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Air Space In Perspective

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AIR SPACE IN PERSPECTIVE

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WITH the development of rockets, missiles and artificial satellites, thinking on earth is rapidly becoming space-oriented.[1] The purpose of this article is to sketch a background against which the problems relating to air space may be viewed. The first portion of the article will deal briefly with the physical composition of the atmosphere and the extent to which penetration of the atmosphere has been achieved by science. The second portion of the article will discuss the position of the atmosphere in relation to its surroundings.

The Copernican revolution in the sixteenth century changed man's thinking from the belief in an earth-centered world to the view that his universe was sun-centered. The strong opposition to the discoveries of Copernicus indicates how difficult it was for man to abandon the ego-satisfying geocentric concept. It was painful to think that man was not the center of the world and was but a creature on one of many planets circling the sun, and it became somewhat more difficult to conclude, on rational grounds, that the rewards of salvation had been offered only to the people living on the planet Earth. Man's unique position in the solar system was seriously threatened. But the significant insignificance of man and his world was to be supported by yet stronger proof. The evidence next introduced was that the sun was a star no different from many other stars, that these other stars also had planets revolving about them and that man's world was therefore but one of many such worlds. Thus not only does man's place in his world lack any peculiarly central position, but even man's world lacks any particular individuality in the total universe. This is the mental perspective with which we now enter the realm of air space.

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[1] The front page news stories and headlines appearing in the New York Times during the past seven months are revealing:

August 9, 1958, p. 1, col. 3. GLENNAN, OHIO EDUCATOR, NAMED TO DIRECT NEW U. S. SPACE UNIT; August 3, 1958, p. 1, col. 6, ATLAS LAUNCHED SUCCESSFULLY; ICBM SOARS ON ALL 3 ENGINES, Cape Canaveral, Fla., Aug. 2—An Atlas intercontinental ballistic missile thundered toward space today. The three-engine 100-ton Atlas is the most potent weapon ever fired from here. . . . The propulsion system, which pours out more than 350,000 pounds of thrust, gives the Atlas enough push to travel the intercontinental range of 6,325 miles; August 5, 1958, p. 1, col. 4. TOP-SHAPED DEVICE TO BE SHOT AT MOON, The instrument package the Air Force plans to launch later this month in an attempt to

circulate the moon will be shaped like a toy top. It probably will weigh about 100 pounds, including a rocket charge for turning it into orbit at the last moment; August 2, 1958, p. 1, col. 5. A-BOMB IN MISSILE EXPLODED IN TEST MILES ABOVE SEA, Washington, Aug. 1—An American atomic weapon mounted in a missile was detonated miles above the Pacific Ocean today. It was a step toward creation of a defense against intercontinental ballistic missiles; July 29, 1958, p. 1, col. 4. SATELLITES URGED AS ATOMIC CHECKS. SCIENTISTS IN GENEVA SAY MISSILES COULD BE USED TO DETECT EXPLOSIONS; July 27, 1958, p. 1, col. 7. U. S. ARMY ORBITS SATELLITES TO GET COSMIC RAY DATA. EXPLORER IV FIRED 38.43 POUND DEVICE TAKES A NEW PATH AROUND EARTH, Cape Canaveral, July 26—The United States launched its fourth and heaviest satellite into orbit today; July 24, 1958, p. 1, col. 3. 3D MISSILE FIRED ACROSS ATLANTIC IN RE-ENTRY TEST. SHIPS AND PLANES HUNT NOSE CONE CARRYING A MOUSE—TRIAL HELD SATISFACTORY, Cape Canaveral, Fla., July 23—The third Air Force missile to carry a mouse into space thundered from its pad here tonight at 6:13 o'clock, Eastern Daylight Time. It was aimed over a trajectory of 6000 miles toward the vicinity of the Ascension Islands in the South Atlantic; July 21, 1958, p. 1, col. 3. FRANCE REPORTED STALLING ON SITES FOR U. S. MISSILES. Washington, July 20—Premier Charles de Gaulle's Government is reliably reported here to be stalling on a planned agreement to establish United States-equipped intermediate range ballistic missile bases in France; July 20, 1958, p. 1, col. 2. A 3-ENGINE ATLAS FALLS IN FLAMES. MOST POWERFUL U. S. MISSILE IS AIRBORNE ONLY 2 MINUTES IN CAPE CANAVERAL TEST, Cape Canaveral, Fla., July 19—The first 3 engine Atlas Intercontinental ballistic missile broke apart and crashed flaming into the sea at 1:36 P.M. today, two minutes after launching; July 18, 1958, p. 1, col. 3. JUPITER NOSE CONE RECOVERED IN TEST. Cape Canaveral, Fla., July 17—The Army launched another Jupiter intermediate range ballistic missile this morning, and its full-size nose cone was recovered intact; July 11, 1958, p. 1, col. 6. MISSILE FIRED 6,000 MILES, LANDS IN THE SOUTH ATLANTIC. AIR FORCE TERMS TEST FLIGHT A SUCCESS AND LONGEST FOR ANY U. S. ROCKET, Washington, July 10—The Air Force announced tonight that the mouse-carrying test vehicle it launched last night at Cape Canaveral, Fla., had landed some 6,000 miles away in the South Atlantic. The Air Force said the test, made with a combination of the military Thor missile and the scientific Vanguard missile, had been "successful" and that telemetry data had been received over the full course of the flight; June 15, 1958, p. 1, col. 3. U. S. LIKELY TO MAKE SOLID-FUEL MISSILES KEY DEFENSE BY '65. By about 1965, solid-propellant ballistic missiles probably will have taken over the chief burden of deterring an all-out enemy attack on this country; June 11, 1958, p. 1, col. 5. AUGUST MOON SHOT FORESEEN. GENERAL SAYS 3 TRIES WILL BE MADE TO HIT THE LUNAR SURFACE; June 1, 1958, p. 1, col. 1. SATELLITES FAIL TO SPUR SCHOOLS. SYSTEM HAS ITS WEAKNESSES 8 MONTHS AFTER SPUTNIK I; May 25, 1958, p. 1, col. 2. U. S. LAGS IN SPACE RACE 8 MONTHS AFTER SPUTNIK I. Nearly 8 months after the abrupt dawn of the space age, the United States still has no firm program, organization or funds for the race into space with the Soviet Union; May 23, 1958, p. 1, col. 8. 8 NIKES EXPLODE AT JERSEY BASE; 7 DEAD, 3 MISSING. 24 NON-ATOMIC WARHEADS ARE SCATTERED OVER 2 MILES OF MIDDLETOWN MISSILE BASE; May 20, 1958, p. 1, col. 5. BAR SPACE CLAIMS UN CHIEF URGES. HAMMARSKJOLD ASKS STATUS LIKE THAT OF HIGH SEAS. PROPAGANDA HELD PERIL: Miami Beach—Dag Hammarskjold, Secretary General of the United Nations, called on all nations tonight to renounce any territorial claims to outer space. In this way he said development would be for the benefit of all living on earth; May 19, 1958, p. 1, col. 3. U. S. TESTS NOSE CONE AS MOSCOW SHOWS ITS SATELLITE; May 19, 1958, p. 1, col. 3. U. S. REGAINS CONE OF JUPITER FIRED IN RE-ENTRY TEST. NOSE FOUND INTACT IN OCEAN AFTER 9000 M. P. H. PLUNGE INTO THE ATMOSPHERE. ACCURACY IS ACCLAIMED. SOVIET DISCLOSES MORE DATA ON SPUTNIK III

