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MARINER V PASSES VENUS

The United States spacecraft Mariner V is approaching Venus on a path that will reach closest to that mystery planet at 1:34 p.m. EDT, Thursday, Oct. 19.

Mariner V will fly within 2,500 miles of Venus at a communications (direct) distance of about 49 million miles from Earth.

Launched by the National Aeronautics and Space Administration last June 14, Mariner V will have traveled about 217 million miles in its arcing trajectory when it moves closest to the planet.

Preparations for the encounter with Venus will begin at NASA's Jet Propulsion Laboratory, Pasadena, Calif., about 13 hours before closest approach -- or at 7:24 a.m. EDT -- when the spacecraft is commanded to turn on a planet sensor.

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The sensor is required to signal automatic commands to the spacecraft during encounter and to turn on power to Mariner's tape recorder.

As Mariner approaches Venus, its scientific instruments will begin measuring the planet's magnetic field, if any; charged particles and gasses present in the upper atmosphere, and radiation levels.

Mariner's flight path then will curve behind the planet and it will vanish from view of tracking stations on Earth. Just before it goes behind the planet (as seen from Earth) its radio signals will pass through the atmosphere of Venus.

The effect of the Venusian atmosphere on Mariner radio signals will be measured, thereby providing a measure of the density of the planet's atmosphere. Current scientific theory on the density ranges from five times Earth's atmosphere to several hundred times.

This density measurement is one of the prime objectives of the Mariner V flight project.

Some of the scientific data gathered as Mariner passes Venus will be immediately transmitted to Earth. While it is behind the planet, other data will be recorded on tape for later transmission to Earth. The tape playback will begin about 14 hours after the spacecraft passes the planet. Transmission of all the information to Earth will take 34 hours.

On Oct. 11, the gravitational pull of Venus began to increase the velocity of Mariner V when it was some 1.4 million miles from the planet. The velocity relative to Venus will increase from 6,900 miles per hour on Oct. 11 to a maximum of 19,000 miles per hour on Oct. 19 as Mariner V whips around in front of Venus.

The gravitational attraction of Venus will alter the spacecraft's flight path, bringing it closer to the Sun than any other U. S. spacecraft. Mariner V will come within 54 million miles of the Sun early next January.

Mariner II flew past Venus at a distance of 21,648 miles on Dec. 14, 1962. Mariner IV flew past Mars at a distance of 6,118 miles on July 14, 1965.

(BACKGROUND AND TECHINCAL INFORMATION FOLLOWS)

MARINER V FLYBY OF VENUS

Major Events

Oct. 18, 1967 EDT	10:50 p.m.	Tape recorder, terminator sensor on
Oct. 19, 1967	6:45 a.m.	Goldstone Rise
	7:24 a.m.	Planet sensor on, mode 3 data (science data only)
	12:30 p.m.	Sensor detects planet, science recording begins
	1:31 - 1:37 p.m.	Enter Occultation
	1:34 p.m.	Closest approach (2,500 miles)
	1:41 p.m.	Terminator sensor sees shadow line
	1:44 p.m.	Antenna position angle change
	1:50 - 1:56 p.m.	Exit occultation
	2:00 p.m.	Canberra rise
	2:39 p.m.	Tape recorder off
	2:49 p.m.	End of tape, mode 2 data (mixture science and engineering)
	about 6:45 p.m.	Goldstone set
	about 11:15 p.m.	Madrid rise
Oct. 20, 1967	about 12:25 a.m.	Canberra set
	3:25 a.m.	Begin playback for 34.4 hours, will go on for second playback automatically unless stopped.
	about 7:15 a.m.	Goldstone rise

MARINER V SCIENTIFIC INVESTIGATIONS

Despite its closeness to Earth and the measurements made by Mariner II and Earth telescopes, Venus remains one of the most mysterious planets in the solar system.

It is similar to Earth in mass, density and size but it is enshrouded with clouds and no one has ever seen its surface.

Because Venus is closer to the Sun than the Earth, some theories of planetary atmospheres lead to the conclusion that its atmosphere should be thinner than the Earth's. Yet most of the evidence indicates a very dense atmosphere, variously estimated at five to several hundred times as dense as the Earth's atmosphere.

