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COMMENT ON WICKRAMASINGHE: INTERSTELLAR DUST, COMETS AND PANSPERMIA

by

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DISCUSSION PAPER

on

N. Chandra Wickramasinghe's

INTERSTELLAR DUST, COMETS AND PANSPERMIA

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The paper on "Interstellar Dust, Comets and Panspermia" by N. Chandra Wickramasinghe has achieved the goal, to a good measure, of pointing out through presentation of available data that biology is not merely a terrestrial affair but can extend to the galaxies. In order to appreciate this observation, one has to address oneself to a number of basic questions like 'What does the interstellar dust consist of?', 'What does the nature of the constituents of the dust say about the existence of life forms far out in the galaxies?', etc. In the final analysis, the issue becomes a synthesis of the physical and the biological sciences. This synthesis is based on the answers to a number of other questions like 'How does one know if there is any interstellar dust at all?', 'What are the sizes of the dust particles?', 'What are their chemical structures?', 'How does one find out about these structures?', 'How does one identify these structures with possible early life-forms?', and finally 'How unique is the identification?'.

The author has attempted to provide the answers to the above questions, which are essentially linked with the tools and techniques of radio-astronomy and chemistry as well as with the biology of micro-organisms. More specifically, molecular spectroscopy is exploited. The spectroscopic signatures of the molecular lines are examined in order to find out if they correspond to any of the fifty organic molecules, essential for the activities of life, out of the tens of billions of known kinds of organic molecules. One thus establishes the evidence of the presence of organic molecules in interstellar dust. Assuming that life elsewhere in the universe is presumably based on the same types of organic molecules as are observed in the living things back on earth, general inferences are drawn from these spectoscopic data about the possibility of life formation in space. In order to obtain more specific information about the nature of the dust grains, one can attempt to find out if the infra-red spectra from the grains are in any way similar to the ones that would be obtained by assuming that the grains were indeed bacteria. Thus one could obtain infra-red spectra from known bacteria and observe any similarity with the spectra from the interstellar dust. This is exactly what has been done by the author and his collaborators and a striking similarity of spectral curves has been obtained, thus lending credence to the bacterial hypothesis of the interstellar grains. Before we discuss this any further, let us discuss the logic followed in the paper.

The author starts out by showing a long-exposure photograph of our galaxy which shows dark patches and striations caused by clouds of gas and dust in front of distant stars. Later photographs are also illustrative of gas and dust clouds in other galaxies. The paper then discusses the presence of organic molecules in the clouds and mentions the 150 molecular lines that were observed by 1975 and were identified with 45 terrestrially known organic molecules and radicals. Without making any science-fiction, the author could have stressed, however, that the basic assumption involved in looking for these molecules is that life far-out in the galaxies is based on the same organic molecules as are observed in terrestrial life. This assumption, although a logical one to the earth-dwellers, cannot be absolutely unquestionable. Terrestrial life and extra-terrestrial life while presumably having equal regard for the same periodic table could have followed altogether different chemistries. Again, when one talks of formic acid (HCOOH) and methanimine (CH_2NH) observed in dense interstellar clouds as precursors of a simple amino acid, the assumption is that life elsewhere is based on some 20 amino acids which have yielded all the proteins we need.

The paper has dealt at some length on the historical evolution of the ideas about the composition of interstellar dust. Two things are relevant here--the nature of the dust particles or grains and their size. It has been pointed out that the early studies on both of these aspects, i.e. those during 1930-40 and during 1940-60 turned out to be wrong. The particles were thought to be those of iron and later, of ice and of soot with submicron dimensions. The author's own contribution in showing that the particles could be formed in both carbon-rich as well as oxygen-rich red giant stars has indeed been valuable. This together with the fact that the feature expected of graphite particles at $\sim$2200 Å was observed in the spectra of most stars dimmed by dust clouds and that a broad special feature at $\sim 10\ \mu$ in both carbon-rich and oxygen-rich red giant stars was detected by infra-red astronomers brings one to a recent appraisal about the source, nature and size of the dust particles. It is felt, however, that a little more digression on the size-determination of the dust particles could be of further interest especially to the uninitiated readers. As far as the nature of the interstellar dust is concerned, mention has been made of C, N, O forming the main contribution to the mass of the dust, the cosmic abundances of Mg and Si being low. Such findings, it has been argued, are obtained from the astronomical data on the extinction of starlight at visible wavelength together with the elemental abundance ratio in space. However, no mention is made of phosporus which is one of the few chemical alphabets that occur in the DNA molecules of life-forms. If molecular biology in space is anywhere near to that on this planet, the issue of the occurrence of phosporus has to be addressed to in some way.

