

The Origin of Life and Spaceflight Biospherics

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Presentation Overview

- Introduction
- Origin of Life
 - Old and New Theories
 - Implications
- Chemistry and Physics of Reaction
- Spaceflight Biospherics
 - Integration of Concepts
 - Implications
- Summary

Introduction

- Premises
 - Manned exploration: prohibitive technology is biospheric-, not launch-related
 - No excessive dependencies, no excessive launches
 - Origin of life is relevant; useful
 - Abiogenic production of organic mono- and polymers
 - Abiogenic processes liberate spaceflight logistics from Earth refueling dependencies
 - Life originating here yields life thriving there

Origin of Life

- Many theories; no definitive proof
 - Miller-Urey (lightning synthesis)
 - Sagan (infalling meteor shock synthesis)
 - Panspermia (extraterrestrial material/biota)
 - Cairns-Smith (crystalline mineral catalysis)
 - Waschterhauser (chemolithotrophic catalysis)

New Theory- Radiolytic Synthesis, Organic Takeover

- Life has a terrestrial origin
 - Radioactive decay provides energy impetus
 - Mineralogical associations provide elements and molecules as nutritive resources, helpful catalysts
 - Environmental (geological + atmospheric) setting provides effective reaction matrix
 - Localized production site provides recombinant reaction processes and diversification of reaction yield

Chemistry/Physics – Homolysis

- Basics of Homolysis:
 - Low-entropy energy bombardment (Initiation)
 - Extremely reactive free radicals w/unpaired valence electrons (Propagation)
 - Radical recombination and product yield (Termination)



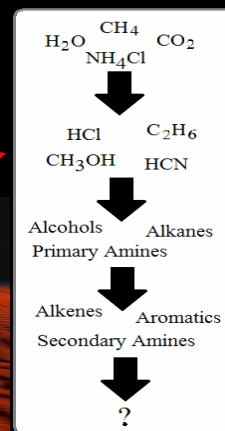
1. Initiation



2. Propagation



3. Termination



Chemistry/Physics – Energy (1)

- Many energy sources possible
 - Chemical, radiative, electrical, thermal, etc.
- $E = U - TS$
 - E = Helmholtz free energy [J]
 - U = Total input energy [J]
 - T = Temperature of reaction [K]
 - S = Entropy of reaction [J/K]
 - Decrease T , decrease S , or increase U to increase E , the ‘useful’ energy left to do productive work (under optimal conditions)

Chemistry/Physics – Energy (2)

- Energetic considerations

Source	Energy (cal/cm ² /yr)
Sunlight (all wavelengths)	260,000
Electric Discharges	4
Cosmic Rays	4
Radioactivity (to 1.0 km depth)	0.8
Volcanoes	0.13

Source: Miller and Urey

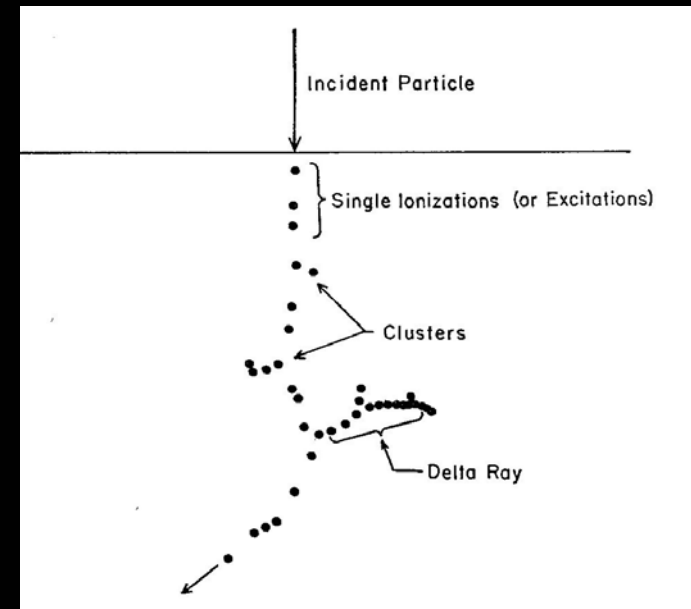
- Entropic considerations

Form of Energy	Entropy Per Unit Energy
Gravitational Energy	0
Nuclear Energy	10 ⁻⁶
Internal Heat of Stars	10 ⁻³
Sunlight	1
Chemical Reactions	1-10
Terrestrial Waste Heat	10-100
Cosmic Microwave Radiation	100-1000