—SAYS RED CHINA PLANS SATELLITES; May 18, 1958, p. 1, col. 8. U. S. TO SPEED WORK ON ATOMIC ROCKETS; May 18, 1958, p. 1, col. 4. JUPITER IS LAUNCHED IN A RE-ENTRY TRIAL; May 17, 1958, p. 1, col. 1. RUSSIANS DESCRIBE GEAR IN SPUTNIK III; May 16, 1958, p. 1, col. 1. SOVIET SATELLITE WEIGHING 1.5 TONS FIRED INTO ORBIT. PREMIER REJOICES. KRUSCHEV GIBES AT AMERICAN ORANGES CIRCLING THE EARTH. The Soviet Union roared back into the satellite race today by launching a new space vehicle that weighs nearly one and one-half tons; May 12, 1958, p. 1, col. 5. ATOM ACCELERATORS PROBE UNIVERSE. In drab university workrooms from the Atlantic to the Pacific and around the world the lights burn late at night over blackboards covered with symbols in chalk. The symbols represent man's latest efforts to understand the nature of the universe; May 5, 1958, p. 1, col. 3. THOR GIVEN LEAD OVER THE JUPITER. CUT BACK REPORTED IN ARMY ICBM WITH AN INCREASE FOR AIRFORCE MISSILE; May 2, 1958, p. 1, col. 4. U. S. SATELLITES FIND RADIATION BARRIER. DETECT INTENSE BLOCK TO SPACE TRAVELER 600 MILES UP. PRAVDA SAID FLIGHT IN SPACE AFFECTED LAIKAS HEARTBEAT; April 29, 1958, p. 1, col. 8. VANGUARD FIRED BUT FAILS TO ORBIT 20 INCH SATELLITE. NAVY SAYS THIRD STAGE OF ROCKET DID NOT IGNITE AFTER A SUCCESSFUL LAUNCHING. PENTAGON GIVES REPORT. OFFICIALS EXPLAIN THAT MISSILE DIDN'T ATTAIN REQUIRED SPEED—NEW SHOT SET; April 26, 1958, p. 3, col. 1. ANTI-MATTER RAIN ON EARTH HINTED. FLORIDA PHYSICIST SUGGESTS SOME CRATERS RESULTED FROM SUCH ASSAULTS. London—Has the earth been bombarded by substance from outer space known as anti-matter?; April 24, 1958, p. 1, col. 7. U. S. ROCKET FAILS OVER ICBM RANGE. FLIGHT SPANS ABOUT TENTH OF 6,300 MILE COURSE IN TEST OF NOSE CONE RE-ENTRY. Cape Canaveral—The Air Force last night made its first attempt to fire a nose cone the full range of an ICBM missile. But indications were that it flew only 600 or 700 miles; April 22, 1958, p. 1, col. 1. RISK SEEN IF MOON IS TAKEN FOR ICBM. HAGAN FEARS RADAR ERROR ASKS INTERNATIONAL RULE; April 23, 1958, p. 1, col. 4. BALLOON PLANNED TO ORBIT MOON. SCIENTISTS TELL HOUSE GROUP SPHERES WILL BE INFLATED IN SPACE—BACK NEW UNIT. Washington—Space scientists told Congress today of plans to give a satellite "a kick in the apogee" and to float huge aluminum balloons around the moon; April 19, 1958, p. 1, col. 7. S. A. C. MAINTAINS 15-MINUTE ALERT. MARGIN REDUCED AS RESULT OF SOVIET FIRING OF ICBM—SAFEGUARDS DESCRIBED; April 14, 1958, p. 1, col. 8. SPUTNIK II REPORTED DOWN IN CARIBBEAN; April 12, 1958, p. 1, col. 4. THE NAVY FIRES A DUMMY POLARIS FROM AN UNDERWATER POPUP LAUNCHER; April 3, 1958, p. 1, col. 5. EISENHOWER ASKS NEW SPACE AGENCY. URGES CONGRESS TO ESTABLISH CIVILIAN CONTROLLED UNIT TO DIRECT ALL U. S. PROJECTS; April 3, 1958, p. 1, col. 4. SECRET RADIO BEAM DRAWS MORE DATA FROM EXPLORER III; April 2, 1958, p. 1, col. 1. SCIENTISTS STUDY BIG SOLAR FLARES. I. G. Y. UNITS REPORT INTENSE ACTIVITY OVER WEEK-END; March 30, 1958, p. 1, col. 6. PRESIDENT READY TO ASK SPACE UNIT RUN BY CIVILIANS. CONGRESS STATED TO GET PLAN THIS WEEK—KEY ROLES MAY GO TO AERONAUTICAL AIDES. Washington—President Eisenhower's plan for a civilian agency to conduct explorations of outer space is expected to be sent to Congress next week; March 27, 1958, p. 1, col. 7. 2 BILLION COST SET FOR TRIP TO MOON. PRESIDENT RELEASES "SPACE PRIMER" BY SCIENCE AIDES, AND URGES ALL TO READ IT. 3D U. S. SATELLITE FIRED INTO ORBIT; SHORT LIFE SEEN. ANGLE IS WRONG. BUT THE EXPLORER III IS EXPECTED TO YIELD VALUABLE DATA. Cape Canaveral—Explorer III was fired into orbit today by an Army Jupiter-C Rocket. It was this nation's third artificial satellite and world's fastest; March 23, 1958, p. 1, col. 3. MARS STUDY DOUBTS HUMAN LIFE THERE; CALLS AIR TOO THIN; March 20, 1958, p. 1, col. 2. SPACE SCIENTISTS PROPOSE PROGRAM LEADING TO MOON. RE-

