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THE DISCOVERY OF ETI AS A HIGH-CONSEQUENCE, LOW-PROBABILITY EVENT

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ABSTRACT

The authors use the opportunity of presenting a paper during the 51st International Astronautical Congress in Rio de Janeiro to introduce a numerical method of characterizing the potential significance of any announcement of discovery of extraterrestrial intelligence. This approach uses the Torino Scale (for characterizing asteroid impacts) as a model for constructing a proposed "Rio Scale" to assist the discussion and interpretation of any claimed discovery of ETI.

INTRODUCTION

The object of this paper is to demonstrate that the consequences and the significance of the announcement of a discovery of extraterrestrial intelligence (ETI) depends very sensitively on both the nature of the potential consequences and the credibility of the discovery. In this respect such an announcement would be like the announcement of the impending impact of a large asteroid – another example of a potentially high-consequence, low-probability event. The recently published two dimensional Torino scale[1] takes into account both the potential damage from an asteroid impact, as well as the probability of its collision with the Earth (lower numbers are used to describe less certain impacts, and impacts with predictions of less severe damage). In this paper we generate a 3-dimensional phase space for describing the potential consequences of the detection of extraterrestrial intelligence (ETI), and sum these indices in order to estimate the magnitude of the potential consequences with a single variable. We then develop a two-dimensional Rio Scale, similar to the Torino Scale, by multiplying this variable by an assessment of the credibility of the discovery circumstances. We hope that such a scale will be included in any future announcement concerning a possible detection of ETI, in order to help the public, as well as the physical and social science communities, to assess the significance of the event.

EVALUATION OF CONSEQUENCES

In 1993, Almár[2] discussed a number of factors that would be important in evaluating the possible consequences of an ETI detection. These included the type of the actual discovery, and a classification for the possible detected phenomena. In this paper, we add the distance to the detected ETI civilization or artifact, as another dimension to be evaluated. Table 1 lists the numerical indices and the definitions that have been assigned to these different factors. In all cases, larger values of indices represent potentially more important consequences. For the distance, the index has values 1 to 4, the index for the type of discovery extends from 1 to 5, and finally, the classification of the phenomena requires index values from 1 to 6. We attempted to use a uniform index scale for all three factors, but found that the enumeration of possible consequences required different limits for the index scales. In all cases, we believe that each entry in Table 1 represents an independent circumstance. The union of all three parameters should describe the complete set of possible scenarios in a three-dimensional space. The probability that any future discovery will occupy a particular cell is far from uniform, but it is hoped that any discovery team will find a suitable combination of indices with which to characterize their discovery.

The three parameters (class of phenomenon, type of discovery, and distance) can be combined together into a single linear variable by addition of the indices. We denote this variable as Q, which can take a value from 3 to 15. While the three-dimensional volume of Figure 1 allows a unique characterization of any discovery, a single value of Q may represent a number of different cases. Nevertheless, for the purposes of public communication concerning the probable consequences, a linear variable Q should prove very useful.

CLASS OF PHENOMENON	INDEX	TYPE OF DISCOVERY	INDEX	DISTANCE	INDEX
Earth-Specific Message	6				
Omnidirectional Message	5	Result of SETI /SETA - Steady	5		
Earth-Specific Beacon	4	Result of Other Kind of Obs.-Steady	4	Within the Solar System	4
Omnidirectional Beacon	3	Result of SETI /SETA - Transient	3	Within 50 Light Years	3
Leakage Radiation	2	Result of Other Kind of Obs-Transient	2	Within the Milky Way Galaxy	2
Traces of Astroengineering Activit	1	Re-evaluation of Archival Data	1	Extragalactic	1

Table 1. Table of Indices

<u>Remarks on Table 1:</u>

Earth-Specific vs. Omnidirectional – the difference depends on whether the ET civilization knows about the planet Earth.

Leakage vs. Astroengineering – the difference is that leakage refers to EM radiation, whereas astroengineering may refer to any other indication of technological activity by an extant or extinct civilization.

SETI and SETA vs. Other Observations – the first refers to dedicated searches intended to find ET signals and artifacts, whereas the latter may be serendipitous detections resulting from astronomical or other observations.

Re-evaluation of Archival Data – such discoveries take place after the collection of the data, so verification may be difficult.

50 light years – represents a distance within which round-trip communication at light speed can be considered within a human lifetime.

As can be seen in Figure 2, the majority of the possible 120 cases of discovery illustrated in Figure 1 will have values of *Q* in the vicinity of 9. We have arbitrarily sorted values of *Q* into three categories containing approximately the same number of cases. The label assigned to each category subjectively indicates the level of probable consequences (social, political, intellectual, scientific, and religious). There is substantial literature discussing such consequences (cf. Tarter[3], Vakoch[4], and Harrison[5]) but this is the first attempt at quantification. The subjective titles, and numerical ranges given below will benefit from future elaboration by social scientists.

