The Radio Science Collection, 1961-1980
3.6 cubic feet
JPL 155

History

The radio transmitters/receivers aboard spacecraft are used for more than just communicating planetary data and receiving commands. A number of scientific experiments can be conducted by analyzing radio signals sent back from the spacecraft.

Key times to conduct radio science experiments are during conjunction or just before or after an occultation. Conjunction is when two or more astronomical objects apparently pass near one another, while occultation is when one astronomical object passes in front of another (as seen from the Earth). When the path of a radio signal passes close to a planet, the signal is usually bent, delayed, obscured or reflected by the planet. The measurement of these alterations to the signal allows scientists to extract information about planet size, atmospheric density, and other factors not easily observable by other means. An example is measuring the General Theory of Relativity by measuring the delay of the radio signal as it passes near a massive object with a large gravity field, such as the Sun. Einstein's theory predicted an apparent slowing in the speed of a radio signal when the signal passes near any massive body. Radio science experiments have validated this theory.

Early Solar occultation experiments were conducted in April 1966 during the Mariner 4 mission to Mars, and in October 1967 during the Mariner 5 mission to Venus. The Pioneer 6 mission also sent back a radio signal that was occulted by the Sun in November 1968.

The missions most often referred to in this collection are the Viking Orbiters and Landers to Mars, and the two-spacecraft Voyager mission to the Outer Planets. Each of these missions had radio science teams of investigators.

Viking

The objectives of the Viking Radio Science Team were to conduct scientific studies of Mars using the Viking Orbiter and Lander tracking and communications system. The primary frequencies used were 400MHz (UHF), 2200 MHz (S-Band) and 8300 MHz (X-Band). The two Viking Orbiters were equipped with dual frequency S- and X-band transmitters, while the two Landers were equipped only with an S-band transmitter. The instrumentation at the Deep Space Network (DSN) tracking stations measured frequency changes and signal amplitudes while recording signal properties. A lower power UHF link was used to send signals from the Landers to the Orbiters.

There were three general areas that the radio science team was involved with: dynamical, surface and internal properties of Mars; atmospheric and ionospheric properties of Mars; and solar system properties. For the first time Doppler and range data between the Earth and a spacecraft on another planet became available, using the Viking Lander S-band radio transmitter. The spin-axis and spin rates of Mars were calculated while the position and motion variance of the Orbiters were used to study the Martian gravitational field. The pressure, temperature, and density of the atmosphere of Mars were also calculated. Various solar system properties were also calculated, such as the ephemerides of Mars and Earth and the masses of the Martian satellites Phobos and Deimos. During conjunction, data was gathered for studies of the solar corona. Relativity experiments were also conducted, by observing the delay in radio signals as they passed near the sun.

Overall responsibility for the management of Project Viking was at NASA's Langley Research Center at Hampton, VA. Langley turned management of Viking over to JPL in April 1978. William H. Michael, Jr. of NASA-Langley was the principal investigator for the Orbiter and Lander Radio Science experiments. At JPL, the principal investigator of the Radio Science Team was Joe Brenkle.

Voyager

The twin Voyager spacecraft to the outer planets had similar radio science goals to the Viking Radio Science Team. The Voyager Radio Science Team used the telecommunications system of the Voyager

spacecraft, a coherent S-and X-band downlink and S-band uplink. Voyager was the first spacecraft to use X-band as the primary encounter telemetry link frequency; previous missions had used S-band as the primary frequency, with X-band as an experiment. However, X-band reception capability was only available at the three 64 meter DSN ground stations: DSS 14, Mars Station, in Goldstone, CA; DSS 63, Robledo de Chavela, Spain, and DSS 43, Tidbinbilla, Australia.

There were three major objectives to the radio science experiments aboard the Voyager spacecraft: planetary and satellite atmospheres, including the solar corona, planetary and satellite masses, and the rings of Saturn. A fourth experiment testing the relativity theory was also conducted.