PORT TO PRESIDENT ASKS WIDE RESEARCH—VIEWS SATELLITE TRIP AS A PRELUDE TO DRAMA OF MANNED FLIGHT; March 19, 1958, p. 1, col. 5. FULL SCALE NAVY SATELLITE TO TEST X-RAYS FROM SUN; March 18, 1958, p. 1, col. 4. NAVY PUTS VANGUARD IN ORBIT; 2D U. S. SATELLITE UP 2,513 MILES: EXPECTED TO LAST 5 TO 10 YEARS. PROJECT PLANS TO FIRE LARGE SATELLITES IN SPACE STUDY. SPHERE CARRIES SOLAR BATTERIES—PART OF ROCKET TRAILS IT; March 7, 1958, p. 1, col. 2. U. S. PLANS MOON ROCKETS INITIAL OUTLAY IS 8 MILLION; March 7, 1958, p. 1, col. 1. SECOND EXPLORER FAILED TO ORBIT ROCKET IS BLAMED. ARMY SAYS FINAL STAGE DID NOT FIRE CAUSING SATELLITE TO PLUNGE EARTHWARD. REASON UNDETERMINED. SCIENTISTS BELIEVE PROJECTILE BURNED UP IN ATMOSPHERE IN FALL NORTH OF TRINIDAD; March 6, 1958, p. 1, col. 7. MOON SHOT LIKELY TO BE ARMY'S JOB. AIR FORCE EXPECTED TO GET MOSTLY MILITARY TASKS —HOUSE ADDS SPACE UNIT; March 6, 1958, p. 1, col. 7. 2D U. S. EXPLORER FIRED VANISHES, ORBITING IN DOUBT. Early Signals Die. Official says evidence shows malfunction in the missile; March 3, 1958, p. 1, col. 8. SATELLITE FIRINGS SET FOR THIS WEEK. Army to Launch 2nd Explorer—Navy Plans New Attempt; March 2, 1958, p. 1, col. 8. PERFECTED THOR SEEN IN 3 MONTHS. Air Force ICBM is reported far ahead of schedule. March 1, 1958, p. 1, col. 2. THOR SHOT WITH NEW CONE FOR ATMOSPHERE RE-ENTRY. Test said to keep plan for missiles to Britain ahead of schedule. Washington—The Air Force fired the first Thor Missile fitted with the critically important re-entry nose-cone; February 28, 1958, p. 1, col. 8. AN ATLAS EXPLODES IN AIR AFTER TWO MINUTES. Cape Canaveral—An Atlas Intercontinental Ballistic Missile exploded in a flash of flame today shortly after an apparently successful take-off; February 28, 1958, p. 1, col. 2. 500 TO 5,000 MILE MISSILE IS APPROVED FOR AIR FORCE; February 26, 1958, p. 1, col. 3. SHOT AT MOON IN 58 URGED BY AIR FORCE TO OUTDO RUSSIANS; February 25, 1958, p. 1, col. 6. R. A. F. TO GET U. S. THORS FOR USE AT BRITISH BASE. Washington to provide missiles capable of reaching Soviet from English sites—launching needs joint decision; February 22, 1958, p. 1, col. 2. AIR FORCE SCORES McELROY OVER ARMY'S MISSILE ROLE. Secretary was "premature" in deciding anti-ICBM set-up, House unit told—Pentagon consultants in Puerto Rico; February 20, 1958, p. 1, col. 5. U. S. PLANS FALL LAUNCHING OF 3,000 POUND SATELLITE. Washington—The Air Force expects to launch a 3,000 pound test satellite in October. It would be a forerunner of reconnaissance satellites that would be able to observe the earth from space; February 13, 1958, p. 1, col. 3. ONE EXPLORER RADIO SILENT AFTER 11 DAYS; February 10, 1958, p. 1, col. 4. AIRMAN BEGINS TEST IN SPACE CABIN. San Antonio, Texas—A young airman "stepped into space" today at the School of Aviation Medicine at Randolph Air Force Base; February 9, 1958, p. 1, col. 2. SECTION OF VANGUARD ROCKET IS RECOVERED FROM OCEAN; February 9, 1958, p. 1, col. 2. BLUE RIBBON SENATE GROUP IS PICKED. Washington—Thirteen Senators were named today to a special committee that will frame legislation for the coordinated exploration and development of outer space; February 9, 1958, p. 1, col. 4. SERVICES REPORT MISSILE PROGRESS. Anti-satellite weapons and 3000 mile radar defense forecast by Pentagon; February 8, 1958, p. 1, col. 1. AN ATLAS ICBM DESTROYS ITSELF AFTER LAUNCHING PROVES SUCCESS; February 7, 1958, p. 1, col. 5. SENATE CREATES GROUP TO CHART SPACE PROGRAM. Ellender is lone dissenter in 78-1 vote—military-civilian control an issue; February 6, 1958, p. 1, col. 8. VANGUARD CRASH CAUSED BY FLAWS IN ENGINE SYSTEM. Defense Department says rocket broke because of defects in first stage. Navy to try again—2 more test vehicles due for firing before larger satellite is launched; February 6, 1958, p. 1, col. 7. SPACE UNIT STUDY BACKED IN SENATE; February 5, 1958, p. 1, col. 8. VANGUARD FIRED BUT FAILS AGAIN DESTROYED IN AIR. Navy's satellite carrier is launched but soon goes off prescribed course; February 4, 1958, p. 1, col. 7. PENTAGON TO SPUR SATELLITE

