NASA Technical Memorandum 89605

Publications of the Exobiology Program for 1985

A Special Bibliography

JANUARY 1987
Publications of the Exobiology Program for 1985

A Special Bibliography
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHEMICAL EVOLUTION</td>
<td>5</td>
</tr>
<tr>
<td>ORGANIC GEOCHEMISTRY</td>
<td>17</td>
</tr>
<tr>
<td>ORIGIN AND EVOLUTION OF LIFE</td>
<td>25</td>
</tr>
<tr>
<td>PLANETARY ENVIRONMENTS</td>
<td>41</td>
</tr>
<tr>
<td>LIFE IN THE UNIVERSE</td>
<td>49</td>
</tr>
<tr>
<td>SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE</td>
<td>57</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td>65</td>
</tr>
<tr>
<td>ERRATUM</td>
<td>69</td>
</tr>
<tr>
<td>APPENDIX: PROGRAM PARTICIPANTS</td>
<td>73</td>
</tr>
</tbody>
</table>
INTRODUCTION

The Exobiology Program, within the Office of Space Science and Applications of the National Aeronautics and Space Administration, is an integrated program to methodically investigate those processes that may have been responsible for, or related to, the origin, evolution, and distribution of life in the universe.

This report contains a listing of 1985 publications emanating from research supported by the Exobiology Program. Our intent in compiling this report is twofold: we want to provide the scientific community with an annual publication listing (as we have done since 1975) of current NASA-supported research in this field, and we hope to stimulate the exchange of information and ideas among scientists working in the different areas of the program.

Research supported by the Exobiology Program is explored in the areas of Chemical Evolution, Organic Geochemistry, Origin and Evolution of Life, Planetary Environments, Life in the Universe, and Search for Extraterrestrial Intelligence (SETI).

Each area is defined as follows:

**Chemical Evolution** focuses on the non-biological synthesis of biologically significant organic molecules under conditions presumed to have existed on the primitive earth or on any primitive planet before the advent of life.

**Organic Geochemistry** involves:

1) analyzing ancient terrestrial rocks for organic molecules and inclusions of biological origin, and
2) developing techniques to isolate organic matter of biological origin from that of non-biological origin.

**Origin and Evolution of Life** includes studies of:

1) the origin of essential life processes and systems including the nucleic acid and protein biopolymers, mechanisms, genetic information transfer, energy collection and cellular and subcellular structures, and
2) the evolution of primitive microbial ecologies.

**Planetary Environments** includes:

1) characterizing microorganisms capable of surviving and/or growing in extreme conditions approaching those of planetary environments, 2) developing methodologies and techniques to detect and characterize life-related molecules in extraterrestrial environments, and
3) developing methods to determine planetary environmental characteristics important for chemical evolution processes.

**Life in the Universe** involves research and analysis in two distinct but related areas:

1) forms, abundances, and reactivity of the biogenic elements and
2) effect of planetary, solar, and astrophysical phenomena on evolution of complex life.
SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI) involves the search for extraterrestrial intelligent life by detecting signals in the microwave region of the spectrum.

This bibliography is divided into the six research areas noted above and a miscellaneous section. Within each research area, references are listed alphabetically by author. Authors who are principal investigators are identified by an asterisk. In addition, current addresses for all Principal Investigators are given in the Appendix.

We wish to thank all the participants in the Exobiology Program for their cooperation in responding to our request for a listing of their 1985 publications.

Donald L. DeVincenzi
November 1986
CHEMICAL EVOLUTION
BANIN*, A.; LAWLESS*, J.G.; MAZZURCO, J.; CHURCH, F.M.;
MARGULIES, L.; ORENBERG*, J.B.
PH Profile of the Adsorption of Nucleotides onto Montmorillonite.
II. Adsorption and Desorption of 5'-AMP in Iron-Calcium
Montmorillonite Systems.
Origins of Life
(GWU 6478)

BIEMANN*, K.; GIBSON, B.W.; MATHEWS, W.R.; PANG, H.
The Determination of Protein Structure with
the Aid of Mass Spectrometry.
In: Mass Spectrometry in the Health and Life Sciences
(Burlingame, A.L., Castagnoli, N., Jr., Eds.).
Amsterdam, The Netherlands: Elsevier Science Publishers
(GWU 6693)

BONNER*, W.A.; HALL, H.; CHOW, G.; LIANG, Y.; LEMMON, R.M.
The Radiolysis and Radioracemization of Amino Acids on Clays.
Origins of Life
(GWU 6448)

CANUTO, V.M.; LEVINE*, J.S.; IMHOFF, C.L.; GOLDMAN, I.;
AUGUSTSSON, T.R.; HUBICKYJ, O.
The Young Sun, The Early Earth and the Photochemistry of
Oxygen, Ozone and Formaldehyde in the Early Atmosphere.
In: Chemical Events in the Atmosphere and Their
Impact on the Environment, Proceedings of the Conference
on Chemical Events in the Atmosphere and Their Impact
on the Environment, Rome, Italy, November 7-11, 1983.
(GWU 6638)

CHANG*, S.
Origin of Life.
In: The Global Sulfur Cycle (Sagan, D., Ed.).
(NASA-TM-87570) (GWU 6395).

CORIGLIANO-MURPHY, M.A.; LIANG, X.; PONNAMPERUMA*, C.; DALZOPPO,
D.; FONTANA, A.; KANMERA, T.; CHAIKEN, I.M.
Synthesis and Properties of an all-D Model Ribonuclease S-peptide.
International Journal of Peptide and Protein Research
(GWU 6832)

COYNE*, L.M.
A Possible Energetic Role of Mineral
Surfaces in Chemical Evolution.
Origins of Life
(GWU 6683)
COYNE*, L.M.
Clay Energetics in Chemical Evolution (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6766)

FERRIS*, J.P.
Photolysis Products of CO, NH₃ and H₂O and Their Significance to
Reactions on Interstellar Grains (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6779)

FERRIS*, J.P.; KHWAJA, H.
Laboratory Simulations of PH₃ Photolysis in the
Atmospheres of Jupiter and Saturn.
(GWU 6704)

FOLSOME*, C.E.
Photochemical Reactions of Various Model
Protocell Systems (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6790)

HARTMAN*, H.H.
Origin of Life and Iron-rich Clays (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 64, 1985. (NASA-CP-2425)
(GWU 6768)

HARTMAN*, H.; VICHNIAC, G.Y.
Inhomogeneous Cellular Automata (INCA).
In: Disordered Systems and Biological Organization
(Bienenstock, E., Fogelman, F., Weisbuch, G., Eds.).
(GWU 6964)

HARTMAN*, H.; LAWLESS*, J.G.; MORRISON, P.
Search for the Universal Ancestors.
Moffett Field, CA: NASA, Ames Research Center,
129 P., 1985. (NASA-SP-477)
(GWU 6401).
HEGSTROM, R.A.; RICH*, A.; VAN HOUSE, J.
New Estimates of Asymmetric Decomposition of Racemic Mixtures by Natural Beta-radiation Sources.
(GWU 6321)

(GWU 6967)

KASTING*, J.F.
Climatic Consequences of Very High CO₂ Levels in Earth's Early Atmosphere (Abstract).
(GWU 6817)

KASTING*, J.F.
Photochemical Consequences of Enhanced CO₂ Levels in Earth's Early Atmosphere.
In: The Carbon Cycle and Atmospheric CO₂: Natural Variations Archean to Present (Geophysical Monograph 32).
(GWU 6854)

KASTING*, J.F.
Greenhouses and Glaciers: Climatic Change and the Continuously Habitable Zone Around the Sun.
(GWU 6856)

KASTING*, J.F.; RICHARDSON, S.M.
Seafloor Hydrothermal Activity and Spreading Rates: The Eocene Carbon Dioxide Greenhouse Revisited.
(GWU 6853)

KASTING*, J.F.; HOLLAND*, H.D.; PINTO, J.P.
Oxidant Abundances in Rainwater and the Evolution of Atmospheric Oxygen.
(GWU 6606)
Stratospheric Tholins in the Outer Planets: Synthesis by Coronal/Plasma Discharge in \( H_2,CH_4 \) Flows (Abstract).
Bulletin of the American Astronomical Society
(GWU 6965)

