



第14回宇宙科学シンポジウム
1/8-9/2014

惑星間塵中の有機物と生命の起源： 宇宙実験「たんぽぽ」による検証

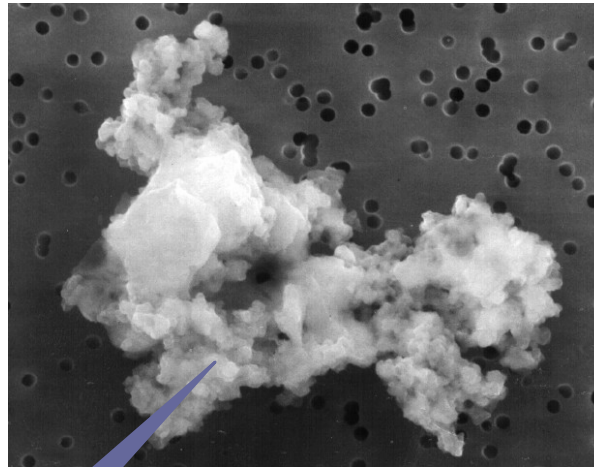
小林 憲正^{1,2}, 三田 肇³, 中川和道⁴, 藪田ひかる⁵,
奥平 恭子⁶, 今井栄一⁷, 田端 誠^{8,9}, 矢野 創⁹, 橋本博文⁹,
横堀伸一¹⁰, 山岸明彦^{2,10}, たんぽぽWG⁹

¹横浜国立大学, ²自然科学研究機構, ³福岡工業大学, ⁴神戸大学,
⁵大阪大学, ⁶会津大学, ⁷長岡技術科学大学 ⁸千葉大学,
⁹JAXA宇宙科学研究所, ¹⁰東京薬科大学

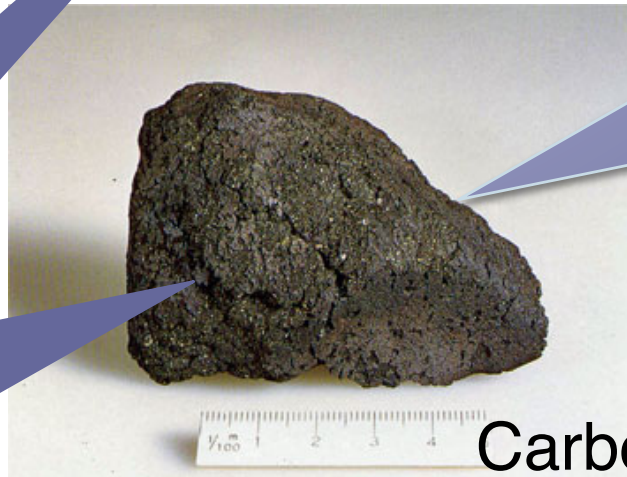
要旨

炭素質コンドライトや彗星に含まれる有機物と地球生命誕生との関連が議論されている。しかし、隕石や彗星は地球との衝突により含有する有機物が分解する可能性が高い。一方、惑星間塵はより安全に多くの有機物を供給できたと考えられるが、これまでそれらが地球生物圏で捕集されてきたことなどから、その有機物、特に生体関連有機物の有無に関しては不明な点が多い。われわれは、現在準備中の宇宙実験「たんぽぽ計画」で、宇宙ステーション曝露部での惑星間塵を含むダストの捕集や、アミノ酸等の宇宙環境への曝露を行う予定である。前者では、新たに開発された低密度($\sim 0.01 \text{ g cm}^{-3}$)のエアロゲルを用いて、高速($\sim 10 \text{ km/s}$)で飛来するダストの捕集を行う。後者では、隕石や彗星で検出され、惑星間塵にも存在が期待されるアミノ酸前駆体等を宇宙環境に曝露してその安定性を評価する。この準備として、二段式軽ガス銃や種々の加速器、紫外線ランプを用いた地上予備実験を行っている。

Complex (High Molecular Weights) Organics in Space as Possible Sources for the First Life



