SPATIOGRAPHY

(Astronautical Aspect)

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Never before in its history has the imagination of mankind been captivated so much by the concept of space as today, following the rapid progress in Rocketry. It is used in a great variety of versions such as near space, outer space, deep space, free space, interplanetary space, cosmic space, blue yonder, and so on. But space is an immensely vast area even within our solar system. From the standpoint of astronautics and especially of Space Medicine or bioastronautics, we need a specification of just what is meant by these terms topographically and environmentally.

Just as the traveler on the earth's surface uses the science of geography for his orientation concerning distance, climate, etc. to be encountered on his journey, so does the astronaut need a topographical and environmental description of space, a kind of spatiography for orientation, navigation, the designation of the various kinds of space operations, and the estimation of the medical problems involved. At first glance, it may seem strange to draw borderlines or demarcation lines for subdividing an environment distinguished by emptiness; there are, however, several possibilities.

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First, the question arises "Where does Space begin?" This is the title of a paper published by the writer with H. Haber, K. Buettner, and F. Haber in 1951, in which the concept of the functional borders between atmosphere and space was introduced. In this publication, it was shown that the various atmospheric functions for manned flight come to an end at various altitudes, some even within the lower regions of the stratosphere. The final functional limit of the atmosphere is found at a height of 120 ro 140 miles, where the atmosphere aerodynamically terminates though it continues as a material medium up to 600 miles. Expressed in another way, the atmosphere begins to become partially space equivalent at about 10 miles and progresses to total space equicalence at about 120 to 140 miles, as far as the atmospheric functions are concerned. There the laws of aerodynamics lose their meaning (except for objects of enormous velocity) and those of astrodynamics become fully effective. This is the dividing line between space equivalent flight and true space operations, or between the aerodynamically effective air space and free space. Such is the picture concerning the border between atmosphere and space as seen from the standpoint of Space Medicine.

Now, what are the possibilities of subdividing, for astronautical purposes, the regions beyond this border: - the vast extra-atmospheric void of our solar system?

First, we can use as demarcation lines the orbital distances of the moon and the planets. Then we speak of cislunar space, translunar space, cismartian, and transmartian space, etc., as Frafft Ehricke has suggested.(Cislunar - on this side; Translunar beyond)

Of special interest from the standpoint of navigation is the gravitational situation in Space. The gravitational field of the Earth, as of every other body, extends of course to infinity. But for the astronaut, the sphere of predominant gravitational attraction is of most importance. It might be practical to call these gravitational control zones, briefly, gravispheres. The gravisphere of the Earth extends to about 1 million miles. This is the arena in which satellites are conceivable. Escape velocity thrusts a vehicle eventually out of the Earth's gravisphere into the gravitational control zones of other celestial bodies. Thus we arrive at an astronautical subdivision of space based on the extension of the gravitational territories of the various celestial bodies.

Of practical and vital importance to the astronaut are differences in the environmental conditions of space itself. To begin with, the space environment in the vicinity of celestial bodies is different from that in free interplanetary space. It shows some peculiarities caused by the mere presence of their solid bodies, by optical properties of their surfaces and by forces originating in these boides and extending into space.

In the vicinity of the earth for instance, on one side we are protected by the solid body of our globe itself from cosmic rays and meteorites just as we are protected in the lee of a house against rain, hail or wind. Other peculiarities of the space environment in the vicinity of the earth are the shadow of the earth and the earth's own and reflected radiation, which pose special visual problems and influence the heat balance of a space vehicle.

The forces which cause special regional environmental differences in the space near the earth are those of the geomagnetic field. The magnetic field of the earth strongly influences the influx of corpuscular rays of solar and cosmic origin by channeling them into the polar regions. The density distribution of these ray particles in adjacent space in fact shows considerable variations with the earth's latitudes.

For all these reasons, the space in the vicinity of the earth is somewhat different from open interplanetary space. To emphasize these differences, Krafft Ehricke has introduced the concept of the "terrestrial space" and assumes for it an extension of 1 earth radius or 4,000 miles where they dominate the picture. "Circumterrestrial space" might be another suitable designation. For this region within which the earth's influence upon the ecological qualities of space is distinctly recognizable, it might be advisable to use the term "near space", and for the region beyond, the term "deep space" or "outer space".

But this outer space again shows environmental differences in the various parts of our solar system. These are based on variations in the intensity of solar radiation as a function of the distance from the sun.

A vehicle in the neighborhood of Venus receives about fifty times as much heat per unit of surface area each minute as a vehicle in the area of Jupiter. This is an important factor in the climate control wtthin the space cabin. A vehicle fitted for a trip to Venus is not equipped for an excursion to Jupiter, just as an expedition outfitted to hunt alligators in the jungles of the Amazon could not be sent to hunt Polar bears in the Arctic. Any vehicle entering the mercurian space would finally run into a kind of solar heat barrier.

With respect to visible radiation, or light the sky in space is dark everywhere. However, the illumination received from the sun varies considerably. In the orbit of Mercury it amounts to almost 80,000 foot candles while at the remote distance of Pluto, it is only 8 foot candles.

Finally, the ultraviolet range of solar radiation, which is chemically very active, has strongly influenced environmental conditions on the planets. This is shown by the division of their atmospheres into an inner oxygen belt, and an outer hydrogen belt. The first includes Venus, the Earth, and Mars. The second comprises the planets from Jupiter to Pluto. Spatiographic Ecology then, covers two areas; The ecology of space itself, and the ecology of the planets, or planetary ecology.

For manned space operations there seems to be, at least for the time being and in the near future, a limited area in the solar system with regard to the ecological condistions of space itself and the planets, a kind of ecosphere as a function of the distance from the sun and the resulting radiation intensities. This sphere includes the region from Venus to Mars.

We get a dramatic impression of the radiation intensiveness of the sun in both respects by comparing the size of the sun as seen from the various planets. For instance, from the distance of Pluto the sun would not appear larger than the Evening Star, Venus, appears to us on earth.

For hundreds of years, astronomers have been mapping the stars, measuring their distances, and defining their motions. The astronomer performs these magical feats from afar while he sits behind ~~th~~ his telescope in a well-tempered observatory, surrounded by the fresh air of Texas or the California mountains. By contrast, the astronaut leaves the life-supporting air of our planet terra and ventures far into space itself in his little terrella. He has to know where he is going, into what physical environment. He needs indeed as guidance a "geography of space," or Spatiography, based essentiall on ecological considerations concerning space itself and the planets.

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