KOBAYASHI, K.; PONNAMPERUMA*, C.
Trace Elements in Chemical Evolution, I.
Origins of Life
(GWU 6985)

KOBAYASHI, K.; PONNAMPERUMA*, C.
Origins of Life
(GWU 6986)

LAHAV*, N.
The Synthesis of Primitive 'Living' Forms: Definitions, Goals, Strategies and Evolution Synthesizers.
Origins of Life
16(2): 129-149, 1985.
(GWU 6987)

LAHAV*, N.; COYNE*, L.; LAWLESS*, J.G.
Characterization of Dehydration-induced Luminescence of Kaolinite.
Clays and Clay Minerals
(GWU 6682)

\( pH \) Profile of the Adsorption of Nucleotides onto Montmorillonite. I. Selected Homoionic Clays.
Origins of Life
(GWU 6695)

LEVINE*, J.S.; EDITOR.
(GWU 6852)

LEVINE*, J.S.
The Photochemistry of the Early Atmosphere.
In: The Photochemistry of Atmosphere: Earth, The Other Planets, and Comets (Levine, J.S., Ed.).
(GWU 6637)
LEVINE*, J.S.; AUGUSTSSON, T.R.
The Photochemistry of Biogenic Gases in the Early and Present Atmosphere.
Origins of Life
(GWU 6636)

The Production of Trace Gases by Photochemistry and Lightning in the Early Atmosphere (Abstract).
(GWU 6777)

MACKLIN, J.W.; WHITE*, D.H.
Infrared Spectroscopic Studies of the Effect of Elevated Temperature on the Association of Pyroglutamic Acid with Clay and Other Minerals.
Spectrochimica Acta
(GWU 6962)

MELNICK, J.L.; OCHOA, S.; OR6*, J.; VOLUME EDS.
Viruses, Oncogenes and Cancer.
In: Progress in Medical Virology, Volume 32 (Melnick, J.L., Series Ed.).
(GWU 6961)

MILLER*, S.L.
Clathrate Hydrates in the Solar System.
In: Ices in the Solar System (Klinger, J., Ed.).
(GWU 6692)

Bulletin of the American Astronomical Society
(GWU 6968)

ORENBERG*, J.; LAHAV*, N.
Adsorption and Condensation of Amino Acids and Nucleotides with Soluble Mineral Salts (Abstract).
(GWU 6841)
ORENBERG*, J.B.; CHAN, S.; CALDERON, J.; LAHAV*, N.  
Origins of Life  
(GWU 6623)

LAZARD, D.; LAHAV*, N.  
(GWU 6698)

ORGEL*, L.E.  
Molecular Replication (Abstract).  
(GWU 6761)

ÓRO*, J.; ARMANGUE, G.; MAR, A.  
(GWU 6767)

PINTO, J.P.; LUNINE, J.I.; KIM, S.-J.; YUNG*, Y.L.  
(GWU 6776)

PONNAMPERUMA*, C.  
Louis Pasteur and the Origin of Life.  
In: World's Debt to Pasteur.  
(GWU 6990)
PONNAMPERUMA*, C.
Synthesis and Analysis in Chemical Evolution (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6770)

PONNAMPERUMA*, C.
Synthesis and Analysis in Chemical Evolution.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6982)

PONNAMPERUMA*, C.
The Track of Extraterrestrial Life Grows Warmer.
Aerospace America
(GWU 6831)

PRINN,*, R.G.
The Volcanoes and Clouds of Venus.
Scientific American
(GWU 6441)

SAGAN*, C.; THOMPSON, W.R.; KHARE*, B.N.
Titan's Organic Chemistry.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
(GWU 6966)

SAGAN*, C.; THOMPSON, W.R.; SQUYRES, S.W.; KHARE*, B.N.
Photometry, Multiple Light Scattering, and Lab Simulations:
Constraints on the Structure of Titan's Haze/Cloud (Abstract).
Bulletin of the American Astronomical Society
(GWU 6970)

SCHWARTZ, A.W.; ORGEL*, L.E.
Template-directed Polynucleotide Synthesis on Mineral Surfaces.
Journal of Molecular Evolution
(GWU 6634)

SCHWARTZ, A.W.; ORGEL*, L.E.
Template-directed Synthesis of Novel, Nucleic Acid-like Structures.
Science
(GWU 6407)
STRIBLING, R.; MILLER*, S.L.

USHER*, D.A.; NEEDELS, M.C.; BRENNER, T.
Stereoselective Aminoacylation of RNA (Abstract).

WAGENER, R.; CALDWELL, J.; OWEN*, T.; KIM, S.-J.; ENCRENNAZ, T.; COMBES, M.
The Jovian Stratosphere in the Ultraviolet.
(GWU 6836)

WALKER*, J.C.G.
Carbon Dioxide on the Early Earth.
(GWU 6992)

WALKER*, J.C.G.; BRIMBLECOMBE, P.
Iron and Sulfur in the Pre-biologic Ocean.
(GWU 6755)

WALKER*, J.C.G.; ZAHNLE, K.J.
The Lunar Nodal Tide and the Distance to the Moon during the Precambrian Era (Abstract).

WANG, W.; KOBAYASHI, K.; PONNAMPERUMA*, C.
Prebiotic Synthesis in a Mixture of Phosphine, Methane, Nitrogen and Water — The Possible Role of Chemical Evolution.
(GWU 6991)
WEBER*, A.L.
Alanine Synthesis from Glyceraldehyde and Ammonium Ion in Aqueous Solution.
Journal of Molecular Evolution
(GWU 6635)

WEBER*, A.L.
(GWU 6786)

Cooperation of Catalysts and Templates (Abstract).
(GWU 6763)
ANDRAWES, F.; GIBSON*, E.K.
Pyrolysis Gas Chromatography - Helium Ionization Detection
(Abstract).
In: Abstracts, 1985 Pittsburgh Conference and Exposition
on Analytical Chemistry and Applied Spectroscopy,
(GWU 6620)

BAUR, M.E.; HAYES*, J.M.; STUDLEY, S.A.; WALTER, M.R.
Millimeter-scale Variations of Stable Isotope
Abundances in Carbonates from Banded Iron-formations
in the Hamersley Group of Western Australia.
Economic Geology
(GWU 6629)

DES MARAIS*, D.J.
Carbon Isotopic Fractionation in Heterotrophic
Microbial Metabolism.
Applied And Environmental Microbiology
(GWU 6845)

CARR, L.P.; GIBSON*, E.K, JR.; PILLINGER, C.T.
An Investigation of the Nitrogen Isotopic Composition
of the Earth's Early Atmosphere (Abstract).
In: Abstracts, British Isotope Geology Group
Cambridge, England: University of Cambridge,
(GWU 6621)

Amino Acids of the Murchison Meteorite: II. Five Carbon
Acyclic Primary Beta-, Gamma-, and Delta-Amino Alkanoic Acids.
Geochimica et Cosmochimica Acta
(GWU 6642)

DES MARAIS*, D.J.
Carbon Exchange Between the Mantle and the Crust,
and Its Effect Upon the Atmosphere: Today Compared
to Archean Time (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 81, 1985. (NASA-CP-2425)
(GWU 6791)
DES MARAIS*, D.J.
Carbon Exchange Between the Mantle and the Crust, and Its Effect Upon the Atmosphere: Today Compared to Archean Time.
In: The Carbon Cycle and The Atmospheric CO₂: Natural Variations Archean to Present (Geophysical Monograph 32).

DES MARAIS*, D.J.; PETERSON, E.; KWONG, E.; BUI, H.
Organic S¹³C Values Vary Slightly with Salinity in Microbial Mats at Guerrero Negro, Baja California Sur, Mexico: Implications for Stromatolite S¹³C Values (Abstract).

FRY, B.; GEST, H.; HAYES*, J.M.
Isotope Effects Associated with the Anaerobic Oxidation of Sulfite and Thiosulfate by the Photosynthetic Bacterium, Chromatium vinosum.