I. THE ATMOSPHERE

A. PHYSICAL DESCRIPTION

MAN lives at the bottom of a sea of air known as the atmosphere. This atmosphere performs the function of a thermostat in controlling

PLANS. Vast spending increase set—Army designs 2 space ships to scan earth; February 4, 1958, p. 1, col. 6. RADIOED DATA OF SATELLITE EASE FEAT OF SPACE TRIPS. Cosmic rays and meteoric dust found to be less than was expected—little danger to travel seen; February 3, 1958, p. 1, col. 8. JACKSON PREDICTS A MOON SHOT SOON. Senator says U. S. could be ready in a few months; February 3, 1958, p. 1, col. 7. U. S. ROCKET PLAN HAS BLUNT DESIGN. 50 foot craft is expected to exceed 4000 MPH—due to fly next year; February 3, 1958, p. 1, col. 7. TRACKERS REPORT SEEING A SATELLITE OVER NEW MEXICO. Signals continue. Maximum height now put at 1800 miles; February 2, 1958, p. 1, col. 7. SOVIET'S SCIENTISTS CONGRATULATE U. S. ON "GOOD NEWS" OF SATELLITE; February 2, 1958, p. 1, col. 7. ARMY'S EXPLORER CHEERS CONGRESS. "It's Wonderful" leaders of two houses agree—Johnson urges greater effort; February 2, 1958, p. 1, col. 5. U. S. SATELLITE IS "WORKING NICELY"; ARMY ORDERED TO LAUNCH ANOTHER ALSO PLANS RECONNAISSANCE "MOON". Data sent back. Explorer's top height 1700 miles—orbit takes 2 hours; February 1, 1958, p. 1, col. 7. SATELLITE TAKES 114 MINUTE ORBIT. Scientists estimate speed at 1800 miles an hour; February 1, 1958, p. 1, col. 1. ARMY LAUNCHES U. S. SATELLITE INTO ORBIT PRESIDENT PROMISES WORLD WILL GET DATA 30 POUND DEVICE IS HURLED 2,000 MILES. Jupiter-C is used. Roars up in Florida tense 15-3/4 seconds after it is completed. Success is attained. At his Georgia retreat Eisenhower gives news of ascent; January 28, 1958, p. 1, col. 4. ARMY TAKES OVER SATELLITE FIRING WITH JUPITER-C. Gets priority after defect in Navy's Vanguard is found to be serious; January 27, 1958, p. 1, col. 2. VANGUARD FIRING PUT OFF ENDING 4 DAY NAVY EFFORT; January 19, 1958, p. 1, col. 7. U. S. HAS 2 PLANS FOR SPACE PEACE; January 18, 1958, p. 1, col. 4. ATOM CLOCK IN SATELLITE PROPOSED TO TEST TIME-RELATIVITY THEORY; January 17, 1958, p. 1, col. 6. DEMOCRATS ASK ATOM USE TO WIN SPACE SUPREMACY; January 17, 1958, p. 1, col. 8. DULLES PROPOSES BOARD TO CONTROL OUTER SPACE USE. SAYS BULGANIN SHOULD JUMP AT CHANCE TO PROVE HIS PEACEFUL INTENTIONS. Washington—Secretary of State Dulles proposed today the formation of an international commission to insure the use of outer space exclusively for peaceful purposes; January 15, 1958, p. 1, col. 5. AIR FORCE PLANS SEEING SATELLITE BY SPRING OF 1959. Missile chief says vehicle has recoverable capsule; January 13, 1958, p. 1, col. 5. EISENHOWER BIDS SOVIET JOIN A BAN ON SPACE WAR AND LIMIT U. N. VETO ASKS STUDIES BEFORE SUMMIT TALK; January 11, 1958, p. 1, col. 7. ATLAS ICBM TEST AGAIN A SUCCESS. Missile fired over limited range—Navaho also shot at Cape Canaveral base; January 11, 1958, p. 1, col. 6. ARMY SOLID-FUEL MISSILE TO REPLACE THE REDSTONE; January 11, 1958, p. 1, col. 6. SPACE BOARD PLAN SCORED BY AIR FORCE MISSILE CHIEF. Sees a costly duplication in agency that Eisenhower praised; January 10, 1958, p. 1, col. 6. HIGHER MISSILE GOAL URGED BY JOHNSON; January 10, 1958, p. 1, col. 4. PRESIDENT ASKS MORE MISSILES FURTHER AID, PENTAGON UNITY BULGANIN RENEWS BID FOR TALK. Message is given. End of arms rivalry urged in 8-point listing of aims; January 8, 1958, p. 1, col. 7. JOHNSON BIDS U. S. GAIN SPACE RULE. IN REPORT TO DEMOCRATS HE PICTURES THE GRAVITY OF CHALLENGE BY SOVIET. Washington—Senator Johnson called today for a national policy dedicated to winning control of outer space; January 8, 1958, p. 1, col. 6. PRESIDENT ASKS 1.3 BILLION FOR MISSILES, AIR DEFENSE AS CONGRESS RECONVENES. New funds asked. Eisenhower request adds 683 million for missile work.

the earth's heat by protecting the earth from too much solar radiation during the day and by acting as an insulating blanket to keep most of the heat from escaping at night. It is also the earth's guard in preventing the majority of meteorites from reaching the earth and in screening out much of the ultraviolet and cosmic rays. Theoretically, the atmosphere is divided into four layers, the troposphere, stratosphere, ionosphere and exosphere.

