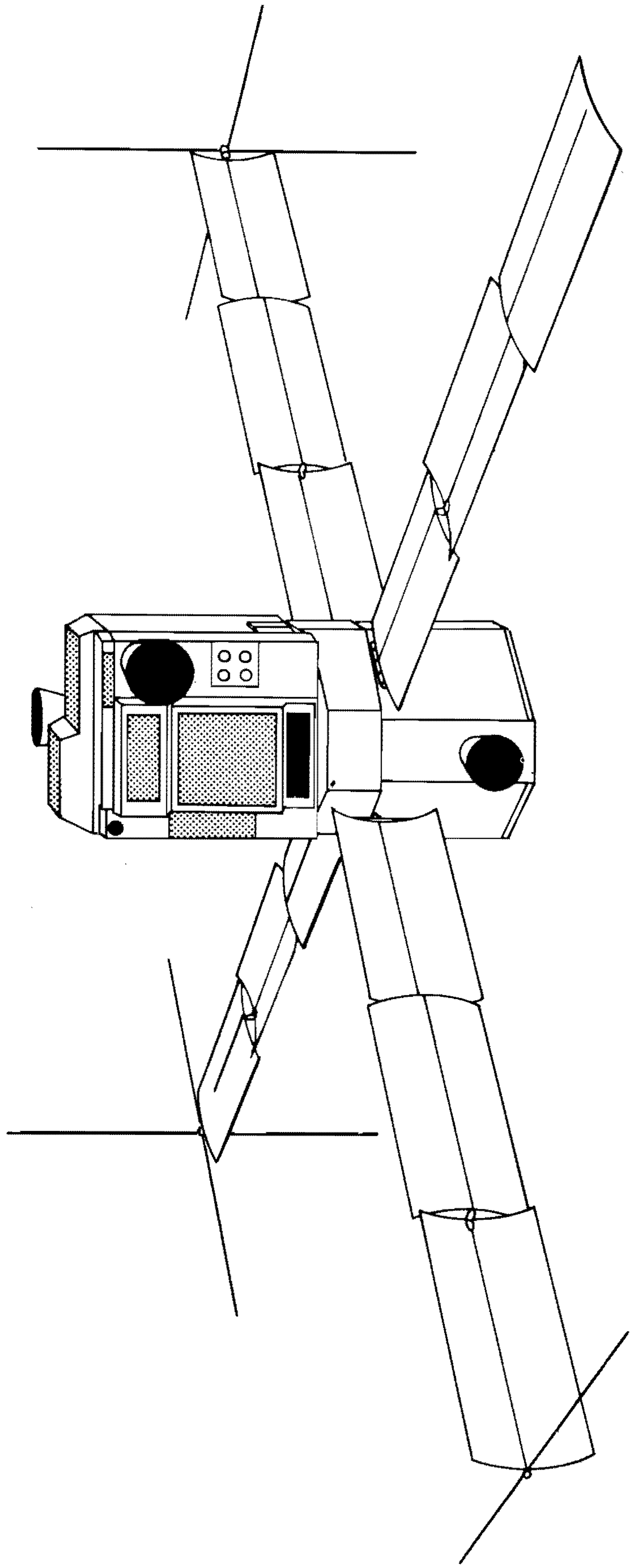
Four foldable solar panels extend from the control section in orbit to collect the Sun's energy for use by the spacecraft.

THE X-RAY EXPERIMENT

The X-ray experiment is a composite of four sub-experiments, each with its own detection system. The experiment includes an aspect system, consisting of two star cameras to provide information for correlation of the collected X-ray data with a specific object or a particular region of the sky. The Massachusetts Institute of Technology's Center for Space Research, Cambridge, Mass., designed and built the X-ray experiment. Principal investigator is Dr. George W. Clark of MIT.

<u>Galactic Absorption Experiment</u> (Dr. George W. Clark, MIT) This experiment will record data on the absorption of the low energy diffuse X-ray background interstellar matter in the galaxy. By measuring the variation in the intensity of this background as a function of galactic latitude at various energies, the density and distribution of the interstellar matter can possibly be determined.

<u>Scorpio Monitor Experiment</u> (Dr. Walter H. G. Lewin, MIT) This experiment will view the time variations of X-ray activity in the X-ray source Sco X-1, located in the constellation Scorpius. Discovered in 1962 by means of an instrument carried aloft by a sounding rocket, this was the first non-solar X-ray source discovered. Sco X-1 will be monitored by this experiment in nine intervals in the energy range from 0.2 to 50 keV. Thus, overall intensity variations will be observed as well as changes in the broad spectrum and in the intensities of line emissions.