Spectroscopic studies have indicated the presence of carbon-dioxide and water vapor in very small amounts but the composition of the Venusian atmosphere remains 99 per cent unknown.

The scientific investigations to be conducted on the Mariner V mission are designed to produce additional information on the structure of the planet's atmosphere and on its radiation and magnetic environment.

Mariner V will pass within 2,500 miles of the surface of Venus (compared Mariner II's 21,600 miles) and on the side of the planet away from the Sun favorable for detecting its magnetic wake.

Mariner V's experiments are ultraviolet photometry, S-band occultation, dual-frequency radio occultation, trapped radiation detection, magnetic field measurements, solar wind measurements, and celestial mechanics.

The ultraviolet photometry experiment is designed to measure atomic hydrogen and atomic oxygen in the upper atmosphere from which atmospheric scale height and a temperature profile of the upper atmosphere can be calculated.

The radio occultation experiments should provide data on the refractivity profile of the atmosphere. Temperatures, pressures and densities can then be deduced by assuming model atmospheres composed of various constituents.

The magnetic field measurements are designed to determine the direction and strength of any magnetic field that may exist around Venus as well as provide data on the interplanetary magnetic field.

The trapped radiation experiment will observe charged particles of various energies around Venus.

The solar wind experiment has studied the density, velocities and direction of the relatively low energy particles of the solar wind during the cruise phase of the mission to determine their possible interaction with Venus.

The celestial mechanics experiment will use tracking data to refine knowledge of the astronomical unit and the mass and ephemeris of Venus.

The three experiments primarily designed for atmospheric studies (ultraviolet photometry and the two occultation experiments) are being flown to Venus for the first time.

Following are the scientific experiments and investigators of Mariner V:

Experiment	Description	Investigators
Solar Plasma Probe	Measures density, velocities, temperatures and direction of low-energy protons from Sun (the solar wind).	Prof. Herbert L. Bridge (Principal Investigator) and Dr. Alan S. Lazarus, both, Massachusetts Institute of Technology, and Dr. Conway Snyder, JPL.
Trapped Radiation Detector	Measures electrons, protons, and X-rays in space and at Venus.	Dr. James A. Van Allen (Principal Investigator), Dr. Louis A. Frank, and Stamatios N. Krimigis all of the University of Iowa.
Magnetometer	Measures intensity and direction of magnetic fields encountered by the spacecraft.	Dr. Edward J. Smith, JPL; Paul J. Coleman, Jr., UCLA; Prof. Leverett Davis, Jr., California Institute of Technology; and Dr. Douglas L. Jones, Brigham Young University.
S-Band Occultation	To determine the density of the Venusian atmosphere as a function of altitude.	Dr. Arvydas J. Kliore (Principal Investigator), Dan L. Cain and Gerald S. Levy, all of JPL; G. Fjeldbo, Stanford University; and S.I. Rasool, Goddard Institute for Space Studies.

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Experiment	Description	Investigators
Dual-Frequency Receiver Experiment	Measures abundance of electrons in the ionosphere of Venus and in space between the Earth and the spacecraft.	Dr. Von R. Eshleman (Principal Investigator), G. Fjeldbo, H.T. Howard, and B.B. Lusignan, all of Stanford University; R.L. Leadabrand and R.A. Long of Stanford Research Institute.
Celestial Mechanics Experiment	To refine the ephemerides of Earth and Venus; and the relative masses of Sun, Moon, and Venus, and the astronomical unit.	Dr. John D. Anderson (Principal Investigator), L. Efron, G.S. Pease, and Dr. R.C. Tausworthe, all of JPL.
Ultraviolet Photometer Experiment	To measure the density and temperatures of two of the principal components, atomic hydrogen and atomic oxygen, expected to be present in the Venus exosphere.	Dr. C.A. Barth (Principal Investigator), K.K. Kelley and J.B. Pearce of the University of Colorado; W.G. Fastie of Johns Hopkins University; E. Mackey of Packard Bell; and L. Wallace of Kitt Peak Observatory.