The troposphere extends approximately 10 miles from the earth's surface. This region is composed of 78% nitrogen; 21% oxygen; 0.94% argon; 0.03% carbon dioxide; 0.01% hydrogen; 0.0012% neon; 0.0004% helium; minute traces of other gases, and varying amounts of water vapor. The greatest portion of the atmosphere's gases are contained in the troposphere and it has been estimated that eighty percent of the atmosphere's molecules are found in this layer.[2] The phenomena appearing in the troposphere are those relating to weather. This is where the clouds and weather occurrences such as rain, snow and winds appear. The air becomes more rarified above the troposphere, thus preventing water-carrying clouds from rising above this layer. A boundary known as the tropopause appears where the troposphere ends and the stratosphere begins. It is found at an average height of 5 miles above the earth near the poles and 11 miles above at the equator. The tropopause consists of overlapping, leaf-like structures at which jet streams form. A jet stream is a tubular ribbon of high-speed wind generally from the west about 300 miles wide and 4 miles high which is found at altitudes of between 20,000 and 40,000 feet. At its center, the strength of the jet stream may reach 250 miles per hour but it averages 100 miles per hour in winter and 50 miles per hour in summer. The jet stream is, of course, important for airplane travel, but it also significantly affects man's weather. Descriptions of its activity have stated that the jet stream: "Sometimes . . . contracts and wanders to the north, where it bottles up the cold air over the pole. The warm air of the equatorial latitudes expands to the north and the countries are flooded with warm air. At other times the jet stream wanders southward; then the arctic air can spread out, and the countries affected become cold. Occasionally the jet stream fluctuates violently, whole pools of polar air are torn away and drift over the countries as 'cold fronts'. The jet stream

[2] BATES, Composition and Structure of the Atmosphere, THE EARTH AND ITS ATMOSPHERE 97-102 (1957).

acts like an atmospheric egg beater which whirls the arctic air and sprays splashes of cold air toward the south."[3]

The stratosphere is the layer extending for 50 miles above the troposphere. The air here is thin and the visibility clear. This region of no weather and horizontal air movements has been found to be well suited for air travel.[4] Originally, it was believed that the atmosphere became colder as we ascended. This view has, however, proved to be inaccurate. Temperature in the stratosphere decreases steadily to —50°F. until a height of about 15 miles is reached. But at this altitude, there occurs a surprising rise in temperature and at 30 miles the temperature is about +170°F. A layer of ozone 15 miles deep is the significant phenomenon in the stratosphere responsible for this temperature fluctuation.[5] Normally, oxygen molecules in the air are composed of two atoms—O_2. Ozone is produced when the ultraviolet radiation of the sun combines the two oxygen atoms into three —O_3. It is this transformation which produces the heat present in stratosphere. The ozone layer is important because it acts as a protective filter in absorbing fatal ultraviolet light rays coming from the sun.[6]

The ionosphere is the region of the earth's atmosphere extending roughly 650 miles above the stratosphere. Though the air in the ionosphere is extremely thin (about 10 million times rarer than at sea level), it generates sufficient friction to destroy most of the meteors approaching the earth.[7] The temperature of —100°F. found in the lowest portion of the ionosphere rises steadily as our altitude increases. It is estimated that at 180 miles the temperature is above 1000°F., and that at higher levels the temperature exceeds 3000°F. The process in the ionosphere which accounts for these extremely high temperatures is that of ionization. The short waves of sunlight push electrons out of atoms in the air leaving positively charged particles known as ions. This activity produces the high temperature found in the ionosphere.[8]

Winds with velocities of 300 miles per hour are present in the ionosphere, causing the ions to move which in turn creates a circu-

[3] KAHN, DESIGN OF THE UNIVERSE 310-11 (1954).
[4] LEHR, WEATHER 44 (1957).
[5] See note 3, *supra* at 304-6; see note 2, *supra* at 110.
[6] Engel, *Mystery of the Air We Explore,* N. Y. Times, April 15, 1956, p. 62.
[7] See note 4, *supra* at 45; *id.* at 27.
[8] See note 3, *supra* at 306.

lating electric current, known as the "dynamo" current. This current affects the earth's magnetic field and the phenomenon of the "polar lights" is believed to be one of its results.[9] The ionosphere is of great use in reflecting radio wavelengths. The free electrons electrify the ionosphere and this layer acts as a mirror, sending the radio waves back to earth. Without the ionosphere, the waves would radiate into cosmic space. The ionosphere also presents a warning to attempts at flight beyond its limits. The process of ionization consumes the energy of the sun's short waves and allows sunlight to reach the earth without any short wavelengths. However, flights above the ionosphere will not have the benefit of this filtering operation and the short waves or the cosmic rays present above the ionosphere may prove to be a serious obstacle to cosmic flight.[10]

The exosphere is the highest layer of the atmosphere. The ions of gas are so fiercely bombarded in this layer that the average night temperature of —460°F. is thought to rise to 4500°F. during the day.[11] The gravitational effect of the earth becomes weak in this area and it is believed that the molecules of gases escape into empty space. Present conjectures place the end of the exosphere at approximately 20,000 miles.[12] Theoretically, at this point, free space is reached; atoms and molecules do not exist here and only an occasional dust particle or hydrogen atom from interplanetary space is to be found. It is the exosphere through which the energy phenomenon of cosmic radiation first passes. Cosmic radiation is the richest source of energy known to man, rendering insignificant even the energy derived from the sun. A German physicist, Albert Gockel, discovered that radiation grew stronger as man ascended the atmosphere and evolved the theory that radiation from cosmic space reaches the earth. This theory has been substantiated and it is now accepted that the earth is struck by a continuous rain of atomic particles. These particles move at three-quarters the speed of light and their energy content has been estimated to be equal to trillions of electron volts. Neither the sun, nor the hottest known stars could be responsible for this enormous amount of energy. Harmless, this cosmic radiation is the potential energy of the future. These particles have been de-

[9] RATCLIFFE, THE IONOSPHERE; THE EARTH AND ITS ATMOSPHERE 215-17 (Bates ed. 1957).

[10] See note 6, *supra; id.* at 204-222.

[11] See note 4, *supra* at 46.

[12] See note 6, *supra.*

scribed as follows: ". . . they can pass through a skyscraper and still have enough energy to penetrate a mine beneath the ground. A man sitting in his home can be pierced, too. In the time it has taken you to read this page, hundreds or even thousands of mesons and electrons have darted through your skull into your brain, down into your chest and blood and have finally left your body through the soles of your feet. The uninterrupted bombardment is, of course, harmless; otherwise you would not be sitting here reading. The whole evolution of life took place in the uninterrupted rain of cosmic radiation."[13]

B. Penetration of the Atmosphere

Since the time of Icarus, man has attempted to meet the challenge of space. Today, heights of over 1000 miles have been attained. The possibilities for scientific exploration are rich; those for attack, deadly.