SMALL ASTRONOMY SATELLITE - C
(SAS - C)

Galactic Monitor Experiment (Dr. Hale V. D. Bradt, MIT) This experiment is designed to help locate X-ray sources in the Milky Way galaxy to a precision of within 15 arc seconds. (This might be compared to spotting a basketball from a distance of 4 km (2.6 mi.).) Flares and other unexpected X-ray phenomena occurring in the celestial sky will be monitored by this experiment.

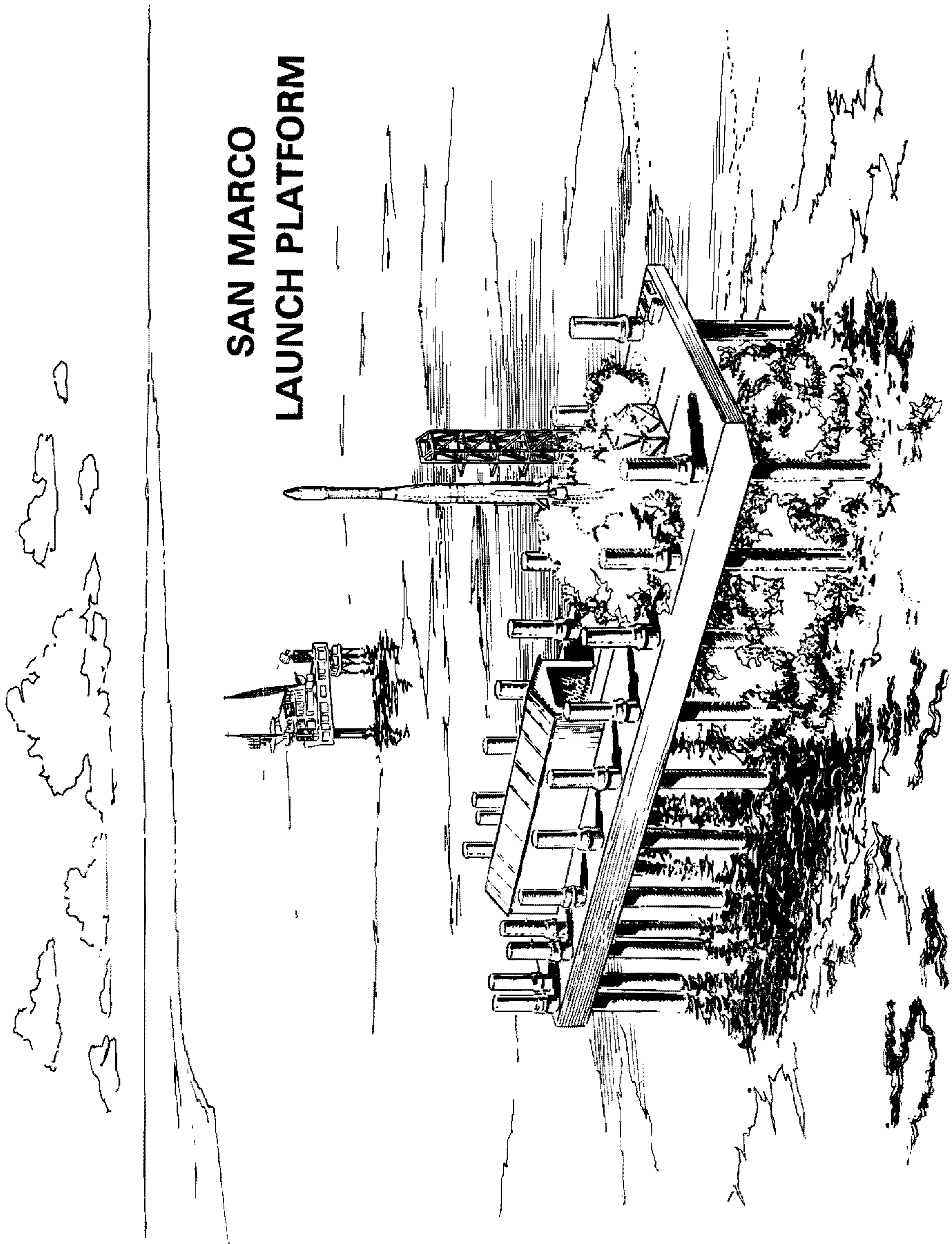
Extra Galactic Experiment (Dr. Herbert W. Schnopper, Smithsonian Astronomical Observatory, Cambridge, Mass.) This experiment will collect data for the investigation of weak X-ray sources outside our galaxy, the Milky Way. This experiment will view a 100-square-degree region of the sky in the fields surrounding the spacecraft's spin axis. For this purpose, the direction of the spacecraft's spin axis will be kept near specific stations for long periods of time. During the first year of the spacecraft's life, the following targets are planned for observation: (1) The Virgo Cluster of galaxies for four months; (2) the Andromeda galaxy for three months; (3) the Large Magellanic Cloud for three months; and (4) the Galactic Equator for two months.