Q	Category
3-7	Minor Consequences
8-10	Moderate Consequences
11-15	Substantial Consequences

Table 2. Categories for *Q*

ASSESSMENT OF SIGNIFICANCE

In the case of the impactors to Earth, there are additional factors, beyond the probable consequences of a particular impact, which influence the significance of any impending event. These are the epoch of the forecasted impact and the probability that the impact will actually occur. In the case of the discovery of an ET civilization, the date of epoch is not a consideration, but the probability that the discovery is real or accurate most certainly is.

The Torino Scale is a linear construction that combines the consequences of the forecasted impact with the collision probability. We suggest an analogous Rio Scale that accounts for the probable consequences of the detection (the one-dimensional variable *Q*) as well as the assessed credibility of any claimed discovery of ET civilizations. We introduce the parameter δ, which has a value between 0 to 1, and represents the estimated credibility of the claimed discovery. In the case of an impact scenario, the collision probability can be objectively calculated, and will depend on the orbital accuracy that improves over time with additional observations; the probability of collision will converge toward 0 or 1 with time.

In the case of ET civilizations, the credibility of a claimed detection can only be estimated subjectively. The credibility of the detection δ may increase or decrease with time, independent of the nature and consequences of the discovery. Subjective assignment of values for δ should be straightforward, and relatively incontrovertible, when its value is near the extremes. Data that are obviously faked or fraudulent (as was the case in the signal reported from the star EQ Peg in 1999[6]) will receive a value of $\delta = 0$. Claims of a discovery of signals or artifacts that have been independently verified by credible scientists in multiple, unrelated ways will justify a value of δ close to 1. In any other circumstances, there is likely to be debate, and subsequent temporal evolution of the subjective value of δ that is accepted.

We now define the Rio Scale for the level of significance of any claimed discovery of ETI; $RS = Q \times \delta$ (the level of probable consequences weighted by the assessed credibility of the claim).

For communication purposes at the time of an initial announcement of such a discovery, and in the subsequent period of evaluation, we feel that the RS is the most meaningful tool we can construct. For simplicity, we have created levels of significance from ranges of RS which represent approximately uniform steps in δ. They appear in Table 3.

RS	Level of Significance
0	None
$0<RS\leq 3$	Low
$3<RS\leq 7$	Ambiguous
$7<RS\leq 11$	High
$11<RS\leq 15$	Extraordinary

Table 3. Level of Significance

In defining these subjective labels, we assert that even though the consequences may be enormous (large Q value), the Rio Scale giving the level of significance should be low if, for example, the announcement issues from a team of limited credibility (or for any other reason one assigns a small value of δ). This intent can be seen clearly in Figure 3.

We can envision a serendipitous discovery during the course of some form of traditional astronomical observations, that is subsequently confirmed in a number of different ways, for which the discovery team might choose to assign only a moderate value of the Rio Scale in their announcement. This would reflect the case when it is unclear whether the newly discovered phenomenon is the result of an ET technology, or previously unknown astrophysics. It is harder to envision a case when a team conducting dedicated SETI investigations would classify a suspected discovery with a very low value on the Rio Scale. It is instructive to remember that there will be inherent predispositions among different classes of observers.

USE OF THE RIO SCALE

Within the International Academy of Astronautics, the standing committee on SETI[7] has established a subcommittee to deal with post detection issues[8]. We suggest that this subcommittee may find the Rio Scale a particularly useful tool, and further that they should attempt to assign a value (or to reassess a previously assigned value) of RS to any announcement. In the case of the Torino Scale, the community of observers searching for near-Earth objects (NEOs) have voluntarily agreed to delay any announcement of potential collisions by Earth-crossing objects for 72 hours, in order to allow an *ad hoc* committee of their peers to make independent evaluations of the data and search for additional archival measurements. Thus it is expected that the announcement itself will contain an initial value on the Torino Scale as well as the epoch of forecast collision. In the case of SETI and SETA, the community of researchers is much less cohesive, and there is also the possibility that a discovery may occur as the serendipitous result of other types of activity.

Given the 120 possible cells in Figure 1, and the diversity of potential discoverers, it will not always (or even often) be possible for the IAA SETI Post-Detection subcommittee to function in the same way as does the NEO *ad hoc* committee. Discovery announcements of ETI can be anticipated, with no mention of the Rio Scale, and no assessed value. Nevertheless, it will be very important to attach a well-considered value of the Rio Scale as quickly as possible following any announcement. Only in this way can the potential adverse effects on SETI programs (analogous to those experienced by the NEO observers following recent premature predictions of asteroidal collisions) be efficiently contained. And further, the inclusion of the Rio Scale in subsequent discussion of credible discoveries will help social scientists and the media to realistically portray the likely consequences of such unprecedented events.