GIBSON*, E.K., JR.
Chemical Weathering of Soils from the Dry Valleys of Antarctica: A Terrestrial Analog of Martian Weathering Processes.
In: Reports of Planetary Geology and Geophysics Program-1984 (Holt, H.E.; Watters, T.R.; Eds.).

GIBSON*, E.K.; MOORE, C.B.; PRIMUS, T.M.; LEWIS, C.F.
Sulfur in Achondritic Meteorites.

GIBSON*, E.K., JR.; CARR, L.P.; GILMOUR, I.; PILLINGER, C.T.
Earth's Early Atmosphere as Seen from Carbon and Nitrogen Isotopic Analysis of Archean Sediments (Abstract).
GILMOUR, I.; GIBSON*, E.K.; ABELL, P.I.; PILLINGER, C.T.

$^{13}$C Depleted Kerogens in Some Archean Stromatolites (Abstract).
(GWU 6619)

BAUR, M.E.; WALTER, M.R.
Isotopic, Petrologic, and Biogeochemical Investigations
of Banded Iron-Formations (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 84, 1985. (NASA-CP-2425)
(GWU 6794)

HOLLAND*, H.D.; ZBINDEN, E.A.; PINTO, J.P.
Paleosols and the Chemical Evolution of the Atmosphere (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6764)

HOLLAND*, H.D.; ZBINDEN, E.A.
Precambrian Paleosols (Abstract).
In: Abstracts with Programs, Geological Society of
(GWU 6709)

KAPLAN*, I.R.; TANNENBAUM, E.; HUIZINGA, B.E.
Use of Laboratory Simulated Pyrolysis in Tracing
the History of Sedimentary Organic Matter (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6793)

KERRIDGE*, J.F.
Carbon, Hydrogen and Nitrogen in Carbonaceous Chondrites:
Abundances and Isotopic Compositions in Bulk Samples.
Geochimica et Cosmochimica Acta
(GWU 6691)

KERRIDGE*, J.F.; CHANG*, S.
Survival of Interstellar Matter in Meteorites:
Evidence from Carbonaceous Material.
In: Protostars and Planets, II (Black, D.,
Matthews, M., Eds.).
(GWU 6993)
KERRIDGE*, J.F.; CHANG*, S.; SHIPP, R.; WEDEKING, K.
Isotopic Characterisation of Prebiotic Synthesis
of Organic Material (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6769)

KERRIDGE*, J.F.; SHIPP, R.; CHANG*, S.
Measurement and Interpretation of D/H in Meteorites:
A Reappraisal.
Lunar and Planetary Science
(GWU 6690)

MORRIS, R.V.; LAUER, H.V., JR.; LAWSON, C.A.; GIBSON*,
E.K., JR.; NACE, G.A.; STEWART, C.
Spectral and Other Physicochemical Properties of Submicron
Powders of Hematite (Alpha-Fe₂O₃), Maghemite (Gamma-Fe₂O₃),
Magnetite (Fe₃O₄), Goethite (Alpha-FeOOH), and Lepidocrocite
(Gamma-FeOOH).
Journal of Geophysical Research
(GWU 6617)

NAGY*, B.
New Aspects of Early Organic Evolution (Abstract).
Terra Cognita: The Journal of the European
Union of Geosciences
(GWU 6684)

NAGY, L.A.
Early Evolution of Life on Earth (Abstract).
Terra Cognita: The Journal of the European
Union of Geosciences
(GWU 6685)

OGINO, T.; OGINO, H.; NAGY*, B.
Application of Aspartic Acid Racemization to Forensic
Odontology: Post Mortem Designation of Age at Death.
Forensic Science International
(GWU 6671)

RUDNICK, R.L.; ASHWAL, L.D.; HENRY, D.J.; GIBSON*, E.K., JR.;
ROEDDER, E.; BELKIN, H.E.; COLUCCI, M.T.
Fluid Inclusions in Stony Meteorites - A Cautionary Note.
Journal of Geophysical Research
(GWU 6616)

B. Nagy; PI

-----------------------------
SANTROCK, J.; STUDLEY, S.A.; HAYES*, J.M.
Isotopic Analyses Based on the Mass Spectrum
of Carbon Dioxide.
Analytical Chemistry
(GWU 6632)

SCHOPP*, J.W.
Recent Progress in Precambrian Paleobiology (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 87, 1985. (NASA-CP-2425)
(GWU 6809)

SOMMER, M.A., II.; YONOVER, R.N.; BOURCIER, W.L.; GIBSON*, E.K.
Determination of H2O and CO2 Concentrations in Fluid
Inclusions in Minerals Using Laser Decrepitation and
Capacitance Manometer Analysis.
Analytical Chemistry
(GWU 6615)

TANNENBAUM, E.; KAPLAN*, I.R.
Low-Mr Hydrocarbons Generated During Hydrous
and Dry Pyrolysis of Kerogen.
Nature
(GWU 6688)

TANNENBAUM, E.; KAPLAN*, I.R.
Role of Minerals in the Thermal Alteration of Organic Matter-
I: Generation of Gases and Condensates Under Dry Condition.
Geochimica et Cosmochimica Acta
(GWU 6689)

WACHTER, E.A.; HAYES*, J.M.
Exchange of Oxygen Isotopes in Carbon
Dioxide-Phosphoric Acid Systems.
Chemical Geology
(GWU 6631)

YUEN*, G.U.; BLAIR, N.E.; DES MARAIS*, D.J.;
CRONIN*, J.R.; CHANG*, S.
Organic Chemistry of Murchison Meteorite: Carbon Isotopic
Fractionation (Abstract).
In: Second Symposium On Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6740)
ZBINDEN, E.A., HOLLAND*, H.D.
An Archean Paleosol Below the Dominion Reef Group,
South Africa (Abstract).
In: Abstracts with Programs, Geological Society of America
(GWU 6710)
ORIGIN AND EVOLUTION OF LIFE
AZORIN, F.; RICH*, A.
Isolation of Z-DNA Binding Proteins from SV40 Minichromosomes: Evidence for Binding to the Viral Control Region.
Cell
41(2): 365-374, 1985
(GWU 6947)

BARKER, W.C.; HUNT*, L.T.; GEORGE, D.G.; ORCUTT, B.C.
A Resource for Protein Identification.
In: The Role of Data in Scientific Progress (Glaeser, P.S., Ed.).
(GWU 6701)

BERMUDES, D.; MARGULIS*, L.
Microtubules in Prokaryotes (Abstract).
(GWU 6607)

Inter-chain Interactions in the Triple Helix (Abstract).
Federation Proceedings
(GWU 6742)

BROWN, S.; MARGULIS*, L.; IBARRA, S.; SIQUEIROS, D.
Desiccation Resistance and Contamination as Mechanisms of Gaia.
BioSystems
(GWU 6719)

BUCHANAN*, B.B.
Thioredoxins in Evolutionarily Primitive Organisms (Abstract).
(GWU 6803)

BUSH, J.W.
Enzymatic Lysis of the Pseudomurein-containing Methanogen Methanobacterium formicicum.
Journal of Bacteriology
(GWU 6665)

T.H. Jukes; PI
CALVIN*, M.  
Evolution and Cancer.  
In: Carcinogenesis-A Comprehensive Survey:  
The Role of Chemical and Radiation in the  
Etiology of Cancer (Huberman, E., Barr, S.H., Eds.).  
(GWU 6960)

CHINN, P.C.; PIGIET, V.; FAHEY*, R.C.  
Fluorescent Labeling of E. coli Thioredoxin by  
Monobromobimane (Abstract).  
Federation Proceedings  
(GWU 6743)

EIRICH*, F.R.; PAECHT-HOROWITZ, M.  
Further Work on Sodium Montmorillonite as Catalyst for  
the Polymerization of Activated Amino Acids (Abstract).  
In: Second Symposium on Chemical Evolution and the  
Origin and Evolution of Life, NASA Ames Research Center,  
Moffett Field, CA: NASA, Ames Research Center,  
(GWU 6765)