Balloons

Balloons are flexible bags inflated with a gas lighter than air. When the weight of the balloon is less than that of the air it displaces, it rises into the atmosphere. Instrument carrying balloons operate by transmitting information by radio to a ground station, parachuting the instruments to the ground after a few hours and then allowing the balloon to rise until it bursts. Occupied balloons have reached a height of about 75,000 feet. Sounding balloons have risen to 143,000 feet—over 27 miles.[14]

Rockoons

These are combination balloon-rockets which attain a height of forty miles with the purpose of investigating solar flares, x-rays from the sun, cosmic rays, and short radio waves in the atmosphere. A balloon lifts the rocket to a height of 10 miles where the thinner air then allows the rocket to be projected to its investigation altitude.[15]

Rockets

In 1944 a German V-2 rocket rose to an altitude of 109 miles. In 1946, a V-2 launched from White Sands, New Mexico, soared to

[13] See note 3, *supra* at 95-6.

[14] See note 1, *supra* at 105; The Space Encyclopedia, 50 (1957); see note 6, *supra*.

[15] Ley, Satellites, Rockets and Outer Space 36-38 (1958).

114 miles. The V-2 program reached its climax when the WAC-Corporal achieved a height of 250 miles.[16]

During the past few years, smaller rockets bearing the names Nike-Deacon (DAN), Nike-Cajun, Terrapin, and HTV (Hypersonic Test Vehicle) have made the space news. All of these have diameters of less than one and a half feet, a length of about fifteen feet, are propelled by solid fuels, and are extremely valuable for carrying small instrument packages. As distinguished from the one-stage V-2 and Viking, these rockets operate in two solid-fuel stages, first a boosting, then the actual rocket flight. The DAN weighed 1540 pounds and was lifted to 4900 feet by the Nike booster. It reached a maximum velocity of over 5000 feet per second at 47,000 feet and rose to an altitude of 67 miles. The Terrapin reached 80 miles and the Nike-Cajun has exceeded an altitude of 100 miles. The Navy has added three new rockets, the HASP, Arcon and Iris to our exploration force. HASP carries a few pounds of instruments to a height of 20 miles. The Arcon, about 11 feet tall, has a diameter of half a foot and carries 40 pounds of instruments to a height of 70 miles. The Iris is expected to be 16 feet tall and will carry 100 pounds of instruments to a height of 200 miles. There is also a British rocket known as the Skylark which is 25 feet tall, 17 inches in diameter and is expected to climb to between 70 and 120 miles.[17]

Missiles

Seven Russian missiles are known to be in production. The Comet-1 and Comet-2 are solid-fuel missiles launched from submarines. Comet-1 is thought to have a range of 120 miles, Comet-2, a range of 500 miles. The T-1 or M-101, 50 feet long and 5½ feet in diameter, operates on a kerosene fuel and has a range of 400 miles. The T-4 or M-102 is the T-1 equipped with wings and may have a range of over 600 miles. The T-2 or M-103 is the Russian Intermediate Range Ballistic Missile operating as a two-stage liquid fuel missile, with a weight of 85 tons and a range of 1500 miles. The T-7A, a solid-fuel missile, is 25 feet long, 2½ feet in diameter and has a range of 60 miles. The Russian Intercontinental Ballistic Missile, the T-3 or M-104, will have an expected range of 5000 miles.[18]

The American missiles include anti-aircraft missiles, air-to-air

[16] See note 6, *supra*.
[17] See note 15, *supra* at 31-40; see note 2, *supra* at 106.
[18] See note 15, *supra* at 43-6.

missiles, air-to-ground missiles, ground-to-ground missiles, and long range ballistic missiles. The anti-aircraft missiles are fired from the ground or from shipboard against airplanes. Illustrations are the Nike-Ajax, a liquid fuel rocket, 20 feet in length with a 22 mile range; the Nike-Hercules with an effective range of 50 miles, the Nike-Zeus which is to be used against missiles, and the Navy Terrier with a 20 mile range.

The air-to-air missiles are fired by one airplane against another. The Falcon and Sidewinder "home in" on engine noise or exhaust heat. The Sparrow follows a radar beam. Among the air to ground missiles are the Dart, 6 feet long, with a 3 mile range, and the 35 foot Rascal with a 100 mile range. The ground to ground missiles are unmanned airplanes propelled by turbojet engines. Examples of this type of missile are the Matador, 46 feet long with a range of 600 miles, and the 74 foot Snark with a 5000 mile range.[19]

The long range ballistic missiles develop from the 45 foot Corporal with its 50 mile range, and the 69 foot tall, 6 foot in diameter Redstone with a 200 mile range, to the Intermediate Range Ballistic Missile (those with a range of about 1500 miles) such as the Thor, the Jupiter, and the Polaris, and finally to our Intercontinental Ballistic Missile, the Atlas.[20]

Artificial Satellites

The theoretical basis of the artificial satellite is that a closed orbit results when an object is lifted into the atmosphere and made

[19] See note 15, *supra* at 46-60.

[20] The Atlas was described in a June, 1958, news item as follows: ATLAS FIRED IN TEST. ICBM IN 8TH EXPERIMENTAL SHOT OVER SHORT RANGE. Cape Canaveral, Fla., June 3 (AP)—The Air Force's mighty Atlas intercontinental ballistic missile thundered aloft today on its eighth test journey into space. The Atlas, which packs this country's biggest ballistic punch, rose steadily from a huge cloud of swirling steam and orange flames at 4:28 P. M. It reportedly was another limited distance test of about 600 miles for the $2,000,000 missile. The Atlas was designed to attack a target 6,325 miles away, but it has yet to fly that intercontinental range. The Air Force announced that the test was part of a routine series being conducted in the Atlas ICBM development program. The purpose of the test was not announced, however. The seventy-five foot missile sparkled in the late afternoon sun as it struggled upward, its powerful booster rockets pouring out some 300,000 pounds of thrust. New York Times, June 4, 1958, p. 5, col. 3. The New York Times, August 3, 1958, p. 1, col. 6, carried the following story: ATLAS LAUNCHED SUCCESSFULLY; ICBM SOARS ON ALL 3 ENGINES. Cape Canaveral, Fla., Aug. 2—An Atlas intercontinental ballistic missile thundered toward space today. The three-engine 100-ton Atlas is the most potent weapon ever fired from here. . . . The propulsion system, which pours out more than 350,000 pounds of thrust, gives the Atlas enough push to travel the intercontinental range of 6,325 miles.