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DEEP SPACE NETWORK ENCOUNTER COVERAGE

Four stations of the Deep Space Network space communications complex at Goldstone, Cal., will be trained on Mariner V during the Venus encounter phase of the mission on Oct. 19.

Primary station for commanding and recording S-band occultation data will be Mars (Deep Space Station 14), equipped with a 20-kilometer transmitter, supersensitive receiver and a 210-foot diameter antenna. All other stations at Goldstone are equipped with 85-foot antennas.

Backup S-band occultation recording will be provided by the Venus station (DSS 13).

The Echo station (DSS 12) is the prime station for reception and recording of spacecraft telemetry. The Pioneer station (DSS 11) will receive and record telemetry from Mariner in addition to processing telemetry received by the Mars station.

The critical encounter sequence command--DCV-29--will be transmitted by the DSN's Woomera, Australia, station (DSS 41) at 10:49 p.m., EDT, Oct. 18, about 14.5 hours before closest approach to Venus.

At 4:50 a.m., EDT, Oct. 19, a station near Madrid, Spain, (DSS 62), will transmit a command--DCV-9-- to turn on spacecraft ranging.

The playback sequence, which begins about 14 hours after encounter and continues for about 34 hours, will be received by stations 12, 14, 41, 62, and two additional overseas stations--Johannesburg, South Africa (DSS 51) and Canberra, Australia (DSS 42).

ENCOUNTER SEQUENCE

The first command in Mariner V's encounter sequence will be issued about 13 hours prior to encounter with Venus.

Mariner V can respond to three kinds of commands:

Direct commands, DCV--transmitted from Deep Space Network stations to Mariner V where they are decoded (translated from binary form into electrical impulses) in the command subsystem and routed to their proper destinstion. Mariner is capable of receiving and acting upon 29 separate direct commands.

Quantitative commands, QC--radioed from Earth but stored in the spacecraft's central computer and sequencer (CC&S) until required. A quantitative command is a three-segment command which tells the spacecraft how far and in which direction to rotate on its pitch and roll axes and the firing duration of the rocket engine. The command is used only in connection with the mid-course maneuver.

Master timer commands, MT--pre-set in the spacecraft's CC&S for use in the cruise portion of flight and at Venus encounter. These on-board commands switch the spacecraft telemetry transmission to a lower or higher bit rate; switch the transmitter between the low-gain and high-gain antennas; set the Canopus sensor at various cone angles relative to the predicted encounter time; turn on planetary science equipment a few hours before encounter, and switch the telemetry system to the post-encounter mode for transmission of recorded data.

At 10:50 p.m. EDT, a first command (DCV-25) from Earth will send power to the tape recorder (but not start it recording) and turn on a sensor designed to detect the terminator on Venus.

The tape recorder will be used during the flyby for approximately two hours. High rate data from the dual frequency receiver experiment, the ultraviolet photometer and the trapped radiation detector as well as normal real-time data from all instruments will be recorded on track one through the data automation system.

The data automation system (DAS) accumulates scientific information from five experiments (ultraviolet photometer, dual-frequency radio propagation, trapped radiation detector, helium magnetometer and solar plasma probe) and converts it into a digital form suitable for radio transmission to Earth.

During the central $1\frac{1}{2}$ hours of this period, data from the dual frequency experiment will be recorded on track two. Data will be recorded on each track at a rate of 66 2/3 bits per second. (The telemetry transmission rate from the spacecraft is only 8 1/3 bits per second at encounter, necessitating data storage on tape.) The tape recorder has a storage capacity of one million bits.

The terminator sensor will be used during the occultation to detect the point in time when the spacecraft crosses the line between night and day on Venus. Detection of the terminator will generate a signal to switch the antenna position to compensate for bending of the radio waves by the Venus atmosphere. This is required to permit reception of radio signals as the spacecraft emerges from behind the planet.

At six hours prior to point of closest approach the CC&S will order the data automation system to switch the data mode 3 which eliminates transmission of engineering information, allowing the entire format to be used for science data. This command is backed up by the transmission from Earth of a direct command, DC-24. The planet sensor is also turned on at this point and the plasma probe is switched to the encounter mode.