ELLISON, M.J.; KELLEHER, R.J., III.; RICH*, A.  
Thermal Regulation of Beta-galactosidase Synthesis  
Using Anti-sense RNA Directed against the Coding  
Portion of the mRNA.  
Journal of Biological Chemistry  
(GWU 6955)

FAHEY*, R.C.  
Distribution and Abundance of Organic Thiols (Abstract).  
In: The Global Sulfur Cycle (Sagan, D., Ed.).  
(NASA-TM-87570) (GWU 6558)

FAHEY*, R.C.; NEWTON, G.L.  
Evolution of Thiol Protective Systems in Prokaryotes (Abstract).  
In: Second Symposium on Chemical Evolution and the  
Origin and Evolution of Life, NASA Ames Research Center,  
Moffett Field, CA: NASA, Ames Research Center,  
p. 96, 1985. (NASA-CP-2425)  
(GWU 6800)

FEIGON, J.; WANG, A.H.-J.; van der MAREL, G.A.;  
van BOOM, J.H.; RICH*, A.  
Z-DNA Forms Without an Alternating Purine-pyrimidine  
Sequence in Solution.  
Science  
(GWU 6974)
FENTON, S.S.; FAHEY*, R.C.
Determination of the Thiol Components of Biologically
Important Thioesters and Disulfides (Abstract).
Federation Proceedings
(GWU 6744)

FOX*, G.E.
The Structure and Evolution of Archaebacterial Ribosomal RNA.
In: The Bacteria, Volume 8 (Woese, C.R., Wolfe, R.S., Eds.).
(GWU 6737)

FOX*, G.E.
rRNA Evolution and Prokaryotic Phylogeny (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6807)

FOX*, G.E.
Insights into the Phylogenetic Positions of Photosynthetic
Bacteria Obtained From 5S rRNA and 16S rRNA Sequence Data.
In: The Global Sulfur Cycle (Sagan, D., Ed.).
(NASA-TM-87570). (GWU 6557)

FOX*, S.W.
Physical Principles and Proteinoid Experiments
in the Emergence of Life.
In: Information Processing in Biological Systems
(Mintz, S.L., Perlmutter, A., Eds.).
(GWU 6678)

FOX*, S.W.
Protobiological Self-organization.
In: Structure and Motion: Membranes, Nucleic Acids and Proteins
(Clementi, E., Corongiu, G., Sarma, M.H., Sarma, R.H., Eds.).
(GWU 6679)

FOX*, S.W.
Morphogenesis within Evolution: Morphomolecular Evolution.
In: Evolution and Morphogenesis (Mlikovský, J.,
Novák, V.J.A., Eds.).
(GWU 6680)
FOX*, S.W.; PRZYBYLSKI, A.T.
Organic Photovoltaic Device.
US-Patent-4,514,584
(GWU 6706)

FOX*, S.W.; NAKASHIMA, T.; PRZYBYLSKI, A.
Protobiological Information, Bidirectional Recognition,
and Reverse Translation (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6784)

FOX*, S.W.; PRZYBYLSKI, A.T; NAKASHIMA, T.; VAUGHAN, G.
An Artificial Cell that Models Neurons, Junctions,
Outgrowths (Abstract).
In: Asilomar Conference on Neural Regeneration,
Asilomar, CA, December 8-12, 1985.
(GWU 6674)

FRACEK, S.P., JR.; STOLZ, J.F.
Spirochaeta bajacaliforniensis sp. n. from a Microbial Mat
Community at Laguna Figueroa, Baja California Norte, Mexico.
Archives of Microbiology
(GWU 6608)

FUJII, S.; WANG, A.H.-J.; QUIGLEY, G.J.; WESTERINK, H.;
vander MAREL, G.; van BOOM, J.H.; RICH*, A.
The Octamers d(CGCGCGCG) and d(CGCATGCG) Both Crystallize
as Z-DNA in the Same Hexagonal Lattice.
Biopolymers
(GWU 6971)

New Perspectives on Bacterial Ferredoxin Evolution.
Journal of Molecular Evolution
(GWU 6699)

GEORGE, D.G.; HUNT*, L.T.; BARKER, W.C.
Sequence Evidence Relating to the Origin
and Early Evolution of Life (Abstract).
Biophysical Journal
(GWU 7000)

------------------------------------------
L. Margulis; PI
Structural Basis for Stabilization of Z-DNA by Cobalt Hexaammine and Magnesium Cations.
Biochemistry
(GWU 6529)

GUTELL, R.R.; WOESE*, C.R.
Higher-order Structure of rRNA (Abstract).
(GWU 6808)

Biophysical Journal
(GWU 6625)

HELGERSON, S.L.; STOECKENIUS*, W.
Transient Proton Inflows during Illumination of Anaerobic Halobacterium halobium Cells.
Archives of Biochemistry and Biophysics
(GWU 6624)

HOCHSTEIN*, L.I.; ALTEKER, W.; KRISTJANSSON, H.
Is the ATPase from Halobacterium saccharovorum an Evolutionary Relic? (Abstract)
(GWU 6805)

HOCHSTEIN*, L.I.; TOMLINSON, G.A.
Denitrification by Extremely Halophilic Bacteria.
FEMS Microbiology Letters
(GWU 6842)

HUNT*, L.T.; GEORGE, D.G.; BARKER, W.C.
The Prokaryote-eukaryote Interface.
BioSystems
(GWU 6702)
JAHNKE*, L.L.
Oxygen and the Evolution of Metabolic Pathways (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 95, 1985. (NASA-CP-2425)
(GWU 6801)

JOHNSTON, B.H.; RICH*, A.
Chemical Probes of DNA Conformation: Detection
of Z-DNA at Nucleotide Resolution.
Cell
42: 713-724, 1985
(GWU 6948)

JUKES*, T.H.
A Change in the Genetic Code Mycoplasma capricolum.
Journal of Molecular Evolution
(GWU 6664)

JUKES*, T.H.
Investigations with Methanobacteria and with
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6806)

KIEBER-EMMONS, T.; MCDONALD, J.; REIN*, R.
Conformational Properties of Oncogene Products.
In: Molecular Basis of Cancer, Part A: Macromolecular
Structure, Carcinogens, and Oncogenes (Rein, R., Ed.).
(GWU 6650)

KOUYAMA, T.; BOGOMOLNI, R.A.; STOECKENIUS*, W.
Photoconversion from the Light-adapted to the Dark-
adapted State of Bacteriorhodopsin.
Biophysical Journal
(GWU 6626)

KRISTJANSSON, H.; HOCHSTEIN*, L.I.
Dicyclohexylcarbodiimide-sensitive ATPase
in Halobacterium saccharovorum.
Archives of Biochemistry and Biophysics
(GWU 6745)
LACEY*, J.C., JR.; MULLINS, D.W., JR.
Genetic Coding Catalysis.
Journal of Theoretical Biology
(GWU 6612)

LACEY*, J.C., JR.; HALL, L.M.; MULLINS, D.W., JR.
Rationalization of Some Genetic Anticodonic Assignments.
Origins of Life
(GWU 6611)

LACEY*, J.C., JR.; HALL, L.M.; MULLINS, D.W., JR.; 
WATKINS, C.L.
Chirally Selective, Intramolecular Interaction 
Observed in an Aminoacyl Adenylate Anhydride.
Origins of Life
(GWU 6989)

LACEY*, J.C., JR.; MULLINS, D.W., JR.; WATKINS, C.L.; 
HALL, L.M.
Intramolecular Interactions in Aminoacyl Nucleotides: 
Implications Regarding the Origin of Genetic Coding 
and Protein Synthesis (Abstract).
In: Second Symposium on Chemical Evolution and the 
Origin and Evolution of Life, NASA Ames Research Center, 
Moffett Field, CA: NASA, Ames Research Center, 
(GWU 6828)

LANYI*, J.K.
Functional and Evolutionary Relationships Between 
Bacteriorhodopsin and Halorhodopsin in the 
Archaebacterium, Halobacterium halobium (Abstract).
In: Second Symposium on Chemical Evolution and the 
Origin and Evolution of Life, NASA Ames Research Center, 
Moffett Field, CA: NASA, Ames Research Center, 
p. 92, 1985. (NASA-CP-2425) 
(GWU 6804)