Interplanetary
dust particles

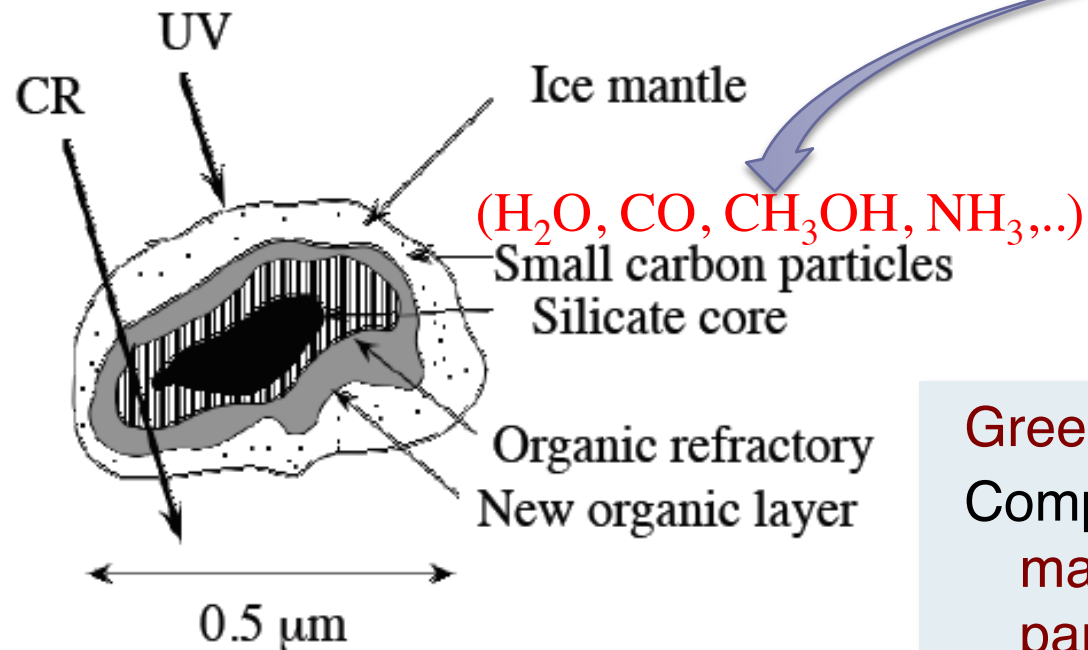


Large
molecular
weight organics

Amino acids
Nucleic acid
bases
Fatty acids,...

Carbonaceous chondrites

Origin of Organics in Comets and Meteorites: Formation in Molecular Clouds



Greenberg Model:

Complex organics are formed in **ice mantles of interstellar dust particles** in molecular clouds