The ideas included within this paper represent the ideas and judgements of the authors. Further discussion within the broadest possible segment of the scientific community is desirable in order to refine and improve the current suggestions. The International Astronautical Congress taking place in Rio de Janeiro during early October of 2000 will provide a forum for the commencement of such a discussion. In anticipation of lively debate, improvement, and adoption of this proposed scale by the IAA SETI Committee, we have named the scale in honor of the Congress location. Following this adoption, a concerted effort must be made to enlarge the audience of discussants. Ultimately, if the Rio Scale is to prove of future value, it must become common knowledge. Having expanded the knowledge of the Rio Scale to the scientific community at large, we must then introduce and explain the adopted scale to the media, and through them to the general public. Since it is likely that the opportunity to assign Rio Scale values to announcements will be infrequent, acceptance of this concept will require continued usage within the literature of scientists, social scientists, and especially within works authored for the public.

CONCLUSIONS

The Torino Scale was developed by scientists studying near-Earth objects. The necessity for such a scale was demonstrated following the premature announcement of an impending collision with a large asteroid, the subsequent media reaction, and rapid re-appraisal of the actual impact probability based on additional data. The detection of ETI may be a similar high-consequence, low-probability event. The necessity for a pre-prepared tool, analogous to the Torino Scale, is obvious. Media interest would be enormous, and every attempt should be made to realistically portray the significance of the announced discovery. If it can be introduced into common usage, the Rio Scale may be our best chance of avoiding misinterpretation and sensationalism.

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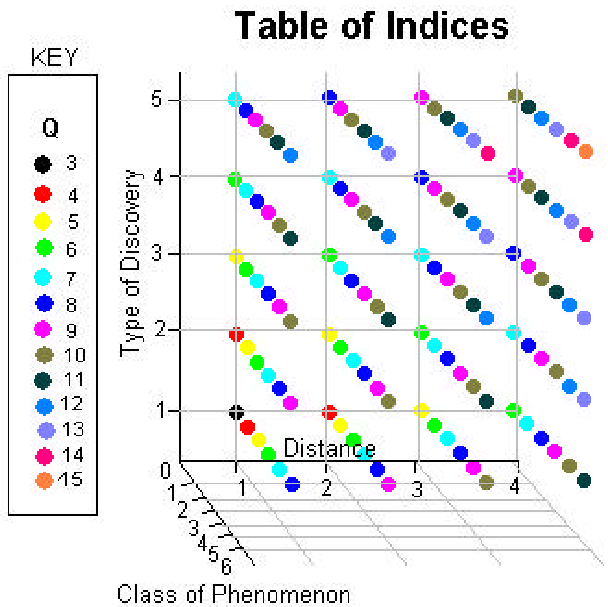

Figure 1. 3-D Figure of Indices

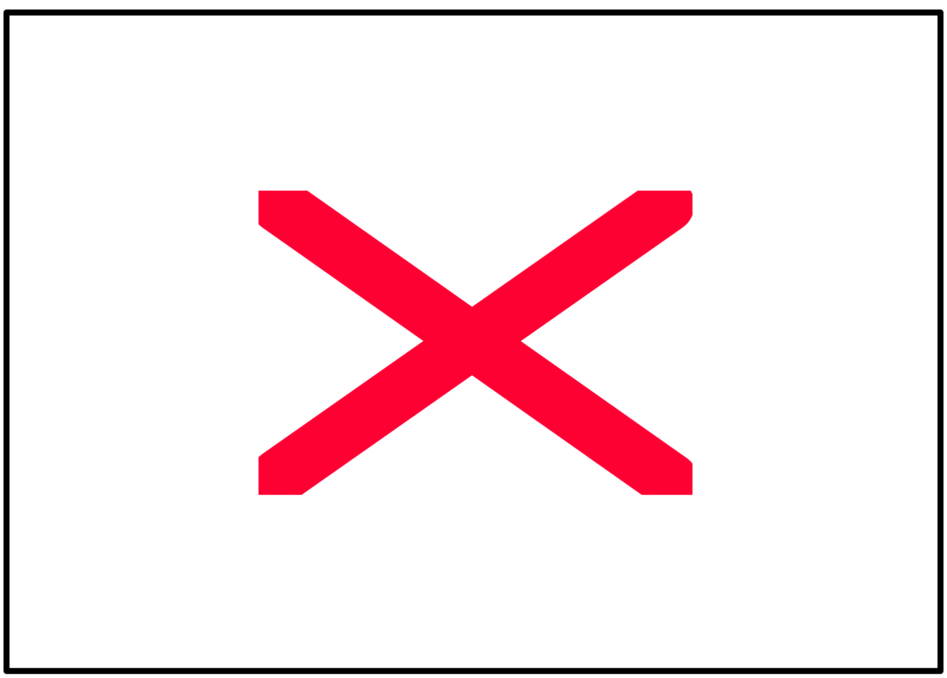

Figure 2. Distribution of Q Values