COMPARISON OF THE SIX U. S. AND SOVIET SATELLITES**

Following is a comparison of the three United States satellites and the three Soviet satellites, as announced by the respective Governments. In three cases—Explorers I and III and Sputnik II—the rocket casing of the final stage was attached to the satellite instrument package in orbit. Figures on the Explorers cover both the satellite and the attached rocket casing. Figures for Sputnik II cover only the top area that contained the dog Laika and instruments. Scientists here estimate, from studies of Sputnik II's resistance to air drag, that its combined weight, including the rocket casing, totaled about 7,000 pounds.

	Vanguard I	Explorer I	*Explorer III	Sputnik I	Sputnik II	Sputnik III
Weight	3.25 pounds	30.8 pounds	31 pounds	184 pounds	1,120-pound payload	2,925.53 pounds
Shape	Sphere	Bullet	Bullet	Sphere	Conical	Conical
Dimensions	6.4 inches in diameter	80 inches long; 6 inches in diameter	80 inches long; 6 inches in diameter	22.8 inches in diameter	19 feet long; 4 feet in diameter	11 feet 9 inches long; 5 feet 8 inches in diameter at base
Initial orbit time	134 minutes	114.5 minutes	115.7 minutes	96.2 minutes	103.7 minutes	106 minutes
Maximum altitude	2,466 miles	1,587 miles	1,741 miles	560 miles	1,056 miles	1,168 miles
Minimum altitude	405 miles	219 miles	117 miles	145 miles	150 miles	150 miles
Angle to equatorial plane	33-34 degrees	34 degrees	34 degrees	65 degrees	65 degrees	65 degrees
Date launched	March 17, 1958	Jan. 31, 1958	March 26, 1958	Oct. 4, 1957	Nov. 3, 1957	May 15, 1958
Payload	Batteries and radios	11 pounds of instruments	11 pounds of instruments	Batteries and radios	Dog and instruments	2,129 pounds of instruments
Lifetime	At least 200 years	Three to five years	Three months or more	3 months, then disintegrated	4½ months, then disintegrated	About 6 months

* Explorer II was launched on March 5, but failed to orbit.

** Explorer IV must be added to this chart. Weight.....38.43 pounds. Orbit time.....110 minutes. Maximum altitude.....1,386 miles. Minimum altitude..... 178 miles. Date launched.....July 26, 1958.

to move parallel to the ground at a speed of 16,560 miles per hour. The theory has proved to be a practical reality. The 1957 Alpha (Sputnik I), 185 pounds, 23 inches in diameter and spherical in shape, was placed in its orbit on October 4, 1957. At the closest distance in its orbit around the earth, it was 155 miles away and at its farthest, 560 miles. 1957 Alpha was a three-stage rocket requiring 96 minutes to complete one tour of its orbit. 1957 Beta (Sputnik II) weighed 1120 pounds, required 104 minutes to travel its orbit, was 150 miles from the earth at its nearest point and 1000 miles at its apogee. 1957 Beta carried a dog, Laika, which lived through 100 circuits, giving strong evidence that man could survive in a satellite orbiting the earth.

Four artificial satellites have been successfully launched during seven months of 1958. Explorer I was a four-stage affair, 220 miles away at its minimum altitude and 1600 miles from the earth at maximum altitude. On March 17, 1958, Vanguard I achieved its orbit of 400 miles when nearest the earth and 2500 miles at its most distant point. Explorer III, weighing 31 pounds and reaching a maximum altitude of 1750 miles followed nine days after Vanguard I. Then on May 15, 1958, Sputnik III, weighing 3000 pounds and attaining a height of 1200 miles, was successfully fired. And finally, on July 26, 1958, Explorer IV weighing 38.4 pounds and having an orbit of 178 miles from the earth at its closest point and 1368 miles at its farthest, was placed in orbit.[21]

Reaching the Moon

The rocket to the moon now has traveled the orbit of possibility and entered the realm of probability. The feat would be accomplished by lifting the rocket to a height of 250 miles by balloon or by a first stage rocket. Several other rockets would then cause the experimentation rocket to attain a velocity of about 7 miles per second. Allowing for the earth's gravitational pull, it has been estimated that this trip to the moon would take about four days.[22]

[21] The N. Y. Times on May 16, 1958, p 9, col. 3, contained the comparison of the artificial satellites (see page 340). Also see note 15, *supra* at 53-77; THE SPACE ENCYCLOPEDIA 1-3 (Supp. Nov. 1957).

[22] See note 15, *supra* at 83-85.

II. AN ATTEMPT AT PERSPECTIVE

THE attainments of science are indeed magnificent. It does not detract from these accomplishments to state that they are also infinitesimal. Indeed, perhaps the most lustrous characteristic of the rockets and satellites is the fact that they bring us to the surface of our groundhog tunnel, allow us to perceive the field in which our tunnel is placed and require us to form some conception of what lies beyond our heretofore complete and wondrously fresh little meadow.

The moon, man's next great advance in exploration, is 240,000 miles from the earth, and it is now thought that the trip will require 4 days of rocket travel. Though the step would be a major one, it represents only a movement to the next blade of grass. Distances become so vast, that it is necessary to introduce a measurement to replace our familiar unit of the mile. The speed of light, a universal constant, is the basis for this new system of measurement. Light travels at a speed of 186,000 miles per second and a light-second, a light-hour, or a light-year is the distance in space over which light travels in a given period of time.[23] Thus, a light-year would be equal to 5,880,000,000 miles and the distance to the moon according to this system would be 1.2 light-seconds. By our present methods of space travel 1 light-second is roughly equal to four days of travel and 1.5 light-minutes of distance would require one calendar year of continuous travel. The distances to the planets and the sun would be as follows: Venus (the planet nearest the earth) would be 2.3 light-minutes away, requiring a rocket flight lasting one and a half years; Mars, 4.4 light-minutes; Mercury, 5.1 light-minutes; the Sun, 8 light-minutes; Jupiter, 35.1 light-minutes; Saturn 1 light-hour and 11 light-minutes; Uranus, 2 light-hours and 32 light-minutes; Neptune, 4 light-hours and 3 light-minutes; and Pluto, 5 light-hours and 21 light-minutes away. Thus, we are somewhat isolated from even our relatively close neighbors. The planet nearest to us would be a year and a half away by our present means of rocket transportation and a visit to our most distant planetary neighbor would take 210 years to complete.

