Letters

Orbital Lifetime of the West Ford Dipoles

On 12 May 1963, the first radar returns were received from orbiting West Ford dipoles. The orbital elements of these copper radio reflectors, appropriate for the ascending nodal crossing at 16.002 GMT on that day, were T_Ω (nodal period of the satellite) = 166.5 min; e (eccentricity) = 0.004; i (inclination) = 87.4°; Ω (right ascension of ascending node) = 229.8°; ω (argument of perigee) = 67.8°. The total number of dipoles in the ensemble is about 4×10^8 with each member approximately 1.8×10^{-8} cm in diameter and 1.77 cm in length.

Recent radar measurements indicate that the cloud is lengthening at approximately the planned rate of 1800 km per day, with a consequent decrease in density. The possibility of detecting the dipoles optically is greatest in the early stages of the formation of the belt; accordingly, within a few hours after radar contact had first been established, the necessary orbital information was provided to a representative of the Space Science Board of the U.S. National Academy of Sciences for further dissemination to the West Ford Committee of the International Astronomical Union and to all interested astronomers.

Before the command was given to eject these radio reflectors from the parent satellite, orbital parameters were carefully determined from many observations. Extensive numerical computations were then performed to insure that not a single individual dipole would remain in orbit longer than 5 years. The lifetime calculations were made on a high-speed digital computer with an orbital prediction method described previously (*1*, *2*). The physical perturbations included in our computations were: the second through the fifth zonal harmonic of the earth's gravitational field; the lunar and solar gravitational fields; direct sunlight pressure; earth-reflected sunlight pressure; and atmospheric drag (both neutral and charge).

It was necessary to make many calculations, covering a wide range of possibilities, since the dipoles' reflecting properties are difficult to measure precisely, their axes of tumble are randomly distributed, and the perturbations of their orbits produced by some small forces such as charge drag (*3*) are not known accurately. Thus, extreme models of charge drag were considered in which the magnitude was (i) independent of altitude but varied (in separate computations) from zero to infinity, (ii) dependent on altitude, and (iii) dependent on whether the satellite was in sunshine or was passing through the earth's shadow. Calculations were also performed for a wide distribution of tumbling axes of the dipoles whose reflecting properties were allowed to vary from complete absorption to complete reflection. Different models of the neutral atmosphere were used encompassing a range from an everywhere-zero density to densities corresponding to the peak of the last solar cycle. The sensitivities of all these results to small changes in the initial conditions were also investigated. In not a single instance did the orbital lifetime exceed 5.5 years and for presently anticipated physical conditions it was less than 3 years.

This lifetime prediction for the actual West Ford orbit is considerably lower than the average 7-year lifetime predicted earlier for dipoles in a hypothetical orbit (*1*). The contributions to this decrease are about equally divided between the effects of the smaller diameter of the wire and those of the differences in the initial orbits.

H. M. Jones
C. W. Perkins
I. I. Shapiro
Lincoln Laboratory, Massachusetts Institute of Technology, Lexington 73*

References

1. I. I. Shapiro and H. M. Jones, *Science* **134**, 973 (1961).
2. I. I. Shapiro, in *Dynamics of Satellites*, M. Roy, Ed. (Springer-Verlag, West Berlin, 1963), p. 257.
3. I. I. Shapiro, I. Maron, L. J. Kraft, *J. Geophys. Res.* **68**, 1845 (1963).

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Manned Lunar Landing Defended

If we are willing to put an enormous effort into a gigantic engineering and development program, we can land men on the moon a few years from now. This is a challenge to the nation, a challenge which President Kennedy has accepted. It is a great adventure which fires the hearts of men. Shall we pass it up and settle comfortably behind our television screens or shall we sweat, struggle, and deprive ourselves of some comforts to accomplish this mission? If weakly we pull back now won't irreparable damage be done to the spirit of the nation?

This is a game we can well afford to play with the U.S.S.R. The loser can magnanimously congratulate the winner. In the other game with nuclear war heads there is no winner. Our economy is larger and more viable than Russia's. The smaller economy of the Soviets can only play by subtracting what they put into it from what otherwise would have gone largely into a military budget.

Landing a man on the moon is a simple and specific goal towards which our space program can be directed. It is an inspiring goal easily understood by the man in the street. It is, however, primarily an engineering, technological, and biomedical project, not a basic scientific effort. Consequently it does not have the enthusiastic support of many scientists. Nevertheless, it is a necessary developmental project for the scientific effort to follow.

Wouldn't we be much better off if we abandoned manned landing and put all our effort and funds into measurements by electronic instruments? The first fallacy in this argument is that funds are not transferable in this manner. Remove the goal which appeals to the public and the appropriations go with it. But the more important fallacy is that instruments can ultimately replace the man. Instruments are quite satisfactory for measuring many of the gross properties of the moon. The man can look around and at a glance pick the significant item or anomaly from among the tens of thousands of items which might be examined. When this point is reached the man becomes vastly more efficient than the instrument because he can discriminate, find, and interpret the unexpected.