Simulation
Experiments



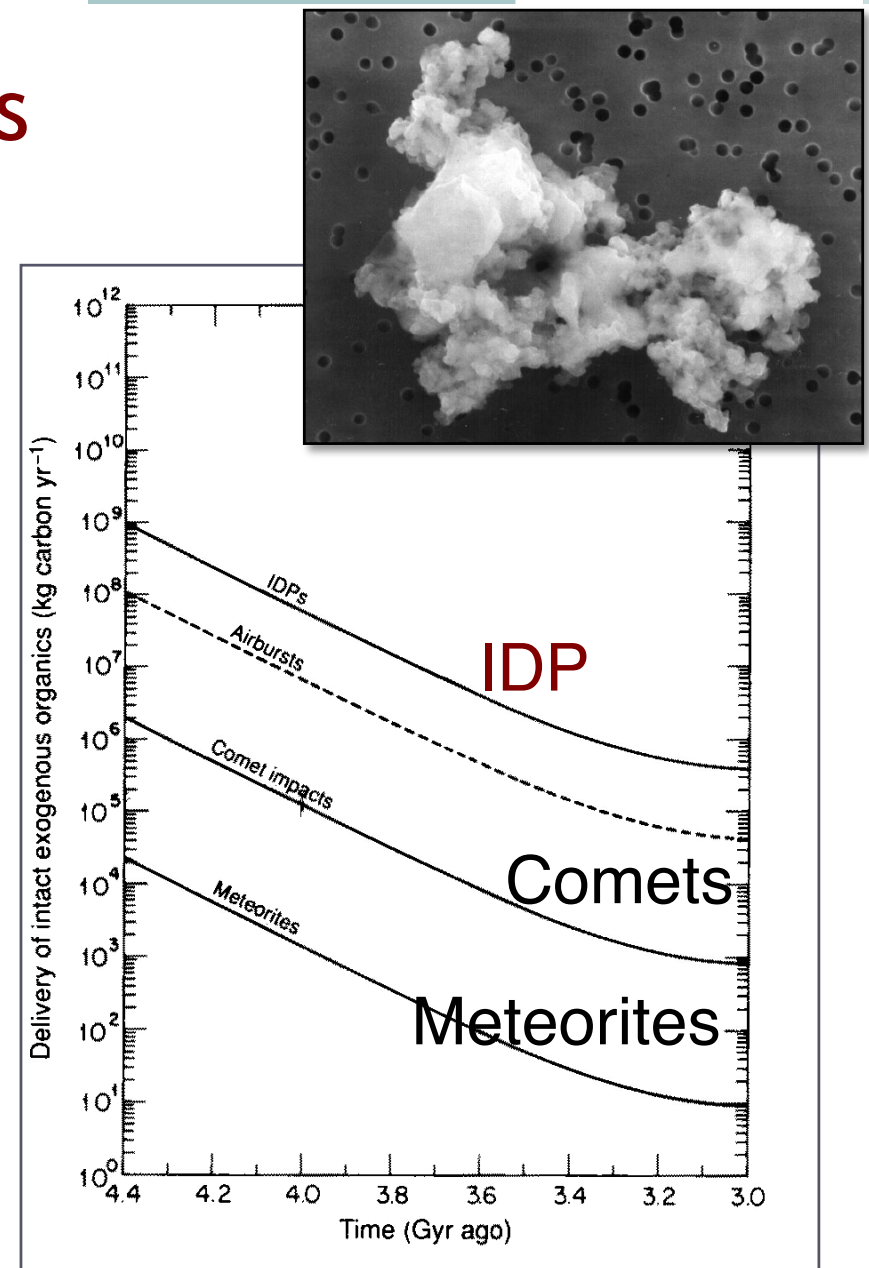
Irradiation Products

- ✓ Estimated molecular weights: **thousands**
- ✓ **Amino acids** were formed after hydrolysis

Alteration and Delivery of Interstellar-origin Organics in the Solar System: Were IDPs major carriers?

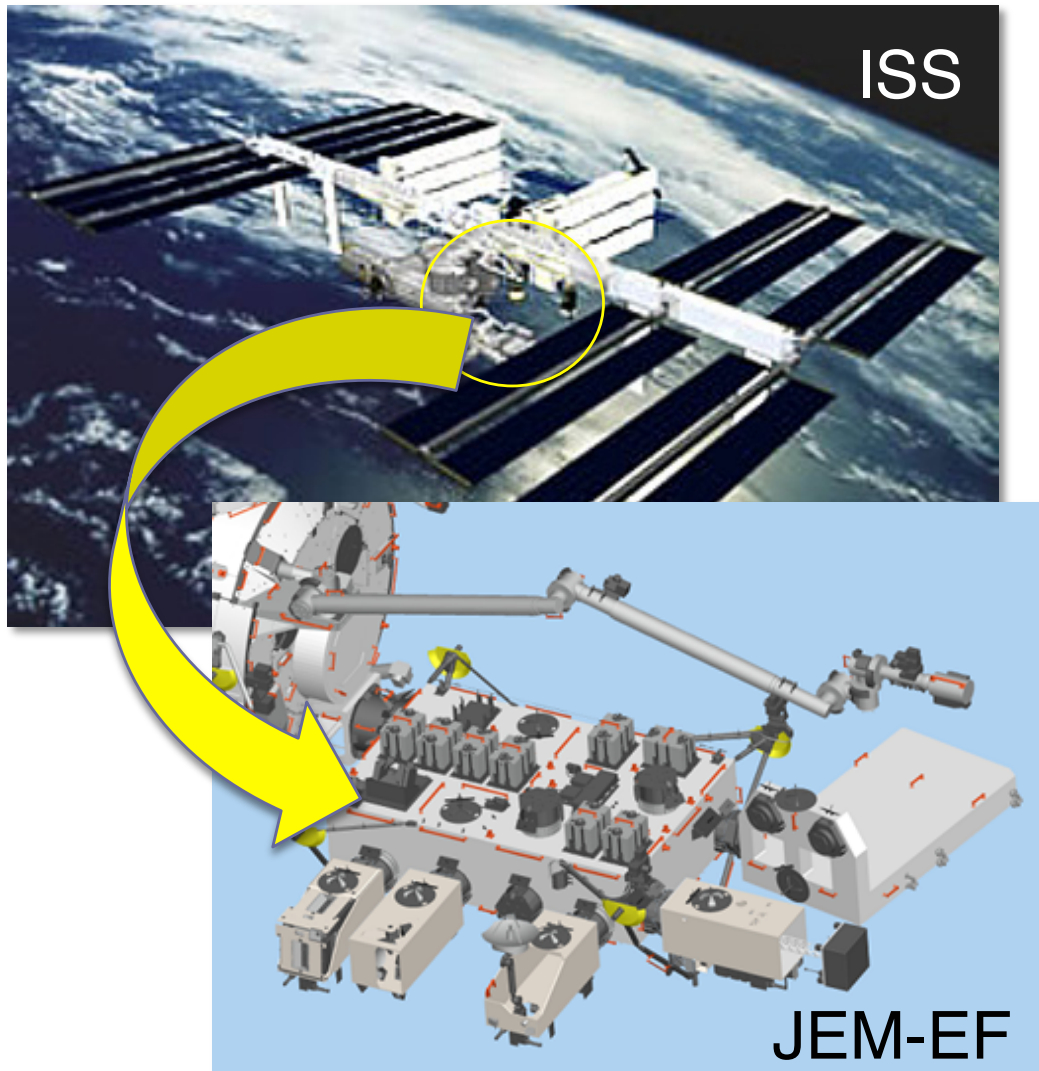
- ✧ IDPs delivered more organics to the Earth than meteorites and comets
- ✧ IDPs delivered organics more safely than meteorite and comets.