Source: Van Nostrand's Sci. Encyclopedia

Chemistry/Physics - LET

- Linear Energy Transfer –
 $L = dE/dx$
- Not all radiolytic sources equal
 - Alpha: high-LET
 - Beta, gamma: low-LET
 - Physics are stochastic, but net effects are quasi-predictable
 - Bragg Curves, radiobiological treatment



Source: LET Physics, ICRU Pub.

Spaceflight Biospherics

- Current reference designs:
 - Initial resources, subsequent replenishment
- Recycling is significant, but so far insufficient for biospheric independence
- Current ISRU techniques produce useful inorganic molecules
- New concept: Origin of life processes yield organically assimilable ISRU products

Implications

- Abiogenic production of (extraterrestrially) exotic monomers and polymers
 - Trophic support for primary (and secondary, tertiary?) members of enclosed biosphere
 - Limited production of mechanically-valuable inorganic monomers and polymers

Closed-system recycling

+ abiogenic molecule production

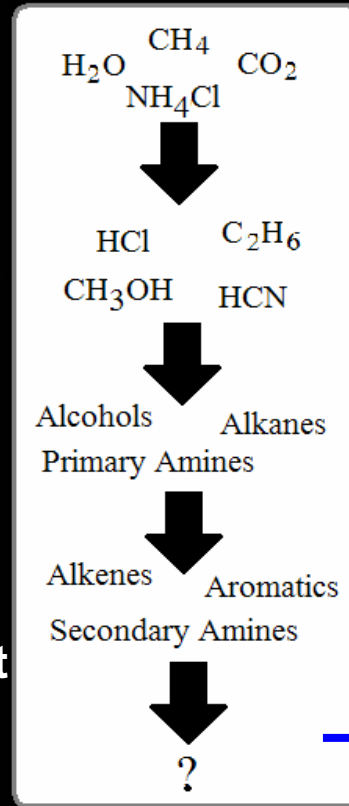
= independent biosphere

Spaceflight biospherics

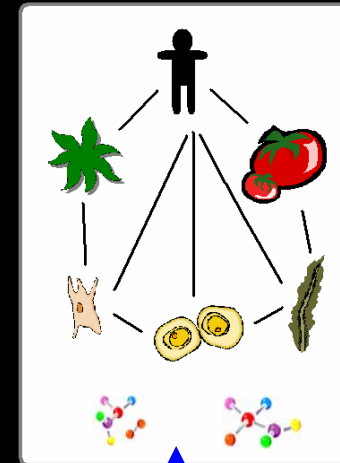
Cosmic, nuclear
technology
radiation



Bombardment



Ionization and
Recombination
(Protection)



Biological
Assimilation

Extraction,
Separation,
and Storage

Conclusions of Research

- Corpuscular radiolytic reactions were not proven unfeasible; ***but*** feasibility requires testing
- Immediate experimentation (new and old theories)
 - No origin of life constraints
 - Wide array of reactants and catalysts
 - Industrialize process
- Proposed device can be multifunctional when integrated with current designs
- Proposed device could revolutionize methods of extraterrestrial survival, and hence methods of exploration, ***enabling colonization.***

Summary

- Biospheric independence leads to reduced overall mission costs, increased flexibility
- Origin of life studies can enable greater understanding of artificial biospheric generation and stability
- Research indicates homolytic processes could revolutionize space survival by protecting crew, and stabilizing biosphere through regenerative organic energy input

End of Presentation

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