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WAYS TO SPACEFLIGHT

By Hermann Oberth

Translation of "Wege zur Raumschiffahrt,"  
R. Oldenbourg Verlag, Munich-Berlin, 1929

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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physical research has still to be done and enormous technical difficulties will have to be overcome.

#### 4. The Remaining Bodies of our Solar System

These cannot be reached with rocket space-ships.

Mercury, for example, is too close to the sun and here a difference in potential would have to be overcome of which the rocket space-ship is no longer capable. For example, the total ideal propulsion for a landing would be  $v_x = 39$  km / sec, for orbiting  $v_x = 3^{\circ}$  km / sec. That would result in a minimum mass ratio of  $\frac{m_0}{m_1} > 13,200$ , a completely indiscussible figure. It would be possible to reach Mercury by electric space-ship, but the question is whether one could land. Since it always turns the same side to the sun and has no atmosphere, the areas illuminated by the sun must have a temperature below 0, and it is more than questionable whether we can cope with such extreme temperature differences with our present-day technical means. Besides, we would presumably find nothing else on Mercury than on the moon.

The comets occasionally come very close to the earth, but in this case they have so high a velocity with reference to the earth that landing with rearward thrust deceleration is out of the question. (Whether the atmosphere of comets is suitable for braking purposes we do not know, but it is unlikely.) They can be reached by electric space-ship, but nothing can be said about the purpose of the flight since too little is known about them.

Finally, Jupiter and its moons can be reached by electric space-ship. To begin with, Jupiter itself is eliminated as goal of a visit because it is surrounded by a very dense atmosphere of at least  $400^{\circ}\text{C}$ . We can say nothing about the moons of Jupiter since they are not sufficiently known. The three outer planets (Saturn, Uranus, Neptune) and their moons cannot be reached even with the electric space-ship, since the best machines cannot work so far from the sun.