- ✧ IDPs are directly exposed to solar / cosmic radiation.
- ✧ IDPs are easily contaminated from terrestrial biosphere.



(Chyba & Sagan, 1992)

The Tanpopo Mission on the Exposed Facility of JEM, ISS

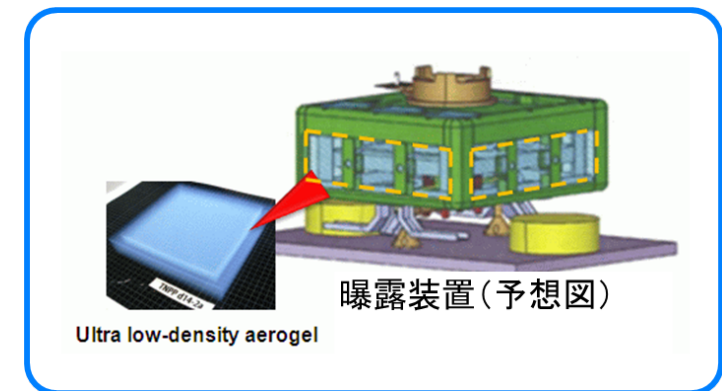


Objectives:

- Microbe capture
- Microbe exposure
- Analysis of organics in space dusts
- Organics exposure
- Development of new aerogel
- Monitoring of space debris

Capture of Cosmic Dusts and Analysis of Organic Compounds in Them

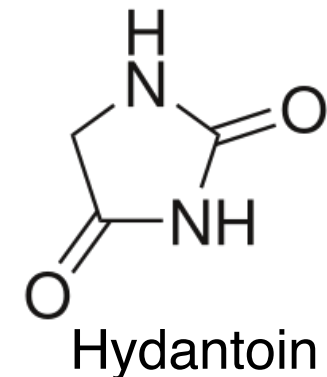
- Capture of cosmic dusts (including interplanetary dust particles) with ultra-low density aerogel
- Analysis of amino acids after HF digestion and hydrolysis
- Characterization of insoluble organic materials



Exposure of Organic Compounds

Amino acids and their precursors will be exposed to solar UV and cosmic radiation for 1-3 years.

- Glycine
- Hydantoin (**Precursor** of glycine)
- Isovaline (α -methyl non-protein amino acid)
- 5-Ethyl-5-methyl hydantoin (**Precursor** of Isovaline)
- “CAW” (**Complex amino acid precursors** produced by proton irradiation of a mixture of CO, NH₃ and H₂O)



Summary

1. The organic exposure experiments in *the Tanpopo Mission* was designed to confirm the hypothesis that extraterrestrial organics played important roles in the generation of the first terrestrial life.
2. In the *Capture Experiment*, cosmic dusts were captured with ultra-low density aerogel, and organics including amino acid precursors will be characterized.
3. In the *Exposure Experiment*, stability of free and combined amino acids will be compared after 1-3 years' exposure to space UV and radiation.
4. Contribution of low MW precursors or high MW ones to the first life on the Earth will become clear in this experiment.
5. The experiments would be launched in Fall, 2014 at the earliest.