Planetary and satellite densities, temperatures, pressures, and atmospheric compositions were calculated by refracting radio signals through the ionosphere or atmosphere of a planet or satellite, at the time of occultation of the satellite. The solar corona was observed in a similar way. The corona's spatial and temporal variations were measured by examining the corona's effects on the radio signals between Earth and the spacecraft. Occultation of the large moon Titan was also a key scientific experiment.

The mass of a planet or moon was estimated by measuring the change in speed of the spacecraft. By measuring the change in frequency of the radio signal, the mass of the planet or moon could be estimated.

Passing a radio signal through planetary rings were used to estimate the number, width, shape and thickness of rings, and the sizes of particles that make up rings. This was especially emphasized in the Saturn encounter, since at the time Saturn was the only planet known to have rings.

A fourth experiment was a test of general relativity, similar to the relativity experiments conducted with the Viking orbiters. The Voyager spacecraft radio signal was measured as it passed close to the Sun. The Voyager 1 encounter with Saturn and the solar conjunction was the first opportunity to test the General Theory of Relativity since Viking in 1976.

The Voyager Saturn encounters were of primary importance to the Radio Science Team. A number of the radio science experiments were deleted for the Jupiter encounter, as it was decided that the Pioneer 10 and 11 results were sufficient, and it would not be cost effective to repeat the experiments with Voyager. The Voyager 2 radio receiver also had some technical problems, and was of concern to scientists. Some radio science Jupiter occultation records were gathered by Voyager 2. Many of the radio science experiments were planned to be later conducted with greater precision by Galileo.

Team leader of the Radio Science Subsystem experiments aboard Voyager was Von R. Eshleman of Stanford University. Chief of JPL's Radio Science Data Team was Gordon E. Wood.

Ulysses

Also represented in the collection is information about the International Solar Polar Mission (ISPM). The ISPM originated as a joint dual probe mission between NASA and the European Space Agency (ESA), with a planned launch in 1983. The U.S. ISPM mission was cancelled in May 1980 when it received no funding in NASA's FY 1982 budget. The remaining probe was designed by ESA, with half the payload comprised of JPL-run science experiments. It was eventually re-named Ulysses and launched aboard the Shuttle Discovery on STS-41 in October 1990.

Provenance

The collection was transferred from Tom Komarek, Section 339, Spacecraft Telecommunications Systems, to the JPL Records Center on November 19, 1981. The collection was transferred from the Records Center to the JPL Archives in August 1988, and was accessioned with other unrelated materials as part of Accession 1989-11. The Records Center material was originally 6 c.f. One box was permanently withdrawn before the accession was transferred to the JPL Archives.

Collection Arrangement and Description

The collection consists of documentation of radio science teams and various tests of telecommunications subsystems of primarily the Viking Orbiters, but also Voyager and Mariner Venus-Mercury 1973 (Mariner 10). Most records are from the office of Tom Komarek, Section 339, Spacecraft Telecommunications Systems. The collection spans the period 1961-1980, with the bulk of the material

from 1973-1980. While the Deep Space Network (DSN) and its various antennas are mentioned throughout the collection, it is more focused on data gathered from spacecraft.

The collection is divided into seven series: Ranging Analysis, Telecommunications Tests, Viking Radio Science Team, Viking Telecommunications Prediction and Analysis Program, Viking Orbiter and Lander Ranging, Voyager Radio Science Team, and International Solar Polar Mission Radio Science. The original order of the collection was largely the series order.

Ranging Analysis (folders 1- 29). This series deals primarily with theoretical aspects of using ranging analysis to obtain scientific data. The series is arranged in chronological order. There are four files at the end of the series that are arranged alphabetically, consisting of ranging analysis memoranda filed alphabetically by Tom Komarek. The three names are Milton H. Brockman, Murray A. Koerner and J. R. McAllaster.

