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QUESTIONS OF SPACE TRAVEL

by Eugen Saenger

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Space travel research will cover nearly all fields of human knowledge, even more so than aeronautical research.

1. Problems of the history of the idea of space travel, of the philospphical background, of the sociological, political, and economic prerequisites and effects, linguistic problems such as new terms, definitions, universal language, standardization of language, etc., problems of artistic and literary effects and, questions of space rights, even of the religious aspects will appear in the fields of the purely intellectual sciences.

We must also consider the careful analysis of the probable or actual effects of space travel on humanity as part of space travel research. This analysis extends to all the above fields of the intellectual sciences, the arts, economics, politics, religion, etc., and in addition to the natural sciences, medicine, and technology.

2. In the field of the general natural sciences it is obvious that many methods of pure and applied mathematics, our knowledge of astronomy, astrophysics, and meteorology must be expanded. We are confronted by new problems of biology, medicine, and psychology. The most prominent of these problems is the behavior of the human mind and body when not under the pull of gravity, when exposed to cosmic rays, under artificial or non-terrestrial living conditions in the loneliness of outer space. However, the physical and psychological effects of contact with other worlds on humanity as a whole must also be considered. Likewise, many probelms of geography, geology, and geophysics will acquire new aspects.

3. At present the problems of basic research on space travel are concentrated mostly in the field of physics. In this connection, we are immediately concerned even with the basic concepts of space and time, mass and energy, gravitation and electricity, matter and

waves. Relativistic, quantum and statistical mechanics become directly applied from physics, while a continuous thread of great interest moves through the fields of photonics, electronics, nuclear physics, atomic physics, and chemical physics through thermodynamics and gas kinetics to physics of flow and physics of solid bodies. The boundaries between these individual fields are indistinct.

The questions of equivalences of space and time, and of mass and energy are central problems also of basic space travel research. Another central problem is the physics of the flow of media which are not only compressible but whose particles have a finite free path length, which may facilitate chemical reaction, which have relaxations in the position of their equilibria, which are composed of variable mixtures of photons, elementary particles atoms, molecules, radicals, or even dust particles, and whose particles can move at a speed comparable to the speed of light, etc. Of just as much importance are the problems of the boundary surfaces between such "gaseous" and solid bodies, from simple heat transfer to cathode disintegration to optical reflection and adsorption.

4. The research problems become more concrete in the fields of chemistry, where the investigation of structural materials and fuels takes first place. The question of chemical fuels must still be solved in regard to the well-known requirements for highest useful energy concentration per mass and tank volume, for high quality and good storage properties; there are the questions of atomic fuels with a controllable rate of reaction, of inert ballast materials, igniters, coolants, structural materials, radiation protectors and auxiliary materials for the propulsion plants, of the structural materials for jet engines, rockets, rocket aircraft, space stations, space ships, and extra-terrestrial ground installations.

5. The technological problems of shaping and connecting the materials, some of which are of recent origin, under the new conditions of outer space or other heavenly bodies, lead us into the field of engineering.

6. When we turn to the fields of engineering proper, e.g. the field of jet engines, the number of problems of applied research becomes immense. Sytematics and general theory of jet engines, their numerical data for evaluation, general principles of design, design

[Note: "Strahltriebwerk" = jet engine, but the author seems to use it to denote reaction motors in general.]

of the parts of the engine, such as combustion chambers, jet nozzles, diffusers, injection devices, fire walls, cooling devices, pumps and pump drives, control devices, starters, ignition installations, fuel tanks, measuring equipment, etc. are just a few terms which illustrate far-reaching problems which will be entirely different, depending on whether the engine is to provide thrust by air, fire, atoms, electrons, or photons.

7. The reaction craft lead us into a composite field of machine construction and structural engineering. The problems here are mostly those of type, performance, configuration, design, statics, stability, manufacture, accessories and equipment of reaction craft. These problems differ widely, depending on whether the craft is to operate in the atmosphere or in space, or whether it is to be an extra-terrestrial station, an interplanetary or an interstellar space ship.

8. Ballistics of reaction craft really represents a field of applied physics, but within the field of space travel research it occupies a special position, because it has direct technical importance. It includes the analysis of the start process, the paths within the atmosphere, the atmosphere - space paths, the interplanetary and interstellar space paths, and landing processes of reaction craft, the processes and equipment used to keep the craft on their paths, thus entire field of navigation and communications. The research problems here will thus coincide partially with those of theoretical and experimental astronomy, partially with those of aeronautics, and especially with those of applied electronics.

9. We also conder the problems of all ground installations connected with space travel as part of space travel research. These problems include those of the already existing organizations which are concerned with the theoretical aspects, research institutes, the development and manufacturing plants, airports, air safety and fuel supply installations of the future, extraterrestrial ground installations and the entire organizational network of space travel to be set up in the future. This will therefore include such technical problems as those of supersonic catapults, of the astronautical federation, and the construction problems of the first human settlements on the moon, and also the equipment

According to this more than summary enumeration of the range of problems of space travel research, nearly all natural science research, especially all theoretical physics, aeronautical, atomic, and astronomic research, is to some extent space travel research, and it seems almost presumptuous to try to reserve certain basic fields for a specific space travel research institute. These institutes will thus naturally be forced into the more technical problems of space travel.

A second and quite considerable restriction stems from the fact that at the present time most of aeronautical and atomic research, and especially reaction propulsion research, is handled by national defense authorities, which of course prohibit international exchange of information. Space travel research will therefore have to concentrate mainly on those technical problems which due to the size of the required funds cannot be handled on a national basis and which thus do not fall within the immediate concern of the national governments, or they must concentrate on those problems which have no military significance.

A third restriction is due to the circumstance that the means and capabilities at the disposal of space travel research in the near future will be quite limited. Extensive experimental or structural research will therefore hardly be feasible. Nevertheless, this third restriction, in conjunction with the two others, by no means indicates that all initiative should be renounced, if one considers the scale of costs of basic research, applied research, development, and manufacture, in that order. At any rate, the present-day conditions do allow the realization of independent and international space travel research in the intermediate fields of basic and applied research.

In the light of these general considerations, it seems that the actual research program will mostly be determined by the individual characters of the researchers available. Therefore, the suggestions listed below for a specific research program to be carried out by an International Astronautical Research Institute bears only the imprint of the author:

1. The chief problem of space travel is the achieving of higher exhaust velocities of rocket motors than have been realized up to now. This task can be divided into two partial problems, viz. the achieving of higher enthalpy in the combustion gas masses (either through chemical boundary reactions, such as the fluorine - hydrogen reaction, or through independent

heating of suitable inert masses) and the protecting of the walls in contact with the fire from the higher fire temperatures due to increased enthalpy, in other words, the physical boundary surface problem. Both partial problems seem capable of being dealt with successfully both theoretically and in regard to the equipment of physical and chemical laboratories. These problems are so extensive that they could by themselves permanently take up the full capacity of a small special institute.

2. Intensive research on the ballistics of the feeder rockets for extraterrestrial stations and of the stations themselves are an indispensable basis of all further technical work on space travel. This work can be carried out successfully by a small work group on mathematics, aided by a calculating bureau and the modern means of practical mathematics.

In addition to these two basic tasks of an International Astronautical Research Institute, further fields could be opened up only depending on the results of this basic research, the financial means available and the research personalities who could be interested in work in the special fields.