LEY, A.; MERCER-SMITH*, J.; MAUZERALL*, D.
Cobalt as a Possible Catalyst for Prebiotic 
Photosynthesis (Abstract).
In: Abstracts of Papers, 189th American Chemical Society 
Washington, D.C.: American Chemical Society, 
(GWU 6640)
The Phylogenetic Position of Streptococcus and Enterococcus.
The Journal of General Microbiology
(GWU 6402)

LUEHRSEN, K.R.; NICHOLSON, D.E., JR.; FOX*, G.E.
Widespread Distribution of a 7S RNA in Archaebacteria.
Current Microbiology
(GWU 6738)

MACELROY*, R.D.; POHORILLE, A.
Molecular Microenvironments: Solvent Interactions with Nucleic Acid Bases and Ions (Abstract).
(GWU 6762)

MARGULIS*, L.
From Microbial Communities to Cells (Abstract).
In: The Global Sulfur Cycle (Sagan, D., Ed.).
(NASA-TM-87570) (GWU 6556)

MARGULIS*, L.
Evolución de la Célula: La Célula Eucariótica Como Comunidad Microbiana.
Arbor
(GWU 6712)

MARGULIS*, L.; SAGAN, D.
The Real Deficit: Our Debt to the Biosphere.
In: The Biosphere Catologue.
(GWU 6954)

MARGULIS* L.; BERMUDES, D.; OBAR, R.
Microbial Contributions to the Precambrian Earth (Abstract).
(GWU 6812)

MARGULIS*, L.; BERMUDES, D.
Symbiosis as a Mechanism of Evolution:
Status of Cell Symbiosis Theory.
Symbiosis
(GWU 6717)
OBAR, R.; GREEN, J.
Molecular Archaeology of the Mitochondrial Genome.
Journal of Molecular Evolution
22(3): 243-251, 1985
(GWU 6610)

PRZYBYLSKI, A.T. 2
Electrical Phenomena in Planar Membranes Made from Polymers of Amino Acids (Abstract).
(GWU 6675)

PRZYBYLSKI, A.T.; FOX*, S.W.
A New Photosensitive Material.
(GWU 6677)

RAY, N.K.; SHIBATA, M.; BOLIS, G.; REIN*, R.
International Journal of Quantum Chemistry
(GWU 6648)

REIN*, R.; SHIBATA, M.; KIEBER-EMMONS, T.; ZIELINSKI, T.J.
Mutational Activation of Proto-Oncogenes.
(GWU 6649)

REIN*, R.; RAGHUNATHAN, G.; MCDONALD, J.; SHIBATA, M.; SRINIVASAN, S.
(GWU 6830)

SAGAN, D.; MARGULIS*, L.
The Riddle of Sex.
The Science Teacher
(GWU 6718)

-----------------------------
1 L. Margulis; PI
2 S.W. Fox; PI
SCHERRER, P.; STOECKENIUS*, W.  
Effects of Tyrosine-26 and Tyrosine-64 Nitration on the Photoreactions of Bacteriorhodopsin.  
Biochemistry  
(GWU 6628)

SHAFFERMAN, A.; FLASHNER, Y.; HERTMAN, I.; REIN*, R.  
DNA Repair in the in vivo Site Specific Excision of Palindromic Sequences.  
In: Molecular Basis of Cancer, Part A: Macromolecular Structure, Carcinogens, and Oncogenes (Rein, R., Ed.).  
(GWU 6651)

STACKEBRANDT, E.; LUDWIG, W.; FOX*, G.E.  
16 S Ribosomal RNA Oligonucleotide Cataloguing.  
Methods in Microbiology  
(GWU 6736)

STOECKENIUS*, W.  
The Rhodopsin-like Pigments of Halobacteria: Light-energy and Signal Transducers in an Archaebacterium.  
Trends in Biochemical Science  
(GWU 6627)

STOLZ, J.F.  
The Microbial Community at Laguna Figueroa, Baja California Mexico: From Miles to Microns.  
Origins of Life  
(GWU 6716)

SYREN, R.M.; SANJUR, A.; FOX*, S.W.  
Proteinoid Microspheres More Stable in Hot Than in Cold Water.  
BioSystems  
(GWU 6676)

A Comparison of the Structure of Echinomycin and Triostin A Complexed to a DNA Fragment.  
Nucleic Acids Research  
(GWU 6416)
VOTANO, J.R.; RICH*, A.
Inhibition of Deoxyhemoglobin S Polymerization
by Biaromatic Peptides Found to Associate with the
Hemoglobin Molecule at a Preferred Site.
Biochemistry
(GWU 6949)

VILLANUEVA, E.; LUEHRSEN, K.R.; GIBSON, J.;
DELIHAS, N.; FOX*, G.E.
Phylogenetic Origins of the Plant Mitochondrion Based on a
Comparative Analysis of 5S Ribosomal RNA Sequences.
Journal of Molecular Evolution
(GWU 6720)

WANG, A.H.-J.; RICH*, A.
Base Pairing and Base Mis-pairing in Nucleic Acids (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 79, 1985. (NASA-CP-2425)
(GWU 6792)

WANG, A.H.-J.; GESSNER, R.V.; van der MAREL, G.A.;
van BOOM, J.H.; RICH*, A.
Crystal Structure of Z-DNA without an Alternating
Purine-pyrimidine Sequence.
Proceedings of the National Academy of Sciences, USA
(GWU 6959)

WEISBURG, W.G.; OYAIZU, Y.; OYAIZU, H.; WOES*, C.R.
Natural Relationship Between Bacteroides and Flavobacteria.
Journal of Bacteriology
(GWU 6749)

WEISBURG, W.G.; WOES*, C.R.; DOBSON, M.E.; WEISS, E.
A Common Origin of Rickettsiae and Certain
Plant Pathogens.
Science
(GWU 6973)
WOESE*, C.R.; DEBRUNNER-VOSSBRINCK, B.A.; OYAIZU, H.; STACKEBRANDT, E.; LUDWIG, W.
Gram-positive Bacteria: Possible Photosynthetic Ancestry.
(GWU 6748)

WOESE*, C.R.; STACKEBRANDT, E.; MACKE, T.J.; FOX*, G.E.
A Phylogenetic Definition of the Major Eubacterial Taxa.
(GWU 6708)

WOESE*, C.R.; STACKEBRANDT, E.; LUDWIG, W.
What are Mycoplasmas: The Relationship of Tempo and Mode in Bacterial Evolution.
(GWU 6834)

YANG, D; OYAIZU, Y.; OYAIZU, H.; OLSEN, G.J.; WOESE*, C.R.
Mitochondrial Origins.
(GWU 6747)

YOPP*, J.H.
The Role of Sulfur in Osmoregulation and Salinity Tolerance in Cyanobacteria, Algae, and Plants.
In: The Global Sulfur Cycle (Sagan, D., Ed.).
(NASA-TM-87570) (GWU 6554)

YOPP*, J.H.; PAVLICEK, K.A.; SIBLEY, M.H.
Evolutionary Significance of Osmoregulatory Mechanisms in Cyanobacteria (Abstract).
In: Second Symposium on Chemical Evolution and the Origin and Evolution of Life, NASA Ames Research Center,
PLANETARY ENVIRONMENTS
BANIN*, A.; MARGULIES, L.; CHEN, Y.
Journal of Geophysical Research
(GWU 6751)

BORUCKI, W.J.; MCKENZIE, R.L.; MCKAY*, C.P.;
DUONG, N.D.; BOAC, D.S.
Spectra of Simulated Lightning on Venus, Jupiter, and Titan.
Icarus
(GWU 6646)

CARLE*, G.C.; KOJIRO*, D.R.; HUMPHRY, D.E.
Modulated Voltage Metastable Ionization Detector.
US-Patent-4,538,066
(GWU 6705)

OBERBECK, V.R.; SCATTERGOOD*, T.W.
A Gas Chromatograph Experiment for a Titan
Entry Probe (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6789)