The problems with the ranging system are sketched out in a folder. According to a 1978 Viewgraph made by Tom Komarek, it was estimated that there was a 50 per-cent success rate of data acquisition from the present ranging system. Ten to twenty percent of the loss was due to equipment, with 30 to 40 percent due to operator error. The problem was ultimately attributed to the lack of an end-to-end system, which was ultimately remedied for future missions.

The success rate of attempted Viking Lander ranging passes were calculated at around 50 percent from June to September 1978. There were a variety of reasons for this, including equipment limitations and operator error. During October 1978, this was improved, when all five ranging passes proved to be good ones.

Telecommunications Tests (folders 30-49). Represented in the collection are items regarding tests of the telecommunication subsystems of Mariner Venus-Mercury 1973 (Mariner 10), Viking Orbiter and Voyager missions. Most of the tests documented in the collection were performed in the Spacecraft Telecommunications Development Laboratory (TDL).

The tests conducted for Mariner 10 also were used in the planning stages for designing the Viking telecommunications subsystem. These tests included ranging and Doppler stability, and range delay calibration. Just as the Mariner 10 tests were used in the planning for Viking, tests conducted on the Mariner Mars 71 mission (Mariner 9) were used for Mariner 10. Other tests of the MVM 73 telecommunications were involving the S/X Band carrier phase, and calibration of the radio frequency subsystem.

Extensive tests were taken for the Viking Orbiter telecommunications subsystems. The tests included examining the S/S and S/X range delay versus uplink signal, various ranging and calibration tests, and radio metric tests. These were documented in one thick binder, divided into three folders.

There is also a folder referring to the use of a Zero-Delay Device with Viking. The Zero Delay Device (ZDD) was used to determine the delay time of a radio signal by substituting the spacecraft transponder with the ZDD, and measuring the ranging channel delay. The ZDD was then removed and the spacecraft transponder replaced, with the ranging channel delay measured again. The difference in recorded delay time obtained during these two measurements is equal to the time delay through the spacecraft transponder ranging channel. There is also information on the Viking Radio Frequency Subsystem in this series. One folder regarding tests of the Voyager telecommunications subsystem is included at the end of the series.

Viking Radio Science Team (folders 50-73). The series documents the actions of the Radio Science Team for the Viking Orbiters and Landers. The first three folders sketch out the responsibilities, goals and objectives of the Viking Radio Science Team. The documents include reports, handwritten notes, and Viewgraphs. A June 15, 1974 report stated that two-way Doppler would be the standard Doppler data type, and that simultaneous S- and X-band ranging would be acquired when a 64 meter DSS was available as well. The 64 meter stations at the time were DSS 14, Mars Station, in Goldstone, CA; DSS 63, Robledo de Chavela, Spain, and DSS 43, Tidbinbilla, Australia.

There are a number of files documenting solar corona observations during periods of occultation, or solar conjunction. Solar corona observations were taken from both the DSN Mars Station (DSS 14) and Tidbinbilla (DSS 43), in December 1976.

Viking Telecommunications Prediction and Analysis Program (TPAP) (folders 74-87). Telecommunications link performance predictions were calculated on the Univac 1108 computer in the Viking Mission Control and Computing Center using the Telecommunications Prediction and Analysis Program (TPAP). The gathering and editing of actual spacecraft and ground telecommunications system data was gathered using the Applications Viking Telecommunications Prediction and Analysis Program (AVTPAP). Data gathered using AVTPAP was then compared with the predicted data, gathered from TPAP.

TPAP replaced the earlier Telecommunications Prediction Program (EDCOM), in use at JPL since the Ranger 3 mission in 1962. An EDCOM user guide in included in the collection. Also, included with the TPAP/AVTPAP documents are handwritten notes. The files are arranged chronologically.

Viking Orbiter and Lander Ranging (folders 88-105). The ranging information includes reports, correspondence and memoranda regarding Viking Radio Science Team activities and plans, ranging performances, logs, summaries and schedules.