At three hours before encounter direct command 16 is transmitted from Earth to activate Timer A in the DAS. Timer A, essentially a counter, will issue backup commands for critical events throughout encounter.

Detection of the planet by the planet sensor will occur approximately 60 minutes before closest approach (about 12:30 p.m. PDT), and will initiate commands ordering the ultraviolet photometer calibrate sequences to be inhibited, increase the sampling rate from the unltraviolet photometer, the trapped radiation detector and dual frequency receiver, start recording data on track one and start Timer B in the DAS. Timer B will order tape recording of data from the dual frequency receiver 13.75 minutes later and Timer A will issue a backup to this command.

About 1:31 p.m. EDT, the spacecraft will enter the Earth occulation zone and disappear behind the planet. Seven minutes after closest approach, the terminator sensor will initiate the command to change the antenna position. This command goes to the pyrotechnic subsystem. An explosive squib is fired, allowing the antenna to switch. Timer A will issue a backup command to the pyrotechnic subsystem for this event.

Mariner will exit occultation and again he in view of Earth stations about 1:56 p.m. giving a total occultation time of about 25 minutes. Earth tracking stations will lock on the spacecraft transmitter as soon as possible after occultation in order to record additional data on the atmosphere from the experiments.

Approximately 50 minutes later, the Timer B in the DAS stops sending dual frequency receiver data to track two of the tape recorder. Recording of track one data continues about nine minutes longer until the tape recorder is stopped automatically by an end-of-tape signal marking the end of the data storage sequence. This will be about 2:39 p.m.

A few minutes later Timer B in the DAS will switch the data encoder to Mode 2 (with a backup command from Earth), send a series of stop-tape commands as a backup to the end-of-tape signal, turn off the planet sensor and command the photometer and plasma probe back to the cruise mode. Timer A will issue a backup command for all these events.

Fourteen hours after encounter, about 3:25 a.m., Oct. 20, the spacecraft will be readied for the playback of the science data recorded during the flyby. The CC&S will issue a command to switch to data Mode 4 to start the playback. A playback command from Earth will also be sent. About 18 hours later the tape recorder will be commanded to switch tracks by an end-of-tape signal or by backup command from Earth.

The playback sequence consists of about 17 hours of science data from track one, two hours of real time engineering data from the spacecraft telemetry system and 14 more hours of recorded science data from track two. If track two is played back first, the timing is reversed. The real time sampling of engineering data between the readout of each of the tracks is required for Deep Space Network operational purposes and to provide information on the condition of systems aboard the spacecraft.

Additional playbacks of the recorded data are optional and can be controlled by ground commands.

Complete recovery of the stored data will satisfy the primary mission objective. An additional desired result is the reception of data as close to the Sun as possible as the spacecraft trajectory, altered by the mass of Venus, will carry the spacecraft nearer the Sun. This will be governed by the effect of the spacecraft's motion pointing the high gain antenna away from the Earth.

MARINER V LOG

EVENT	DATE & TIME (EDT)	REMARKS
	June 14, 1967	
Liftoff	2:01:00.176 a.m.	
Booster engine cutoff	2:03:09 a.m.	
Shroud ejection	2:06:20 a.m.	
Atlas/Agena separation	2:06:22 a.m.	
First Agena ignition	2:07:22 a.m.	
First Agena cutoff	2:09:46 a.m.	
Second Agena ignition	2:23:01 a.m.	
Second Agena cutoff	2:24:36 a.m.	Injection velocity: 25,501 mph Desired velocity: 25,492 mph Injection altitude: 118.5 mi. Earth-Venus distance: 70,659,634 mi.
Spacecraft separation	3:27:17 a.m.	
Sun acquisition	3:44 a.m.	
Canopus sensor on	6:38 p.m.	
Lock on Earth	6:49 p.m.	
Transmit DCV-21	8:30 p.m.	Canopus sensor override: roll search about 240° to star
Transmit DCV-21	8:34 p.m.	Canopus sensor override
Canopus acquisition	9:09:02 p.m.	
	June 19, 1967	
Transmit QCVI-1	4:18:00 p.m.	Stored pitch command (+55.35°)