FRIEDMANN*, E.I.
Antarctic Cryptoendolithic Microbial Ecosystem Research
During the 1983-1984 Austral Summer.
Antarctic Journal of the United States 1984 Review
(GWU 6658)

FRIEDMANN*, E.I.; OCAMPO-FRIEDMANN, R.
Microfossils in the Antarctic Cold Desert -
Possible Implications for Mars (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 97, 1985. (NASA-CP-2425)
(GWU 6810)

HALE, M.E.; OCAMPO-FRIEDMANN, R. ¹
Ascospore Cultures of Lichen Phycobionts
from the Antarctic Desert.
Antarctic Journal of the United States 1984 Review
(GWU 6659)

¹ E.I. Friedmann; PI

---

PRECEDING PAGE BLANK NOT FILMED

PAGE 40  INTENTIONALLY BLANK
HUGUENIN*, R.L.
Iron Oxides of Mars: Evidence for Contemporary Weathering.
In: Reports of Planetary Geology and Geophysics Program-1984
(Holt, H.E., Watters, T.R., Eds.).
(NASA-TM-87563) (GWU 6492)

HUGUENIN*, R.L.
Basalts of Mars: Constraints on Volatile Evolution.
In: Reports of Planetary Geology and Geophysics Program-1984
(Holt, H.E., Watters, T.R., Eds.).
(NASA-TM-87563) (GWU 6494)

Automated Extraction of Absorption Bands from Reflectance Spectra.
In: Reports of Planetary Geology and Geophysics Program-1984
(Holt, H.E., Watters, T.R., Eds.).
(NASA-TM-87563) (GWU 6491)

KOJIRO*, D.R.; CARLE*, G.C.
Ion Mobility Drift Spectrometry (IMDS) as a Flight Analytical Instrument Technique (Abstract).
In: Second Symposium on Chemical Evolution and the Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 58, 1985. (NASA-CP-2425)
(GWU 6773)

MCKAY*, C.P.; CLOW, G.D.; WHARTON, R.A., JR.; SQUYRES, S.W.
Thickness of Ice on Perennially Frozen Lakes.
(GWU 6644)

MCKAY*, C.P.; FRIEDMANN*, E.I.
(GWU 6647)

MCKAY*, C.P.; FRIEDMANN*, E.I.
Continuous Temperature Measurements in the Cryptoendolithic Microbial Habitat by Satellite-relay Data Acquisition System.
(GWU 6660)
SQUYRES, S.W.; MCKAY*, C.P.; REYNOLDS, R.T.
Temperatures Within Comet Nuclei.
Journal of Geophysical Research
(GWU 6645)

VALENTIN*, J.R.
Multiplex Gas Chromatography for Use in Space Craft.
(NASA-TM-86668) (GWU 6673)

VALENTIN*, J.R.; CARLE*, G.C.; PHILLIPS, J.B.
Determination of Methane in Ambient Air by Multiplex Gas Chromatography.
(GWU 6672)

VALENTIN*, J.R.; CARLE*, G.C.; PHILLIPS, J.B.
(GWU 6785)

VESTAL, J.R.; FEDERLE, T.W.; FRIEDMANN*, E.I.
The Effects of Light and Temperature on Antarctic Cryptoendolithic Microbiota in vitro.
(GWU 6661)

VISHNIAC*, H.S.
Cryptococcus socialis sp. nov. and Cryptococcus consortiumis sp. nov., Antarctic Basidioblastomycetes.
(GWU 6344)

VISHNIAC*, H.S.
Cryptococcus friedmannii, A New Species of Yeast from the Antarctic.
(GWU 6394)

WHARTON, R.A., JR.; MCKAY*, C.P.; SIMMONS, G.M., JR.; PARKER, B.C.
Cryoconite Holes on Glaciers.
(GWU 6613)
WOELLER*, F.H.
(GWU 6774)
BUNCH*, T.E.; CHANG*, S.; CASSEN, P.; HOLLENBACH, D.
Dynamic Thermal Episodes in the Protosolar Nebula: 
Development of Models from Observations on CAI's (Abstract).
Meteoritics 
(GWU 6981)

DEFREES*, D.; MCLEAN, D.; HERBST, E.
Interstellar Isomers (Abstract).
In: Second Symposium on Chemical Evolution and the 
Origin and Evolution of Life, NASA Ames Research Center, 
Moffett Field, CA: NASA, Ames Research Center, 
p. 43, 1985. (NASA-CP-2425)
(GWU 6780)

DEFREES*, D.J.; MCLEAN, A.D.
Molecular Orbital Predictions of the Vibrational 
Frequencies of Some Molecular Ions. 
Journal of Chemical Physics 
(GWU 6654)

DEFREES*, D.J.; MCLEAN, A.D.
Does Carbon-protonated Hydrogen Cyanide H$_2$CN+, Exist? 
Journal of the American Chemical Society 
(GWU 6656)

DEFREES*, D.J.; MCLEAN, A.D.; HERBST, E.
Theoretical Investigation of the Interstellar 
CH$_3$NC/CH$_3$CN Ratio. 
Astrophysical Journal 
(GWU 6655)

GILLIS, J.N.; SIEVERS, R.E.; POLLOCK*, G.E.
Selective Retention of Oxygen Using Chromatographic 
Columns Containing Metal Chelate Polymers. 
Analytical Chemistry 
(GWU 6686)

GOLDSMITH, P.F.; SNELL, R.L.; ERICKSON, N.R.; DICKMAN, R.L.; 
SCHLOERB, F.P.; IRVINE*, W.M.
Search for Molecular Oxygen in Dense Interstellar Clouds. 
Astrophysical Journal 
(GWU 6722)

GROPEN, O.; HAALAND, A.; DEFREES*, D.
The Interaction of Main Group Metals with CC Double Bonds. 
Molecular Orbital Calculations on the Model Complexes 
H$_2$Zn'C$_2$H$_4$ AND H$_2$MG'C$_2$H$_4$. 
Acta Chemica Scandinavica 
(GWU 6653)
IRVINE*, W.M.; SCHLOERB, F.P.; HJALMARSON, A.; HERBST, E.
The Chemical State of Dense Interstellar Clouds.
In: Protostars and Planets, II (Black, D., Matthews, M., Eds.).
(GWU 6953)

IRVINE*, W.M.; SCHLOERB, F.P.; ZIURYS, L.M.
Boundary Conditions for the Paleoenvironment: Chemical and Physical Processes in Dense Interstellar Clouds (Abstract).
(GWU 6782)

JOHANSSON, L.E.B.; ANDERSSON, C.; ELLDÉR, J.; FRIBERG, P.;
HJALMARSON, A.; HÖGLUND, B.; IRVINE*, W.M.; OLOFSSON, H.;
RYDBECK, G.
The Spectra of Orion A and IRC+10216 between 72.2 and 91.1 GHz.
(GWU 6730)

LUKE, B.T.; MCLEAN, A.D.1
A Theoretical Investigation of Atmospheric Sulfur Chemistry.
1. The HSO/HOS Energy Separation and the Heat of Formation of HSO, HOS, and HS.
(GWU 6657)

MATTHEWS, H.E.; FRIBERG, P.; IRVINE*, W.M.
The Detection of Acetaldehyde in Cold Dust Clouds.
(GWU 6728)

MATTHEWS, H.E.; IRVINE*, W.M.
The Hydrocarbon Ring C₃H₂ is Ubiquitous in the Galaxy.
(GWU 6739)

PADIAN, K.; EDS.
The Evolution of Complex and Higher Organisms.
(NASA-SP-478) (GWU 6520)

1Doug J. DeFreese; PI
MILNE, D.H.; BILLINGHAM*, J.; RUSSELL, D.A.
Complex Life Elsewhere in Space.
In: The Evolution of Complex and Higher Organisms (Milne, D.,
Raup, D., Billingham, J., Niklaus, K., Padian, K., Eds.).
(NASA-SP-478) (GWU 6519)

RAUP*, D.M.
Magnetic Reversals and Mass Extinctions.
(GWU 6431)