Most of the signals were received at Tidbinbilla (DSS-43), while some were received at Mars Station at Goldstone (DSS 14), and a few received at Robledo (DSS 63). A December 20, 1977 report noted that Viking 2 Landers direct link was inoperative due to failures of both Traveling Wave Tube Amplifiers (TWTA's) in October 1977. Additionally, in May 1978, there were serious problems with the acquisition of the Viking Lander and near simultaneous orbiter ranging, due to an inability to schedule and retain the scheduled ranging passes required for radio science experiments, along with numerous hardware failures and operational setup problems. These problems were eventually solved. All Lander and Orbiter ranging was originally scheduled to end in April 1979. This was planned to be extended through at least April 1981.

All telemetry from the Viking 2 Orbiter stopped on July 25, 1978, when contact with the spacecraft was lost due to a leak in the propulsion system. Viking 2 Lander stopped transmissions in April 1980. Viking 1 Orbiter was turned off on August 7, 1980, due to a lack of altitude control gas. The Viking 1 Lander continued transmissions until November 13, 1982.

Voyager Radio Science Team (folders 106-117). The series of folders documents the actions of the Radio Science Team for the Voyager Project. The first folder sketches out the responsibilities, goals and objectives of the Voyager Radio Science Team. The documents include reports and memoranda. The series as a whole consists of memoranda, reports, meeting minutes, handwritten notes and correspondence. Telecommunications status reports for Voyager are represented in the collection for November 1978 through October 1980. There are also reports describing the Telecommunications System aboard Voyager, and describing the operations plan for the Voyager 1 Saturn encounter.

The Voyager Science Operations Plan for the Voyager 1 Saturn Encounter listed five major radio science observations. These were: celestial mechanics to map the gravity fields of the planet, rings and satellites; Titan occultation to investigate the atmosphere and ionosphere of Titan; Saturn occultation to investigate the atmosphere and ionosphere of Saturn; ring occultation to investigate the microwave transmission and scattering properties of the ring particles; and ring scattering to investigate microwave scattering properties of rings at oblique angles. DSN coverage during the Radio Science observations was about evenly split between the three 64 meter S-band antennas at Goldstone, Madrid and Canberra.

International Solar Polar Mission (folders 118-137). TRW was contracted to manufacture the telecommunications system aboard the International Solar Polar Mission (ISPM), a joint dual probe mission between NASA and the European Space Agency (ESA), with a planned launch in 1983. The U.S. probe was cancelled in May 1980. The remaining probe, designed by ESA, was renamed Ulysses, and deployed from the Space Shuttle in October 1990.

Responsibility for the telecommunications system was made more complex with the introduction of TRW as a contractor. Tests were conducted by TRW regarding the bit rate and subcarrier frequency selections for the ISPM. Results of these tests are documented in JPL interoffice memoranda. Various scenarios resulting in signal degradation were also designed. The radio frequency allocation for ISPM was important as well, since they did not want interference with any of the existing probes, or future probes such as Galileo, as well as each of the separate probes of the ISPM mission.

The trajectory of the ISPM was of concern with the elevation and azimuth angles of the DSN Stations. This is reflected in a folder that has plots of the elevation masks of all the DSN stations. Various computer programs were implemented that calculated the Local Rise Hour Angle and Local Set Hour Angle for any DSS and any declination angle. This was important because the ISPM spacecraft would be outside the ecliptic, at unusual angles (extreme north and south) in the sky as seen from the Earth.

Command testing during superior conjunction was performed on both Voyager and Viking, to benefit ISPM. There was some concern about command link performance degradation at small Sun-Earth-Probe angles. Tests were performed during the Voyager 1 October 1979 Solar Conjunction.

Different methods of sending commands to the spaceship and receiving telemetry from the spaceship were also devised. There are notes from a September 1979 presentation regarding Packet Telemetry. The conventional method of telemetry was generated by multiplexing pieces of each data message, which must be reassembled on the ground before being processed. Packet telemetry assembled a whole message at the source instrument, and transported the message intact from the spacecraft to the end-user on the ground as an automomous "packet" of information. Also of importance was establishing compatibility between the Deep Space Network and the ESA built spacecraft. A compatibility test plan document is located in the series.