SAN MARCO LAUNCH FACILITY

The San Marco launch facility was established by the Italian Government for placing medium sized spacecraft into equatorial orbit with the Scout launch vehicle. It is located in international waters 4.8 km (3 mi.) off the coast of Kenya, some 3 degrees south of the equator.

A number of international spacecraft successfully launched from this facility include:

- San Marco-II (Italian/U.S. atmospheric research satellite) - 4/26/67
- San Marco-III (Italian/U.S. atmospheric research satellite) - 4/27/71
- Small Astronomy Satellite-1 (U.S. X-ray Explorer renamed Uhuru - 12/12/70
- Small Scientific Satellite (U.S. Fields and Particles Explorer) - 11/15/71


SAN MARCO
LAUNCH PLATFORM

- Small Astronomy Satellite-2 (U.S. Gamma Ray Explorer - 11/15/72
- San Marco-IV (Italian/U.S. Atmosphere Research Satellite) - 2/18/74
- Ariel-V (British/U.S. X-ray satellite) - 10/15/74

Several sounding rocket instruments also have been launched from this facility for scientific research.

The San Marco facility consists of the San Marco launch platform and the Santa Rita control platform. Both are connected by submarine power and communications lines.

The launch platform has 20 steel legs embedded in the sandy seabed. It is equipped with an air-conditioned test shed which houses the Scout launch vehicle and the spacecraft payload before launch. A large pit on this platform, open to the sea, absorbs the rocket exhaust during liftoff.

The Santa Rita tower, a modified oil drilling platform, houses the launch control and communications equipment. It is the nerve center for the launch.

SCOUT LAUNCH VEHICLE

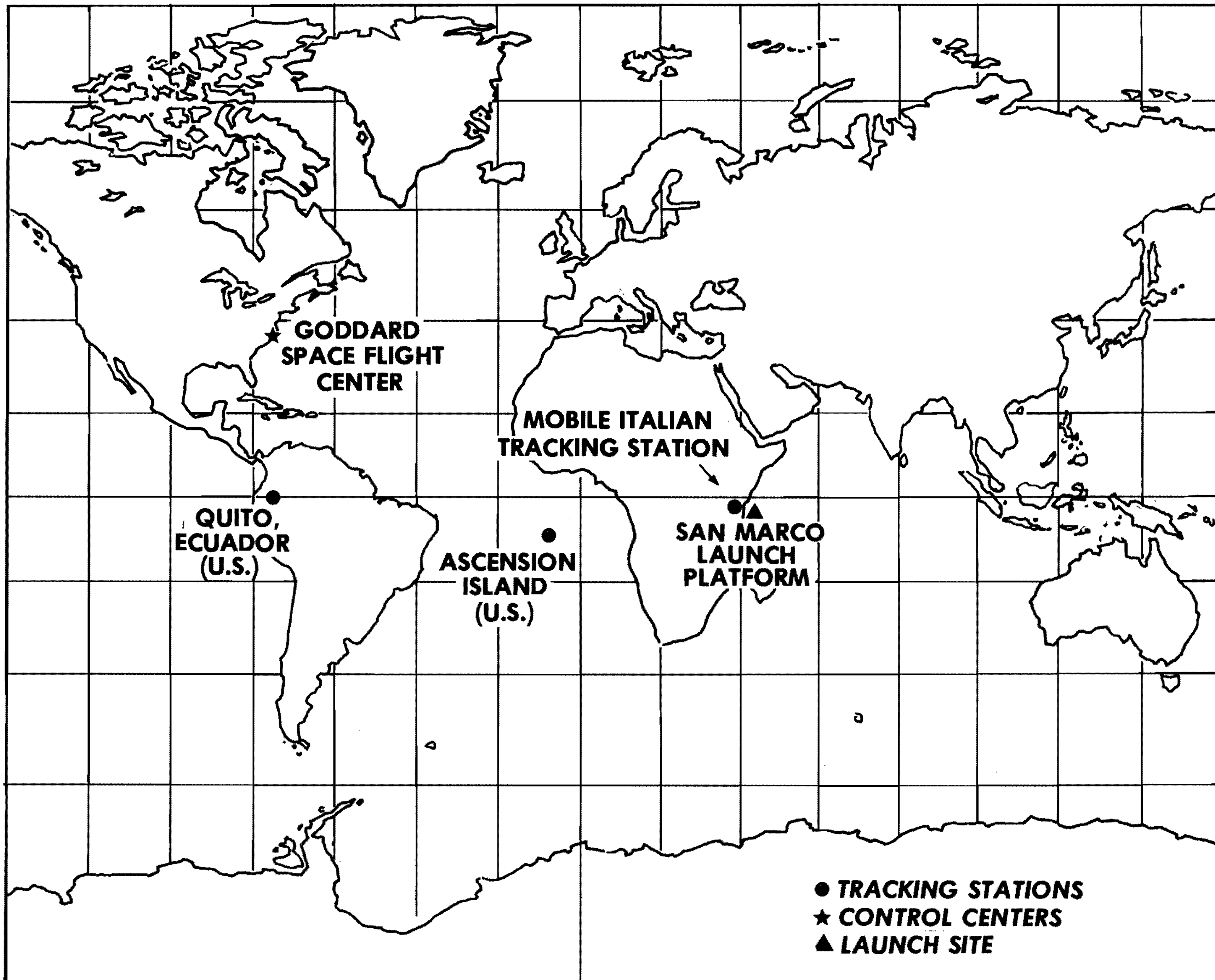
Scout is NASA's only solid propellant launch vehicle with orbital capacity. The first development Scout was launched July 1, 1960. Since the Scout was recertified in 1963, the vehicle has attained a 94 per cent success record.