The author next turns away from the earlier claim that interstellar grains consisted of graphites and silicate particles with possible mantles of icy materials and points to two broad class of grain model, one class including inorganic ions such as CH_4, NH_3, H_2O and the other including organic polymers based on C, H, N, O. The reason for choosing organic polymers as candidates for the interstellar grain has obviously been that such polymers, especially the biopolymer cellulose gives excellent agreement to the infra-red flux curve over the 8-13 μm waveband observed for dust in the Trapezium Nebula. Since the sillicate grain model could not explain the data while the carbonacious polymers did much better, the author seemed to be moving from inorganic to organic dust and finally put forward the attractive hypothesis that interstellar dust grains are bacteria. Before any comment is made on the bacterial hypothesis, it should be pointed out that although the author has given good reasons for the advocacy of the organic nature of the dust, it is by no means certain that inorganic candidates for interstellar dust like sillicates and graphites or several odd combinations of these and other inorganic substances should be ruled out for the purpose of fitting the spectra from the Trapezium Nebula which seems to have been taken as a hinging factor.

Now, coming to the question of bacterial hypothesis, it is undoubtedly true that the spectra from the heated diatom-bacterial mixture as well as those from dehydrated micro-organisms (E Coli bacteria) back on earth over a wider range of the wave band (i.e. both short wave as well as infra-red wave) agree remarkably well with the data from the Trapezium Nebula. Another attractive feature of this hypothesis is that the absence of any strong water-ice absorption near 3.1μ seems to show that organic particles in space are essentially dry. Talking of the bacterial nature of the dust, a point that need not be put aside altogether is the possibility that the micro-organisms in the interstellar dust need not be the same as the ones familiar to us. Again, whether the Trapezium spectra would be invariant with respect to the large number of other micro-organisms, has not been stressed in the present paper. Although the author clearly states that his group was not able to construct the profile of the spectra from other plausible candidates tried out so far, the question still remains as to how exhaustive has been the search with microscopic life-forms. The answer to such a question seems unavoidable in order to rule out even the faintest possibility of the agreement being a strange coincidence of Nature.

The paper has also dealt with the composition of the cometary dust and has presented the findings on the nature of the dust as they became available from observations on the comet Kohoutek in '73 and '74 and also from the instruments abroad Vega 1 and from the observations on Halley's Comet. The story of interstellar dust has been repeated in the case of the cometary one. The infra-red signals observed from Halley's Comets were found to be identical to the spectra observed on the earth from dried bacteria heated to 320° K and closely similar to interstellar bacterial particles. Again, a case seems to be prepared for the replacement of the inorganic picture of comet by an organic one. The author extrapolates the findings from Halley's Comet to other comets. How far such an extrapolation is valid can only be ascertained from further cometary observations in the future. Also, the uniqueness of the finding about the cometary dust remains to be seen on the same logical level as that in the case of interstellar dust.

The cometary conditions might have been conducive to the growth of bacteria, and the author has suggested a bacterial feed-back loop between the interstellar space and cometary systems. Such a suggestion could have implications for the growth of life-forms on earth although the question of the origin of life would remain still unanswered. The author made no attempt to imagine conditions in interstellar space in which life could have sparked off.

Finally, there has been a good discussion of the data on the extinction curve of starlight, and the role of the new satellite technologies in extending the data from the visual region of the spectra to the infra-red and ultraviolet wavelength ranges has been highlighted. Again, a bacterial model explanation in terms of empirical mathematical relationship has been proposed for the entire extinction curve with adequate support from observations on Halley's Comet.

All in all, one can say that the bacterial grain model of both interstellar and cometary dust as put forward in the paper seems to be an attractive proposition. However, the volume of data on which the proposition has been made is far from being sufficient. Further nebular spectra and cometary observations together with more exhaustive attempts at arriving at the uniqueness of interpretation of the signatures of the signals would indeed be of further help in understanding extra-terrestrial biology and the evolution of life even if the mystery of the origin of life ever remains on the distant horizon.