The Reed-Solomon Decoder was to be used for telemetry data error correction on JPL deep space missions. There are several files documenting potential use of the Reed-Solomon Decoder on the ISPM mission. The Reed-Solomon concatenated coding had the advantages of a stronger signal, with less chance of signal degradation and a cleaner channel, especially when performance is degraded by bad weather or low DSS elevation angles. It was recommended that the Reed-Solomon coding capability in the ISPM be concatenated with the established Viterbi coding system. There would be times when it would be desirable to disable the Reed-Solomon coding system and gain the bit-energy advantage of a reduced data rate, especially during periods of solar activity.

The last three files in the series are TRW interoffice correspondence reports regarding various aspects of the ISPM. Examples of the various subjects include radio loss performance, link analysis for X-band noncoherent and S-band/S-band ranging, traveling wave tube amplifier requirements, monthly link analysis reports, ranging and Doppler performance analysis, and minutes of JPL/TRW work unit managers meetings.

Conservation/Preservation

Standard preparations of documents for long term storage were completed.

Separation Statement

The original accession (1989-11) was split up into eight separate collections: Radio Science Collection (this collection), Office of the Director Collection (JPL 142), JPL Executive Council Collection (JPL 150), U.S. Army Projects Collection (JPL 154), Deep Space Network Hardware Collection (JPL 156), Mariner Jupiter/Saturn 77 Configuration Collection (JPL 159), Mariner Mars 1969 Reliability and Quality Assurance Document Collection, and the Optical Image Enhancement Feasibility Study Collection.

Finding Aids

No other finding aids exist for the collection.

FILE FOLDER LIST

Box 1 of 12 – Ranging Analysis

Fld.1 S. Frankel, "Estimation of Range Between a Deep-Space Probe and a Near-By Planet," July 1961.

Fld. 2 Jan W. Martin, " Apollo Pseudo-Random Noise Ranging System," July 6, 1963.

Fld. 3 Limiting-Coherent Phase-Shift Keyed, 1967-1970.

Fld. 4 M. A. Koerner, "Effect of Premodulation Filtering on the Correlation and Error Signals in a Pseudonoise Receiver," c. 1970.

Fld. 5 Sine Wave Ranging Articles, 1968-1978.
Fld. 6 Ranging Channel Interference, 1969-1972.
Fld. 7 Ranging Spectrum, 1970-1973.
Fld. 8 Ranging Spectrum Photographs, c. 1970.
Fld. 9 Channel Frequencies, M. A. Koerner, "Sample Figures," January 14, 1971.
Fld. 10 Ranging Radio Loss, 1971-1975.
Fld. 11 M. A. Koerner, "Effect of Time-Varying Phase Errors in the Spacecraft and DSN RF Receiver on Ranging Channel Margin," June 1, 1972.
Fld. 12 Correlation Curves/ Other Distortion, June 25, 1974.
Fld. 13 Radio Loss, 1974.
Fld. 14 RF Spectrum: Trapezoidal Distortion, 1974.
Fld. 15 Code Assymetry, 1974.

Box 2 of 12
Fld. 16 S-Curve and Error of Tau, notes, 1974-1975.
Fld. 17 Ranging Distortion Analysis, 1974-1976.
Fld. 18 Program RG-3, 1975. [folder 1 of 2]
Fld. 19 [folder 2 of 2]
Fld. 20 Pr/No – T1, T2, T3 [transparencies], c. 1975.
Fld. 21 Sinusoidal Ranging, 1976.
Fld. 22 Advanced Ranging, 1978-1979.
Fld. 23 Ranging System, Problems, 1978-1979.
Fld. 24 Venus Site Radiometrics Team, 1979.
Fld. 25 Baseboard Spectrum, n.d.
Fld. 26 Ranging Analysis, M. H. Brockman, 1976.
Fld. 27 Ranging Analysis, M. A. Koerner, 1973-1975. [folder 1 of 2]
Fld. 28 [folder 2 of 2]
Fld. 29 Ranging Analysis, R. McAllaster, 1975.