There is no important military use for space at the present time, but we cannot afford to let others develop the capability of exploiting space without

grave risk unless we also develop that capability against the unforeseen needs of the future. The insurance provided by planned expenditures on the space program is warranted for this reason if for none other.

Great technological advances commonly have been a by-product of wars since the Industrial Revolution. An almost equal motivation can be supplied by the space program without the disastrous effects of combat. A major breakthrough is just over the horizon in communications. This should have profound effects on our economy as well as on the economies of other nations far enough advanced to take advantage of it. How great will the effect of forcing miniaturization of electronics be on our society? What almost certain advances will come from improved meterological services and their effect on agriculture? What advances can be expected in medicine from the study of physiological effects on man of the space environment?

Our humiliation and the threat to our national prestige and posture which the first sputnik provided resulted in a vigorous rejuvenation of secondary education in the United States. This program is just gathering momentum. Shall we now relax and let this program slump back just as it is about to blossom? What is to hold it up if we don't go all out for the goal we have set?

The spirit of a nation is of supreme importance. The goal has been set. Let us get on with it.

H. H. HESS

Department of Geology,
Princeton University, New Jersey

Channel 37

Having read your comments on the Channel 37 controversy [*Science* **140**, 164 (12 Apr. 1963)] I am unable to make up my mind whether you favor science or amusement and advertising. I therefore enclose three documents which present the radio astronomers' point of view because I assume that your comments were intended to present that of the television interests.

I have been in the forefront of this controversy since May 1960 because at that time the University of Illinois took the lead in petitioning the Federal Communications Commission for the allocation of the 608- to 614-megacycle band to the radio astronomy service.

Your suggestion that the American public prefers the late show to science is unfair. I have seen little evidence of such an attitude, as is pointed out in the enclosed document "Draft Comments on FCC Docket 15022". The citizens of Paterson, N.J., will continue to have a multiple choice of late shows and other forms of television entertainment even if the proposed new station, broadcasting on Channel 37, is not set up. I feel that the public is well aware that scientific results can be of immense importance—even if they are obtained by one man, or by a few men only. The case of Einstein illustrates this point.

Your sentence saying that the question is one of "upholding the interests of a few score radio astronomers at the expense" of the public entirely misrepresents the case. There are 70 UHF television channels, which were assigned to this service in the days when radio astronomy was in its infancy. The question now is: Will the public interest be damaged by the reduction in the number of channels to 69, so that a branch of space science can be prosecuted? I feel sure that, if you would look into the problem, you would find the answer to the question to be "No."

G. C. MCVITTIE

University of Illinois
Observatory, Urbana

The purpose of the comment was not to promote the interests of radio astronomy or television; it was simply to illuminate the difficulties involved in the complex Channel 37 case. As for the public's appreciation of radio astronomy's significance: let us recognize that very few people have the remotest notion of what radio astronomy is all about, and the fact that the FCC has not come out on the side of science suggests to me that the public's appetite for entertainment figured mightily in the commission's deliberations.

When all the channels for the Paterson area are in operation, they will total approximately 14, UHF and VHF. This allows for a generous amount of TV, but I know where I'd put my money if anyone asked Patersonians whether they prefer 13 or 14 TV stations.

The final decision in this case is yet to come. If radio astronomy is to have its interests furthered, it is going to have to get into the public arena and state its case. Some efforts in this direction have been made, principally with stories that have appeared in the general press, but since the greatest benefits often come to those who shout the loudest and clearest, it would not hurt if the nation's radio astronomers were to go out and fight for their cause. I am not aware that they are doing that.—D. S. GREENBERG

Abandonment of Rational Attitudes

The spanking Adam Yarmolinsky gives some social scientists [*Science* **139**, 1034 (15 Mar. 1963)], like the one Albert Wohlstetter has given some natural scientists in the current issue of *Foreign Affairs* ("Scientists, seers, and strategy"), is richly deserved.

Yarmolinsky's justified complaint against "abandonment of rational attitudes" and the use of a few scientific-sounding terms to bolster a scientist's political convictions in the absence of any research or data needs to be reinforced by one further point not covered by the short report in *Science*.

Scholars too often neglect the political consequences which even a qualified statement will have if it is injected into popular discussion where it will be read and reported without qualification. It may be true that there is some dissonance in the public mind between a massive and drastic shelter program and disarmament. To make that statement in a popular tract, reprinted in a popular magazine at precisely the moment when a moderate and not drastic piece of civil defense legislation was up before Congress, was a political act bound to be interpreted as an attack upon that legislation. No matter how much the author of *The Shelter Centered Society* report may insist that what he was discussing was in fact a "shelter *centered* society" and not current moderate programs, the placing of such a document into the public arena at a moment of civic debate was irresponsible.

A scientist who chooses the public forum during a controversy has an obligation to make a balanced evaluation of the total issue. To use his status as a scientist to proclaim loudly only one aspect or one set of dangers, while denying that he has taken sides, is a ploy that can only get science into trouble.

ITHIEL DE SOLA POOL

Massachusetts Institute of Technology, Cambridge 39