SUMMARY OF SESSION II
PLANETARY, INTERPLANETARY AND INTERSTELLAR ORGANIC MATTER

William M. Irvine
Department of Physics and Astronomy
University of Massachusetts
Amherst, MA 01003, USA

The second session of the Symposium was concerned with the observation of extraterrestrial organic matter by astronomers, planetary scientists, and geochemists, and relevant complementary work in the laboratory.

It is now well established that all of the basic building blocks of the polymers relevant to terrestrial biochemistry can be synthesized from simple constituents under conceivable paleoenvironmental conditions (Ponnamperuma). Whether such conditions ever actually existed on the early Earth, however, will remain uncertain until more is known about the early terrestrial atmosphere, hydrosphere, and crust. There thus remains at least the possibility that the introduction of extraterrestrial organic matter might have played some role in chemical evolution.

Not surprisingly the most complex, well characterized organic matter of extraterrestrial nature has been found in those samples which could be directly analyzed in the laboratory, the carbonaceous meteorites (Ponnamperuma). Not only all of the relevant nucleic acid bases, but also a whole suite of protein and nonprotein amino acids have been so identified. In all cases the molecules seem to be a racemic mixture. As one proceeds further from the Earth, there is circumstantial but nonetheless considerable evidence for large quantities of complex organic molecules in the outer solar system, particularly on the Saturnian satellite Titan (Sagan). In the interstellar medium, radio astronomers with the collaboration of microwave spectroscopists are continuing to add to the know list of interstellar organic molecules (Brown; Suzuki et al.). It is interesting to observe that interstellar abundances clearly indicate the quite different nature of the chemistry taking place in molecular clouds from that which the organic chemist is most familiar on the Earth. Specifically, the very nonequilibrium nature of interstellar chemistry is well manifested by the considerable umber of radicals and energetically "unfavorable" isomers that are found in the gas phase. It is also perhaps important to note that there are significant differences in the chemical composition among different molecular clouds. The most complex organic molecules in space may well be present in the ubiquitous interstellar grains (Greenberg). Detailed characterization of this material is, however, not possible, although

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laboratory simulations provide interesting clues. It may be that when we better understand the chemistry of both interstelllar clouds and the primitive solar system (e.g., from presolar material surviving in meteorites and/or comets) we will be able to determine much more about the type of interstellar cloud in which the Sun and planets formed.

Most of us are familiar with the suggestions by Hoyle and Wickramasinghe that the interstellar grains are not only organic in nature, but are actually "freeze dried bacteria". Although there is a natural tendency to simply ignore what seem to be such far-fetched hypotheses, I think that this is a mistake. We owe it to our science and to the perception of our science by the general public to show that such ideas can be rigorously analyzed and either supported or rejected. An excellent example of this approach was the paper in the present session by Davies et al., who show that the proposed assignment by Hoyle and Wickramasinghe of an interstellar ultraviolet absorption feature to interstellar tryptophane was not only a sloppy piece of work, but was simply incorrect. The authors conclude that there is no evidence for the presence of proteinaceous material associated with the interstellar grains. On the other hand, Greenberg reports the interesting, preliminary laboratory result that certain bacterial spores are much more resistant to high energy ultraviolet light at the low temperatures characteristic of interstellar dark clouds (~10 Kelvin) than they are at room temperature. The resulting lifetimes for such spores may be long enough to make the old idea of panspermia at least plausible, although here is no direct evidence in its favor.

Finally, the problem of the origin of chirality in biological systems has long been a perplexing one. Wolstencroft suggests that asymmetries in particular terrestrial environments, which might be either due to local topography or weather patterns, could lead to an overall net flux of one sense of circularly polarized sunlight in such locations. Conceivably such asymmetry could have played a role in preferentially selecting a particular isomer at certain sites at an early stage in chemical evolution.