Box 3 of 12 – Telecommunications Tests
Fld. 30 Mariner Venus-Mercury 1973, S/X Band Test Results, 1969-1973. [folder 1 of 2]
Fld. 31 [folder 2 of 2]
Fld. 32 Mariner Venus-Mercury 1973 Telecommunications Development Laboratory (TDL) Tests, 1971-1973.
Fld. 33 Viking Orbiter, MIL Air Links, 1971-1975.
Fld. 34 Viking Orbiter, SXA Cables, 1972-1974.
Fld. 35 TDL Tests, Viking Proof-Test Orbiter, 1973-1974.
Fld. 36 Viking Orbiter Telemetry Tests, 1974-1975.
Fld. 37 Viking Orbiter Radiometric Calibration Accuracy, 1974.
Fld. 38 Viking Orbiter Tests, 1974-1975. [folder 1 of 3]
Fld. 39 [folder 2 of 3]
Fld. 40 [folder 3 of 3]

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Fld. 41 Viking Orbiter, Zero Delay Device, 1974.
Fld. 42 Viking Orbiter Proof-Test Orbiter CTA-21 Tests, August 1974.
Fld. 43 Block IV-III Exciter Comparisons, 1974-1975.
Fld. 44 Viking Orbiter, Telecommunications Tests and Calibration Data, 1974-1975.

Fld. 45 Viking Orbiter, Radio Frequency Subsystem (RFS), Serial No. 202, 1975.
Fld. 46 Viking Orbiter, RFS 203, Traveling Wave Tube, 1974-1975.
Fld. 47 Viking Orbiter, RFS 204, 1975.
Fld. 48 Viking Orbiter Prototype, TDL Tests, c. 1975.
Fld. 49 Voyager TDL Tests, September 25, 1975.

Viking Radio Science Team

Fld. 50 Viking Radio Science Team, Responsibilities, Allocations, 1974-1975.
Fld. 51 Viking Radio Science Team, Objectives, 1975.
Fld. 52 William Michael, "Viking Radio Science Objectives and Investigations," December 6-10, 1976.

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Fld. 53 Viking Orbiter Ranging Parameters, 1972-1975.
Fld. 54 Viking Orbiter Telemetry, Problem/Failure Reports, Incident Surprise Anomaly Reports, 1973-1976.
Fld. 55 Inflight Range Parameters, 1974-1976.
Fld. 56 Navigation Memoranda, D. L. Cain, J. P. de Vries, 1974-1979.
Fld. 57 Viking Orbiter, Spacecraft Temperature Predicts, 1974-1975.
Fld. 58 Viking Phase-Locked Loop, Parameters/Feed Forward, 1974-1976.
Fld. 59 Viking Proof Test Model, Phase Inability Glitch, May-June 1975.
Fld. 60 Viking Orbiter, Auxiliary OSC Frequencies, June 1975.
Fld. 61 Viking Orbiter Telecommunications Anomalies, 1975-1976.
Fld. 62 Viking Lander Ranging, 1975-1976.
Fld. 63 Viking Orbiter Occultations, 1976.
Fld. 64 Viking Orbiter Ranging Validation Background, graphs, charts, 1976.
Fld. 65 Viking Orbiter Ranging Validation, 1976.
Fld. 66 Viking Lander Telecommunications, 1976.
Fld. 67 Viking Lander, General and Anomalies, 1976.

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Fld. 68 Supplemental Tracking Record, Day 316-330, October-November 1976.
Fld. 69 Daily Status Reports, Originals, Conjunction, Day 320, 322, 324, 332-340, November-December 1976.
Fld. 70 Viking Lander Ranging Predicts, 1976-1977.
Fld. 71 FINRAN notes, 1976-1978.
Fld. 72 MIT Correspondence, 1976-1979.
Fld. 73 Solar Corona Experiment, Open Loop Recording Data, 1978-1979.

