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EVALUATION OF A LARGE RADIO-TELESCOPE ARRAY ON THE LUNAR FARSIDE; Roy Basler, George Johnson, and Richard Vondrak, Radio Physics Laboratory, Stanford Research Institute, Menlo Park, California 94025.

The construction of a large radio telescope system has been proposed as part of a program to search for microwave signals being emitted by extraterrestrial civilizations. The design of one such earth-based system has been described in detail and is generally referred to as Project Cyclops. The Cyclops design is based on an incremental approach, starting with a single dish 100 m in diameter, and adding additional dishes only after a search with the existing system has proved unsuccessful. If no signals are detected with initial searches, it may eventually prove necessary to build receiving systems extending up to kilometer dimensions.

At the present time we are making an independent evaluation of alternative antenna design concepts to determine the most promising approach that could be followed in developing an interstellar communication system. In particular, we expect to establish whether the antenna system should be built on earth, in space, or on the moon.

The primary attraction of the moon as the site for a large radio telescope array is the fact that the far side of the moon is completely free from radio frequency interference from transmitters, either on the earth or in orbit around the earth. Secondary benefits are derived from the absence of a substantial lunar atmosphere and from the relatively weak gravitational force on the moon. A serious disadvantage of a lunar site is the high cost for transportation, construction, and operation.

Two basic types of radio telescopes have been considered: free-standing parabolic dishes (similar to the 100 m Bonn antenna) and spherical dishes constructed within lunar craters (similar to the 305-m Arecibo antenna). The abundance of lunar craters of all sizes makes possible a significant improvement in the design of a lunar Arecibo-type system compared to an earth-based system of this same type. A major cost of the actual Arecibo antenna is in the tall towers that support the feed. On the moon it would be possible to reduce the cost of the antennas substantially by only partially filling a lunar crater with the reflector surface and by suspending both the feed and the dish on long cables extending from the crater rim.

The ideal location would be a flat surface near the farside equator, such as mare surface or the flat floor of a large crater. Examination of available topographic maps indicate the availability of acceptable sites within the crater Mendeleev, and it is expected that other additional acceptable locations could be easily found.

In addition to evaluating the required size and preferred design of such a system, our study includes a cost estimate for both the antennas and the lunar colony to house the construction and maintenance workers. The analysis has identified several key items that determine the overall cost and that are relevant to an evaluation of any large-scale operation on the lunar surface. In estimating values for these items we assumed that the antenna systems and colony would be constructed with advanced technology in a time period of 1990 or later. Some of the key cost parameters are:

1. Utilization of lunar resources. Appropriate processing equipment would be brought from earth and would process each year lunar metals equal to seven times its own mass.

2. Basic earth-moon transportation cost. We assume high level of space activity with material transport costs of $264/kg in 1975$. We also assume that the round trip cost for each person is $264,000.

3. Productivity of lunar workers. Each construction worker would process lunar materials and fabricate two tons of general equipment per year. Antenna structures for the Arecibo-type antennas would be fabricated at one-sixth that rate.

4. Degree of independence of lunar colony. A 200-man colony module would be shipped from earth and additional colony structures would be processed from lunar material. We assume that resupply is required for the first five years, but after this we assume the colony is self-sufficient. We also assume that the standard tour of duty on the moon is ten years.

5. Ratio of support staff to working staff on the lunar surface. By analogy with current Antarctic operations, we assume the support staff would be equal to the number of workers. Further, we assume that three-quarters of the total support staff would be on the moon and the remainder on earth.

Costs were computed for antenna systems of various sizes. In addition, in our parametric analysis we determined the sensitivity of the total cost to variations in several of the key cost items. All the lunar systems are more expensive than their terrestrial counterparts, and generally by a factor of two. However, if the cost of the lunar colony is not included, the overall cost of an Arecibo-type array on the moon is comparable to that of a Cyclops-type array on earth.

DISCUSSION (Basler et al Paper)

SPEAKER 1: Were you assuming that this array would be used solely for searching for civilizations, or would you have it being used for other functions as well, on a simultaneous or a part-time basis?

VONDRAK: Yes, that again was a free parameter that we used in our analysis. Radioastronomy would be something that would benefit, quite obviously. We allowed between 10 and 50 percent of the time for radioastronomy use. This system would represent about a two-order or three-order magnitude increase in sensitivity compared to radioastronomy devices that we have now. Also, for the Earth-based systems, we suggested that you might be able to use the antennas for solar energy collectors during the daytime and search at night, and then you'd pay back some of your initial investment. That proves to be promising.

SPEAKER 2: I wonder if you could comment on the sensitivity of your conclusions to the assumed search strategy. You appear to favor an Ozma-type strategy of searching the stars which are nearby one by one. What about the alternative of searching entire galaxies, having an entire galaxy fit within your beam and looking for particularly powerful individual transmitters?

VONDRAK: Yes, well, the Cyclops search strategy is something that we were not asked to consider. We were concerned just with an engineering analysis for a system where the strategy had been specified. And since I wanted today to discuss primarily some points that I think are applicable for construction on the Moon, Cyclops search-strategy decisions are probably best discussed elsewhere.

SPEAKER 3: You need the location on the farside of the Moon for the radio purposes. But isn't it true that other uses of a lunar base would be better on the nearside?

VONDRAK: I guess you mean for the transport linear accelerator?

SPEAKER 3: It would seem to me, for communications reasons, that the nearside would be the obvious place to establish the first lunar base.

VONDRAK: Well, the location of the first lunar base is a separate decision. The farside base would communicate to the Earth by having a relay satellite at the L-2 point, and then it would communicate back to a satellite in geosynchronous orbit so that we would have a continuous communications link from the Earth to the farside.