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EVENT	DATE & TIME (EDT)	REMARKS
	June 19, 1967 (continued)	
Transmit QCV1-2	4:23:00 p.m.	Stored roll command (+71.02°)
Transmit QCV1-3	4:28:00 p.m.	Stored motor burn command (17.66 sec.)
Transmit DCV-20	4:38:00 p.m.	Arm propulsion gyros
Transmit DCV-14	4:48:00 p.m.	Remove maneuver inhibit
Transmit DCV-27	5:23:59 p.m.	Initiate midcourse maneuver (60-minute gyros warmup)
Start pitch turn	6:24:11 p.m.	
Stop pitch	6:29:15 p.m.	
Start roll turn	6:46:10 p.m.	
Stop roll	6:52:32 p.m.	
Motor ignition	7:08:11 p.m.	
Motor cutoff	7:08:26 p.m.	Burn time nominal
Sun reacquired	7:21:19 p.m.	
Start Canopus reacquisition	7:21 p.m.	Automatic from CC&S
Canopus reacquired	7:32:27 p.m.	Gyros still on
Transmit DCV-21	7:33:15 p.m.	Canopus override command
Canopus reacquired	8:24:05 p.m.	
Transmit DCV-21	8:25:00 p.m.	
Canopus reacquired	9:17:00 p.m.	
Transmit DCV-21	9:17:50 p.m.	Canopus override command
Canopus reacquired	10:06:20 p.m.	
Transmit QCV1-1	10:19:00 p.m.	Stored command; minimum pitch turn*

EVENT	DATE & TIME (EDT)	REMARKS
	June 19, 1967 (continued)	
Transmit QCV1-2	10:24:00 p.m.	Stored command; minimum roll turn*
Transmit QCV1-3	10:29:00 p.m.	Stored command; minimum motor burn*

*Transmission of minimum quantitative commands provides protection against accidental initiation of the maneuver sequence. Should the sequence be initiated, Sun and roll orientation will not be lost and minimum effect to the trajectory will result from motor ignition. This action was taken to condition the spacecraft for its long journey (four months) to Venus.

	June 22, 1967	
Transmit DCV-9	3:25:00 a.m.	Turn on ranging
	June 24, 1967	
Transmit DCV-9	11:08:00 p.m.	Turn on ranging
	June 26, 1967	
Transmit DCV-9	7:45:00 p.m.	Turn off ranging
Transmit DCV-7	8:28:00 p.m.	Switch power amplifiers (from cavity to traveling wave tube)
Transmit DCV-28	8:58:00 p.m.	Turn off battery charger
Transmit DCV-9	9:18:00 p.m.	Turn on ranging
	July 1, 1967	
Transmit DCV-9	3:45:00 a.m.	Turn on ranging
	July 5, 1967	
Transmit DCV-9	8:30:00 p.m.	Turn on ranging
	July 9, 1967	
Transmit DCV-9	3:30:00 a.m.	Turn on ranging
	July 21, 1967	
Transmit DCV-9	9:35:00 p.m.	Turn on ranging

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EVENT	DATE & TIME (EDT)	REMARKS
	<u>July 25, 1967</u>	
MT-6	3:19:21 a.m.	Telemetry bit rate change from 33 1/3 to 8 1/3 bps
	<u>July 27, 1967</u>	
Transmit DCV-9	12:40:00 p.m.	Turn on ranging
	<u>August 24, 1967</u>	
MT-1	4:41:07 a.m.	Canopus sensor update; change field of view from preset 80° cone angle to 85.1°
	<u>September 9, 1967</u>	
MT-2	8:41:26 p.m.	Canopus sensor update; change angle to 90.3°
	<u>September 26, 1967</u>	
MT-3	12:43:31 p.m.	Canopus sensor update; change angle to 95.4°
	<u>October 1, 1967</u>	
MT-5	12:43 p.m.	Switch spacecraft transmitter to high-gain antenna
	<u>October 5, 1967</u>	
Transmit DCV-9		Turn on ranging (Simultaneous command and ranging modulation test to assure that spacecraft could receive encounter commands while ranging is in effect.)

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