Viking Telecommunications Prediction and Analysis Program (TPAP)

Fld. 74 Telecommunications Prediction Program (EDCOM), PD 900-47, August 15, 1967.
Fld. 75 TPAP Data File Rationale, 1969-c. 1975.
Fld. 76 Viking Orbiter AVTPAP/TPAP Software Presentation, c. 1974.
Fld. 77 TPAP/AVTPAP Plans, January-May 1974.
Fld. 78 K. R. Taylor, "General Design Document for the Telecommunications Prediction and Analysis Program (AVTPAP) Viking '75 Project," 620-122, March 28, 1974.
Fld. 79 W. E. Ackernecht, K. R. Taylor, "User Acceptance Test for the Telecommunications Prediction and Analysis Plan (TPAP)," 620-220, April 10, 1974.
Fld. 80 W. E. Ackernecht, K. R. Taylor, "User Acceptance Plan for the

Applications Viking Telecommunications Prediction and Analysis Program (AVTPAP)," 620-222, April 10, 1974.

Fld. 81 B. L. Huneycutt, R. E. Loesh, "Program Description Document for the Telecommunications Prediction and Analysis Program (TPAP)," 620-320, July 15, 1974.

Fld. 82 K. R. Taylor, "User's Guide for the Applications Viking Telecommunications Prediction and Analysis Program (AVTPAP)," 620-422, October 1974.

Fld. 83 TPAP Run Requirements/ Costs, 1974-1975.

Fld. 84 Running TPAP, 1974-1975.

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Fld. 85 TPAP/AVTPAP changes, 1974-1977.

Fld. 86 TPAP Data Matrix, May 23, 1975.

Fld. 87 System Assessment, Jay C. Briedenthal, 1978-1980.

Viking Orbiter and Lander Ranging

Fld. 88 Viking Lander Ranging Performance, Joe Brenkle, 1976-1979.

Fld. 89 S-X Ranging Record, December 1975-April 1976.

Fld. 90 S-X Range Data, S-X Range Plus Doppler Data, ver. D04, for July-December 1976, March 1978.

Fld. 91 Corrected Viking S-X Range Data, S-X Range-Only Data ver. R04, S-X Range Plus Doppler Data ver. D07 for 1976, 1978.

Fld. 92 Viking Lander Range Data for 1976, FINRAN files, 1978.

Fld. 93 Viking S-X Range Data for 1977, 1977-1978.

Fld. 94 Viking Lander Range Data for 1977, 1979.

Fld. 95 Viking Lander Range Data for 1978, 1979.

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Fld. 96 S-X Range Data, 1978-1979.

Fld. 97 Relativity and Solar Corona Experiments Aboard Viking, 1979 Conjunction, 1978-1978.

Fld. 98 Viking Lander Ranging Data Acquisition, Extended Mission Proposal, 1978-1980.

Fld. 99 Solar Conjunction Experiments, October 1978.

Fld. 100 Viking MU-II Ranging, 1978-1979.

Fld. 101 Viking Lander Range Data for 1979, 1979.

Fld. 102 Viking Lander Range Data, 1979-1981. [folder 1 of 2]

Fld. 103 [folder 2 of 2]

Fld. 104 Viking S-X Ranging Data, March 1980-April 1981.

Fld. 105 Viking Lander Monitor Mission Status Reports, September 1980-April 1981.

Box 9 of 12 – Voyager Radio Science Team

Fld. 106 Voyager Radio Science Team Objective, Charter, 1974-1978.

Fld. 107 Voyager Spacecraft Data, 1976-1981.

Fld. 108 Voyager Radio Science Team Meeting Minutes, September 1977-October 1978.

Fld. 109 Voyager Radio Science Team notes, correspondence, 1977-1978.

Fld. 110 Voyager Navigation Team Procedures, September-October 1978.