RAUP*, D.M.
Life, Terrestrial Environments, and Events in Space.
In: The Evolution of Complex and Higher Organisms (Milne, D.,
Raup, D., Billingham, J., Niklaus, K., Padian, K., Eds.).
(NASA-SP-478) (GWU 6518)

RAUP*, D.M.
ETI without Intelligence.
In: Extraterrestrials: Science and Alien Intelligence
(Regis, E., Jr., Ed.).
(GWU 6663)

RAUP*, D.M.
The Fossil Record of Evolution: Analysis
of Extinction (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 102, 1985. (NASA-CP-2425)
(GWU 6814)

SEPKOSKI*, J.J., JR.
The Fossil Record of Evolution: Data on Diversification
and Extinction (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6815)

SEPKOSKI*, J.J., JR.
Some Implications of Mass Extinction for the
Evolution of Complex Life.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
(GWU 6687)
SUZUKI, H.; OHISHI, M.; MORIMOTO, M.; KAIFU, N.; FRIBERG, P.;
IRVINE*, W.M.; MATTHEWS, H.E.; SAITO, S.
Recent Observations of Organic Molecules in Nearby
Cold, Dark Interstellar Clouds.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
(GWU 6851)

TARTER*, J.
Observational Exobiology (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6778)

THADDEUS, P.; GOTTLIEB, C.A.; HJALMARSON, A.; JOHANSSON, L.E.B.;
IRVINE*, W.M.; FRIBERG, P.; LINKE, R.A.
Astronomical Identification of the C$_3$H Radical.
Astrophysical Journal
(GWU 6721)

WOLFE*, J.H.; BUNCH*, T.E.; CARLE*, G.C.
New Techniques for the Detection and Capture
of Micrometeoroids (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6772)

WOOD, J.A.; CHANG*, S.; EDS.
The Cosmic History of the Biogenic Elements and Compounds.
Moffett Field, CA: NASA, Ames Research Center, 80 P., 1985
(NASA-SP-476) (GWU 6452)
SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)
BETZ*, A.  
A Directed Search for Extraterrestrial Laser Signals.  
In: 36th Congress of the International Aeronautical Federation  
Meeting, Stockholm, Sweden, October 7-12, 7 P., 1985.  
(IAA-85-471) (GWU 6846) 

BETZ*, A.  
An Infrared Search for Extraterrestrial Laser Signals (Abstract).  

BILLINGHAM*, J.  
Summary of Session III. Universal Aspects of Biological Evolution.  
In: The Search for Extraterrestrial Life: Recent Developments (Papagiannis, M.D., Ed.).  
(GWU 6864) 

BOWYER*, S.; WERTHIMER, D.; TARTER*, J.; BUHSE, R.  
The Berkeley Serendip Project (Abstract).  

CROW*, B.; LOKSHIN, A.; MARINA, M.; CHING, L.  
SETI Radio Spectrum Surveillance System.  
In: TDA Progress Report 42-82.  
(GWU 6724) 

CULLERS, D.K.  
Software Implementation of Detection Algorithms for the MCSA.  
In: The Search for Extraterrestrial Life: Recent Developments (Papagiannis, M.D., Ed.).  
(GWU 6861) 

CULLERS, D.K.; LINSCOTT, I.R.; OLIVER*, B.M.  
Signal Processing in SETI.  
(GWU 6855)
DIXON*, R.S.
A Decade of SETI Observations (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6819)

GULKIS*, S.
Optimum Search Strategy for Randomly Distributed
CW Transmitters.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6850)

GOSLINE, R.M.; LOKSHIN, A.; QUIRK, M.P.; SOLOMON, J.
Objectives and First Results of the NASA SETI Sky Survey
Field Tests at Goldstone, California.
In: 36th Congress of the International Aeronautical Federation
Meeting, Stockholm, Sweden, October 7-12, 14 P., 1985.
(IAA-85-471) (GWU 6694)

GULKIS*, S.; OLESEN, E.T.
Goldstone Field Test Activities: Sky Survey (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6825)

HOROWITZ, P.; FORSTER, J.; LINSCOTT, I.
The Eight-million Channel Narrowband Analyzer.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6865)

KLEIN*, M.J.; GULKIS*, S.
SETI: The Microwave Search Problem and
the NASA Sky Survey Approach.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6849)

1A.M. Peterson: PI
NEWMAN, W.I.; SAGAN*, C.
Nonlinear Diffusion and Population Dynamics.
In: Interstellar Migration and the Human Experience
(Finney, B.R., Jones, E., Eds.).
Los Angeles, CA: University of California Press,
(GWU 6969)

OLIVER*, B.M.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6871)

OLIVER*, B.M.
Overview of the NASA SETI Program (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
(GWU 6826)

OLSEN, E.T.; LOKSHIN, A.; GULKIS*, S.
An Analysis of the Elements of an All Sky Survey.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6848)

PAPAGIANNIS*, M.D.
The Search for Extraterrestrial Life: Recent Developments.
A Report on IAU Symposium 112.
Journal of the British Interplanetary Society
(GWU 6795)

PAPAGIANNIS*, M.D., EDITOR.
The Search for Extraterrestrial Life: Recent Developments.
(GWU 6952)

PAPAGIANNIS*, M.D.
Search for Extraterrestrial Life.
In: Reports on Astronomy (West, R.M., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co,
(GWU 6796)

PAPAGIANNIS*, M.D.
Recent Progress and Future Plans on the Search
for Extraterrestrial Intelligence.
Nature
(GWU 6797)
PAPAGIANNIS*, M.D.
An Infrared Search in Our Solar System as Part of a More Flexible Search Strategy.

PAPAGIANNIS*, M.D.
A Historical Introduction to the Search for Extraterrestrial Life.

PAPAGIANNIS*, M.D.
A Look into the Future.

PAPAGIANNIS*, M.D.
Using the IRAS Data to Search in the Asteroid Belt for any Potential Evidence of Galactic Colonization (Abstract).

PETERSON*, A.; LINS advert, i.; BURR, J.
Stanford Hardware Development Program (Abstract).

PETERSON*, A.M.; CHEN, K.S.; LINS SCOTT, I.R.
The Multichannel Spectrum Analyzer.

QUIRK, M.P.; WILCK, H.C.; GRIMM, M.J.
A Wide-band, High-resolution Spectrum Analyzer.

A.M. Peterson; PI
SEEGER, C.L. 1
Fermi Question, Fermi Paradox: One Hit, One Out.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6859)

SEEGER, C.L.; WOLFE*, J.H.
SETI: The Microwave Search Problem and the
Targeted Search Approach.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6860)

A VLSI Design of a Pipeline Reed-Solomon Decoder.
IEEE Transactions on Computers
(GWU 6753)

SLOBIN, S.D. 2
A Conceptual 34-Meter Antenna Feed Configuration
for Joint DSN/SETI Use from 1 to 10 GHz.
In: TDA Progress Report 42-84.
Pasadena, CA: NASA, Jet Propulsion Laboratory,
(GWU 6725)

SOLOMON, J.; LAWTON, W.; QUIRK, M.P.; OLSEN, E.T. 2
A Signal Detection Strategy for the SETI All Sky Survey.
In: TDA Progress Report 42-83.
Pasadena, CA: NASA, Jet Propulsion Laboratory,
(GWU 6726)

TARTER*, J.
Goldstone Field Test Activities: Target Search (Abstract).
In: Second Symposium on Chemical Evolution and the
Origin and Evolution of Life, NASA Ames Research Center,
Moffett Field, CA: NASA, Ames Research Center,
p. 113, 1985. (NASA-CP-2425)
(GWU 6824)

TARTER*, J.
SETI Observations Worldwide.
In: The Search for Extraterrestrial Life:
Recent Developments (Papagiannis, M.D., Ed.).
Dordrecht, Holland: D. Reidel Publishing Co.,
(GWU 6868)

---------------------------------------------------
1 John H. Wolfe; PI
2 George A. Morris; PI
TARTER*, J.
Searching for Extraterrestrials.
In: Extraterrestrials: Science and Alien Intelligence (Regis, E., Jr., Ed.).
(GWU 6870)

TARTER*, J.
Using the Very Large Array (VLA) and Other Radio Telescopes to Perform a Parasitic Search for Extraterrestrial Intelligence (SETI).
Acta Astronautica
(GWU 6863)

WAGNER, K.; PSALTIS, D.
Time and Space Integrating Acousto-Optic Folded Spectrum Processing for SETI.
In: TDA Progress Report 42-84.
(GWU 6723)

VLSI Architectures for Computing Multiplications and Inverses in GF(2^m).
IEEE Transactions on Computers
(GWU 6750)

WERTHIMER, D.; TARTER*, J.; BOWYER*, S.
The SERENDIP II Design.
In: The Search for Extraterrestrial Life: Recent Developments (Papagiannis, M.D., Ed.).
(GWU 6857)

WOLFE*, J.H.
On the Question of Interstellar Travel.
In: The Search for Extraterrestrial Life: Recent Developments (Papagiannis, M.D., Ed.).
(GWU 6862)

---------------------------
1A.M. Peterson; PI
MISCELLANEOUS
THESE PUBLICATIONS WERE INADVERTENTLY OMITTED FROM THE 1984 BIBLIOGRAPHY.