Though still in his own planetary system, man, the social being, must face the possibility that he may have living companions existing in space. Accepting the definition of life as "a biochemical oper-

[23] See note 3, *supra* at 39.

ation involving carbon and nitrogen and making use of water in the liquid state", it is unlikely that life exists on the comets, meteors and meteorites which enter our solar system.[24] This conclusion has been supported on the grounds that the masses of these objects are too small to hold an atmosphere, that the meteors out between the stars are too cold for liquid water, that the comets pass too near the sun and become too cold in the outer parts of their orbits for living organisms to exist and, finally, that these objects are not sufficiently protected against the lethal ultraviolet radiation emanating from hot stars.[25] The moon must also be eliminated as a possible source of life, since it lacks an atmosphere and cannot maintain the oxygen and carbon dioxide necessary for organisms. The planets in our solar system, however, offer more hopeful possibilities. Of the other planets in our solar system, it is thought possible, by eminent scientists, that Mars and Venus are capable of supporting life. The other planets are unlikely sources of life because among the prerequisites for any form of life would be an orbit of low eccentricity so that the planet does not have too great a temperature variation; a position not too close to the sun but also one not so remote as to result in uninterrupted cold; a non-poisonous atmosphere (but here we are assuming that our susceptibilities to poisonous gases would be shared by our companion in space); and also an atmosphere with the ability to hold oxygen (again assuming that oxygen would be as necessary for our neighbor as it is for us).[26]

Having crossed our own field, we see the rest of a countryside, we perceive other hills and valleys and reasonably suppose that even more of these mountains, trees and valleys exist beyond our actual perception. Since the outermost limits of our own solar system would require a sustained rocket flight of more than 200 years, we must assume that for this next portion of our journey, either the present means of travel become more effective once beyond the moon or that some new force of locomotion is developed. Our sun, the center of this solar system in which the earth is one of nine planets, is known to be a very ordinary sort of star. The stellar system of which the sun is a member is called the galaxy and in terms of distance, it is 100,000 light-years in diameter.[27] Our measure of present rocket

[24] SHAPLEY, OF STARS AND MEN 55 (1958).
[25] *Id.* at 57.
[26] *Id.* at 55, 58.
[27] LYTTLETON, THE MODERN UNIVERSE 144 (1956).

flight as one year's flight per light-minute and a half means that, if man devised a means of travel with 350,000 times the velocity of our present rocket, it would take 100,000 years to cross our galaxy. The furthest planet in our own solar system is about 5 light-hours away. The nearest star in the galaxy, Alpha Centauri, is more than 4 light-years away, and the furthest stars are eighty-eight thousand light years from the earth. Our sun is inconspicuous as one of one hundred thousand million stars (100,000,000,000) in this galaxy.[28]

But the sun's galaxy is only our particular countryside. It is one minute portion of the presently known universe. This universe, even in the present state of our knowledge, has yet a further known limit. The galaxy in which the sun is one of thousands of millions of stars is itself one galaxy among thousands, perhaps millions of similar galaxies in the Meta-galaxy. In terms of distance and time, if man had been traveling in a rocket for the entire time which has passed since the geologic birth of the earth, he would have traveled only one-seventh of the distance across our own galaxy!

There is a possibility that, in our own solar system, Mars and Venus are capable of supporting life. Once we take the step of declaring that the sun is one of billions of typical stars, the statement that there are then billions of possible planetary systems becomes a reasonable corollary. The contracting-nebula theory of the origin of stars is that stars are formed from the condensation of cold clouds of gas and dust and that planets result as a by-product of this process. This theory leads to the conclusion that planets similar in mass, temperature and chemistry to those with which we are familiar are produced naturally by the evolving universe.[29] The conclusion that other planets exist is equally plausible under the Chaos Theory of the origin of stars which postulates the occurrence of a catastrophic collision whose debris became the stars and planets.[30] The significant factors arguing for the existence of other living things in the cosmos are the evidence that the kind of chemistry and physics which we know on earth exists throughout the universe; the fact that our sun, an ordinary star, has created or sustained the creation of life on this planet; and the fact that each of the one hundred thousand million billion stars (100,000,000,000,000,000,000) now computed to exist in our

[28] See note 24, *supra* at 71; *id.* at 144.
[29] *Id.* at 65-69.
[30] See note 3, *supra* at 167-171; *id.* at 61-65.

universe is theoretically equally capable of supporting life. It has been estimated that one out of every fifty stars has a planetary system. Conservatively decreasing this possibility to one in a thousand, Howard Shapley assumed that only one of every thousand of these planetary systems is at the correct distance to provide the water and warmth required for protoplasm. (Two or three of the planets in our solar system would satisfy this requirement.) Then assuming that but one of every thousand of these has an atmosphere (seven of the planets in our solar system have) and that of these one in a thousand would possess the chemical composition of air and water suitable for developing inorganic molecules into the organic, we arrive at the conservative, minimum estimate that there are one hundred million planetary systems capable of sustaining organic life.[31]

Coming down to earth again, we face several problems of immediate and practical importance. A resolution of the legal issues of ownership of the air space, the right to travel through its different layers, the permitted extent of scientific exploration, and the bounds of travel through space for chameleon-like scientific-military purposes are vital to our continued existence. Yet, speculation concerning the extent of the universe and the possibilities of other life is not impractical theorizing. It is suggested that the most effective force for the peaceful solution of these problems of the ownership and use of air space may well be the realization of our true position in the universe. Man is not the center of this solar system, nor is his world more than one of billions of other worlds, each with its own life-sustaining planets. If men continue to find the positive force of peaceful growth together an insufficient reason for cooperation, perhaps the sharing of a common position as inhabitants of one planet faced with the distinct possibility that unknown forms of life exist on other planets may prove to be a more cohesive material with which to build a future.

[31] See note 24, *supra* at 72-75.