Fld. 111 Voyager Telecom Status Reports, November 1978-October 1980.

Fld. 112 Voyager Navigation Operations, 1979-1980.
Fld. 113 Voyager Ranging Performance, 1979-1981.
Fld. 114 Office of Space Science, "Voyager Project Management Report: Voyager 2 Jupiter Encounter," 1618-50 Issue 10, July 24, 1979.

Box 10 of 12
Fld. 115 Charles R. Paul, "Voyager Handbook Telecommunications System Functional Description," 618-822, June 1980.
Fld. 116 Voyager Radio Science Working Group, "Voyager 1 Saturn Encounter, Radio Science Operations Plan," October 1980.
Fld. 117 R. R. Wynn, "Procedure for Real Time Monitoring of Navigation Cycles for Voyager Spacecraft," n.d.

International Solar Polar Mission
Fld. 118 ISPM, Test Reports, 1976-1980.
Fld. 119 Frequency Allocations, 1977-1980.
Fld. 120 ISPM Telecommunications Unit Charter, 1978-1980.
Fld. 121 ISPM Radio Loss, 1978-1980.
Fld. 122 ISPM Spacecraft System, TRW RFP Response, Vol. II, Part 1, Work Unit Implementation, 3.5 Telecommunications, DSN Compatibility Verification, April 23, 1979.
Fld. 123 Spin Modulation, 1979.
Fld. 124 ISPM Trajectory, 1979-1980.
Fld. 125 Command Tests During Voyager Superior Conjunction for ISPM, 1979-1980.

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Fld. 126 Telecommunications Link Analysis, 1979-1980.
Fld. 127 Telemetry Modulation Subsystem, 1979-1980.
Fld. 128 ISPM Packet Telemetry, 1979-1980.
Fld. 129 Telecommunications Link Design Data Base, April-June 1980.
Fld. 130 ISPM DSN-ESA Spacecraft Telemetry Compatibility Test Plan, 628-410, October 16, 1980.
Fld. 131 Reed-Solomon Coding, notes, 1978-1980.
Fld. 132 Reed-Solomon/Viterbi Coding Techniques, 1978-1980.
Fld. 133 Reed-Solomon Decoder Review, 1980.
Fld. 134 Reed-Solomon Decoder, 1980.

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Fld. 135 ISPM TRW Reports, January-May 1980.
Fld. 136 ISPM TRW Reports, June-September 1980.
Fld. 137 ISPM TRW Reports, September 1980-March 1981.

CATALOG DESCRIPTION

Radio Science Collection, 1961-1980 (bulk 1973-1980).
3.6 cu. ft. (12 boxes)
The radio signals from a spacecraft can be analyzed during the passage of that signal close to a planet. The signal is usually bent, delayed, obscured or reflected by the planet. The measurement of these

alterations, called radio science, provides information about planet size, atmospheric density, and other factors not otherwise observable.

The collection consists of documentation of radio science teams and various tests of telecommunications subsystems of primarily the Viking Orbiters and Landers, but also Voyager and Mariner Venus-Mercury 1973 (Mariner 10), as well as the Ulysses mission. They are primarily from the office of Tom Komarek, Section 339, Spacecraft Telecommunications Systems.

Finding aid available in the repository.

Tracings

Jet Propulsion Laboratory – History
Komarek, Tomas A.
Koerner, Murray A.
McAllaster, James R.
Brockman, Milton H.
Stuhr, Frederick
Cain, Dan L.
de Vries, J. Pieter
Brenkle, Joseph P.
Shapiro, Irwin I.
Ackernecht, William E.
Taylor, Kenneth R.
Eshleman, Von R.
Wood, Gordon E.
Radio Science
Voyager Project
Viking Orbiters
Viking Landers
Mariner Venus/Mercury 1973 (Mariner 10)
Mars
Saturn
Relativity
Deep Space Network
International Solar Polar Mission
European Space Agency
Reed-Solomon Decoder

Part of Accession 1989-11; Shipment # 6420.