ORO*, J.; LAZCANO, A.
A Minimal Living System and the Origin of a Protocell.

BASILE, B.; LAZCANO, A.; ORO*, J.
Prebiotic Synthesis of Purines and Pyrimidines.

ORO*, J.
La Evolucion Quimica y el Origen de la Vida a los Cien Anos de la Muerta de Darwin.
In: Darwin a Barcelona (Albert, P., et al., Eds.).

ORO*, J.
El Origen de la Vida.
In: Genetica Molecular (Arana, J., Ed.).
Proceedings of International Symposium on Molecular Genetics, Banco de Bilbao and Instituto de Ciencias del Hombre, Madrid, Spain, p. 25-78, 1984.

ORO*, J.
Las Condiciones Minimas de un Ser Vivo el Origen de la Vida (abstract).
In: XI Congreso de la Sociedad Espanola de Bioquimica, Resumen de las Comunicaciones, Tenerife, September 17-20, C-3, p. 6-8, 1984.
APPENDIX

PROGRAM PARTICIPANTS

DR. LUIS ALVAREZ
Lawrence Berkeley Laboratories
University of California
Berkeley, CA 94720

DR. AMOS BANIN
Department of Soil and Water Sciences
Hebrew University of Jerusalem
P.O. Box 12
Rehovot, Israel

DR. ALBERT L. BETZ
Regents of the University of California
c/o Sponsored Projects Office
M-11 Wheeler Hall
University of California
Berkeley, CA 94720

DR. A.L. Berman
NASA Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

DR. KLAUS BIEMANN
Department of Chemistry
Massachusetts Institute of Technology
Cambridge, MA 02139

DR. JOHN BILLINGHAM
NASA Ames Research Center
Mail-Stop 239-11
Code LX
Moffett Field, CA 94035

DR. WILLIAM A. BONNER
Department of Chemistry
Stanford University
Stanford, CA 94305

DR. STUART BOWYER
Space Sciences Laboratory
University of California
Berkeley, CA 94720

DR. BOB B. BUCHANAN
Division of Molecular Plant Biology
University of California
Berkeley, CA 94720
DR. E. IMRE FRIEMANN
Department of Biological Sciences
Florida State University
Tallahassee, FL  32306

DR. EVERETT K. GIBSON, JR.
SN4/Experimental Planetology Branch
Solar System Exploration Division
Space and Life Sciences Directorate
NASA Johnson Space Center
Houston, TX  77058

DR. SAMUEL GULKIS
NASA Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA  91103

DR. HYMAN HARTMAN
Department of Earth and Planetary Sciences
Massachusetts Institute of Technology
Cambridge, MA  02139

DR. JOHN M. HAYES
Biogeochemical Laboratories
Geology Building
Indiana University
Bloomington, IN  47405

DR. LAWRENCE I. HOCHESTEIN
NASA Ames Research Center
Mail-Stop 239-10
Code LX
Moffett Field, CA  94035

DR. HEINRICH D. HOLLAND
Department of Geological Sciences
Hoffman Laboratory
Harvard University
Cambridge, MA  02138

DR. R.L. HUGUENIN
Remote Sensing Center
Department of Geology and
Geography
University of Massachusetts
Amherst, MA  01003

DR. LOIS T. HUNT
National Biomedical Research
Foundation
Georgetown University Medical Center
3900 Reservoir Road, N.W.
Washington, D.C.  20007
DR. THOMAS W. SCATTERGOOD  
NASA Ames Research Center  
Mail-Stop 239-12  
Code LX  
Moffett Field, CA 94035

DR. J. WILLIAM SCHOPF  
Department of Earth and Space Sciences  
University of California  
3806 Geology Building  
Los Angeles, CA 90024

DR. J. JOHN SEPKOSKI  
Department of Geophysical Sciences  
University of Chicago  
5734 South Ellis Avenue  
Chicago, IL 60637

DR. WALther STOECKENIUS  
Cardiovascular Research Institute  
School of Medicine  
University of California  
San Francisco, CA 94143

DR. JILL TARTER  
NASA Ames Research Center  
Mail-Stop 229-8  
Code SSL  
Moffett Field, CA 94035

DR. DAVID A. USHER  
Department of Chemistry  
Cornell University  
Ithaca, NY 14853

DR. JOSE R. VALENTIN  
NASA Ames Research Center  
Mail-Stop 239-12  
Code LX  
Moffett Field, CA 94035

DR. H.S. VISHNIAC  
Department of Botany and Microbiology  
Oklahoma State University  
Stillwater, OK 74078

DR. JAMES C.G. WALKER  
Space Physics Research Laboratory  
University of Michigan  
Ann Arbor, MI 48109

81
<table>
<thead>
<tr>
<th>1. Report No.</th>
<th>NASA TM-89605</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Government Accession No.</td>
<td></td>
</tr>
<tr>
<td>3. Reponent's Catalog No.</td>
<td></td>
</tr>
<tr>
<td>4. Title and Subtitle</td>
<td>PUBLICATIONS OF THE EXOBIOLOgy PROGRAM FOR 1985 - A SPECIAL BIBLIOGRAPHY</td>
</tr>
<tr>
<td>5. Report Date</td>
<td>January 1987</td>
</tr>
<tr>
<td>6. Performing Organization Code</td>
<td>EBR</td>
</tr>
<tr>
<td>7. Author(s)</td>
<td></td>
</tr>
<tr>
<td>9. Sponsoring Agency Name and Address</td>
<td>National Aeronautics and Space Administration Washington, DC 20546</td>
</tr>
<tr>
<td>10. Work Unit No.</td>
<td></td>
</tr>
<tr>
<td>11. Contract or Grant No</td>
<td>NASA-3165</td>
</tr>
<tr>
<td>12. Type of Report and Period Covered</td>
<td>Technical Memorandum</td>
</tr>
<tr>
<td>13. Subject Category</td>
<td>55</td>
</tr>
<tr>
<td>14. Supplementary Notes</td>
<td>For previous bibliography in this series, see NASA TM-88382.</td>
</tr>
<tr>
<td>15. Abstract</td>
<td>List of 1985 publications resulting from research pursued under the auspices of NASA's Exobiology Program.</td>
</tr>
<tr>
<td>16. Key Words (Suggested by Author(s))</td>
<td>Chemical Evolution, Organic Geochemistry, Life Detection, Origin of Life, Exobiology, Extraterrestrial Life, SETI, Planetary Protection, Bibliography</td>
</tr>
<tr>
<td>17. Distribution Statement</td>
<td>Unclassified - Unlimited</td>
</tr>
<tr>
<td>18. Security Classif. (of this report)</td>
<td>Unclassified</td>
</tr>
<tr>
<td>19. Security Classif. (of this page)</td>
<td>Unclassified</td>
</tr>
<tr>
<td>20. No. of Pages</td>
<td>83</td>
</tr>
<tr>
<td>21. Price</td>
<td>A03</td>
</tr>
</tbody>
</table>

For sale by the National Technical Information Service, Springfield, Virginia 22161 NASA-Langley, 1987