Scout is a four-stage solid propellant rocket system. The launch vehicle and the spacecraft will be set on an initial launch azimuth of 90 degrees.

The four Scout motors -- Algol III, Castor II, Antares III, and Altair III -- are interlocked with transition sections that contain guidance, control, ignition and instrumentation systems, separation mechanisms, and the spin motors needed to stabilize the fourth stage. Control is achieved by aerodynamic surfaces, jet vanes and hydrogen peroxide jets.

The launch vehicle is approximately 22 meters (73 feet) long and weighs about 17,000 kilograms (38,000 pounds) at liftoff.

The Scout Program is managed by NASA's Langley Research Center, Hampton, Va. The launch vehicle is built by LTV Aerospace Corp., Arlington, Tex.


GODDARD
SPACE FLIGHT
CENTER
MOBILE ITALIAN
TRACKING STATION
QUITO,
ECUADOR
(U.S.)
ASCENSION
ISLAND
(U.S.)
SAN MARCO
LAUNCH
PLATFORM
● TRACKING STATIONS
★ CONTROL CENTERS
▲ LAUNCH SITE

SEQUENCE OF LAUNCH AND ORBIT EVENTS

Event	Time: (Min./Sec.)
Liftoff	00:00
First Stage Burnout	01:17
Second Stage Ignition	01:19
Second Stage Burnout	01:59
Third Stage Ignition	02:14
Third Stage Burnout	02:50
Spin-up	09:06
Third Stage Separation	09:08
Fourth Stage Burnout and Orbital Injection	09:43
Solar Panel Deployment	14:17
Spacecraft Separation	15:17

Spacecraft controllers will know whether the Explorer is in a good orbit about one hour after launch. The required information will be obtained from NASA's tracking and data acquisition station at Quito, Ecuador, the prime station for this mission.

Several days in orbit will be required to stabilize the spacecraft fully and to prepare it for operations. Once operational, the Explorer will collect and record X-ray data continuously and transmit the stored data to the Quito station once each orbit.

THE SAS-C TEAM

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~~Dr. Alois W.~~ Schardt	Director, Physics and Astronomy Programs
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John M. Bosworth	Spacecraft Manager
Anthony J. Caporale	Experiment Manager
Norman J. Piterski	Project Operations Director

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Massachusetts Institute of Technology (Cambridge, Mass.)

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Dr. Hale V. D. Bradt	Co-Investigator
Dr. Walter H. G. Lewin	Co-Investigator
Dr. Saul Rappaport	Co-Investigator
Richard Taylor	Project Manager
Dr. William Mayer	Project Scientist

Smithsonian Astrophysical Observatory (Cambridge, Mass.)

Dr. Herbert W. Schnopper	Co-Investigator

Applied Physics Laboratory (Howard County, Md.)

Henry R. Riblet	Project Manager

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