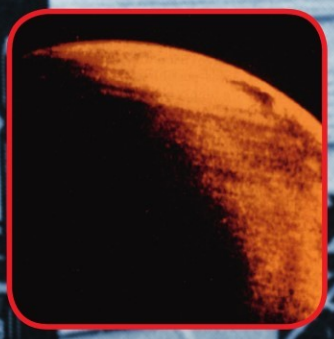
Brian Harvey with Olga Zakutnyaya

RUSSIAN SPACE PROBES

Scientific Discoveries and Future Missions



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Introduction by the authors

Russia launched the first Earth satellite in 1957 and the first scientific laboratory into Earth orbit the following year – Sputnik 3. Most accounts of Russian and Soviet space achievements have, understandably, focused on manned spaceflight, the cosmonauts, the rockets, the politics, and the engineering achievements of the Russian and Soviet space programs. There has not yet been an examination of what Russian space science has actually achieved in building our knowledge of the space environment and the solar system. This is a largely untold story. During the days of the space race, the scientific outcomes of Soviet space missions were not well known and reached only eminent scientists at international gatherings of their peers. In the English-language-speaking world, media coverage of Russian scientific discoveries was limited, some was even dismissive (and, in the Cold War period, suspicious), and the Soviet Union lacked the channels like *National Geographic Magazine* to communicate its message. Their leading scientists were little known.

As we will see, these discoveries were substantial. This book attempts to build a comprehensive picture of the record and story of Russian space science, before, during, and after the Soviet period. It focuses not just on the higher-profile missions to Mars, Venus, and the Moon, but on a broad range of missions from astrophysics to the ionosphere, from solar studies to the plasmasphere. The questions we attempt to answer are: *What scientific missions were undertaken? How? Why? What instruments were used? What was learned? What discoveries were made? Where were the greatest gains in our knowledge? How important was science within the Soviet and Russian space program? Who were the key personalities? What were the principal decisions and priorities?*

Defining what is and what is not "space science" is not as straightforward as it may first appear, especially in the area of space-based applications looking back towards Earth. Here, we have generally excluded the use of space-based instruments to map the Earth and its ground features, as well as other applications of spaceflight, such as communications and navigation. This book includes space-based research to improve our knowledge of the relationship between our atmosphere, water, and land, as well as space biology and the analysis of substances in microgravity in Earth orbit. This book covers not only unmanned robotic probes, but scientific work

undertaken on board orbital space stations, such as Salyut, Almaz, Mir, and the International Space Station.

Although the Soviet Union and Russia have engaged in many international collaborative missions, especially around the space station Mir, the focus here will be on Soviet/Russian space science, rather than on international equipment carried on Russian satellites and space stations. Where international equipment was used as an integral part of Russian space science projects, it is, of course, very much included.

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Glossary

AIS	Automatic Interplanetary Station
ARAKS	Artificial Radiation and Aurora between Kerguelen and the Soviet Union
ARCAD	ARC Aurorale et Densité
AU	Astronomical Unit (distance of the Earth from the Sun = 1 AU)
AUOS	*Avtomaticheskaya Universalnaya Orbitalnaya Stantsiya* (Automatic Universal Orbital Station)
Aureole	AURora and EOLus
CNES	Centre National des Études Spatiales (French space agency)
KORONAS	Comprehensive Orbital Near Earth Observations of the Active Sun
COSPAR	Committee on Space Research
DS	Dnepropetrovsky Sputnik
GAISh	State Astronomical Institute in memory of P.K. Sternberg of Moscow State University
GEOKHI	Vernadsky Institute for Geochemistry and Analytical Chemistry of the Russian Academy of Sciences
IGY	International Geophysical Year
IKI	Institute for Space Research of the Russian Academy of Sciences, Moscow
IZMIRAN	Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Academy of Sciences
KNA	*Konteyner Nauchnoy Apparatury*, or Scientific Equipment Container
KOMPASS	Complex Orbital Magneto Plasma Autonomous Small Satellite
KREEP	Potassium, Rare Earth Elements and Phosphorus (type of Moon rock)
KS	Korabl Sputnik
LMC	Large Magellanic Cloud
MKA	*Maly Kosmicheski Apparat* (Small Space Apparatus)
MS	*Maly Sputnik* (Small Satellite)

NASA	National Aeronautics and Space Administration (United States)
NIIYaF	Skobeltsyn Institue for Nuclear Physics, Moscow State University
OKB	*Oputno Konstruktorskoe Byuro* (Experimental Design Bureau)
OSOAVIAKHIM	Society for the Promotion of Defence, Air Travel and Chemistry
RIFMA	Röntgen Isotopic Fluorescent Method of Analysis
PrOP	*PRibori Otsenki Prokhodimosti* (Penetrometer to test the terrain)
SIGNE	Solar International Gamma Ray and Neutron Experiment

Terminological and translation notes

The term "weightlessness" is used to describe the gravity environment in which people (or other life forms) find themselves during the course of space journeys. Although "microgravity" is more correct, the term "weightlessness" is generally well understood.

Politically, the term "Russia" is used as shorthand for "the Russian federation" in the period from January 1992. In the case of "Germany", the term "Germany" will be used, for convenience, to refer to both the Federal Republic of Germany before 1991 (often then known as "West" Germany) and to the reunited country after 1991. The state known as "East" Germany for 1949–1989 will be called by its formal title, the GDR (German Democratic Republic).

For temperatures, two units of measurement will be used: Celsius and Kelvin. Celsius, which runs from 0° (the freezing point of water) to 100° (boiling) is the most popularly understood and is cited as °C. Where measurements are much larger, many scientists use Kelvin (K), which begins at absolute zero, which is –273°C. Accordingly, both are used and indicated appropriately and readers should add or subtract 273 to make the necessary conversion.

It was a normal habit of the first of a series of Russian spacecraft to have a simple name, without a number. Yuri Gagarin was launched in Vostok, not Vostok 1. Thus, we have the first Moon rover Lunokhod, not Lunokhod 1. There were exceptions of course, when more than one were launched together (e.g. Elektron 1 and 2) or when they were clearly going to be part of a long series (e.g. Cosmos 1) or when they were retrospectively renamed (e.g. Venera 1).

There is a difference in academic degrees between Russia and Europe. In Russia, the first stage is Candidate of Science, equivalent to Ph.D. The second stage is Doctor of Science, which does not have a direct equivalent.

Russian names are transliterated into English in what is called the simplified form (British Standard).

Every effort has been made to ensure that the reproduction of photographs and illustrations is of the highest quality. Readers are asked to make allowances for the fact that in the case of some historic photographs, especially from the early Soviet period, original negatives were not always available and reproduced versions may have aged over time.

Reference notes

The general sources for the research are reported and discussed in more detail in the bibliographical note at the end. In the case of more specific chapter references, rather than disrupt the flow of the narrative by numerous references after each individual point, the scientific results of each mission are given a composite set of references. Where there are multiple authors (three or more), the first named is normally given.

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