# ASTR/GEOL-2040: Search for life in the Universe, Lecture 1


Axel Brandenburg
(Visiting Professor from Nordita, Stockholm)

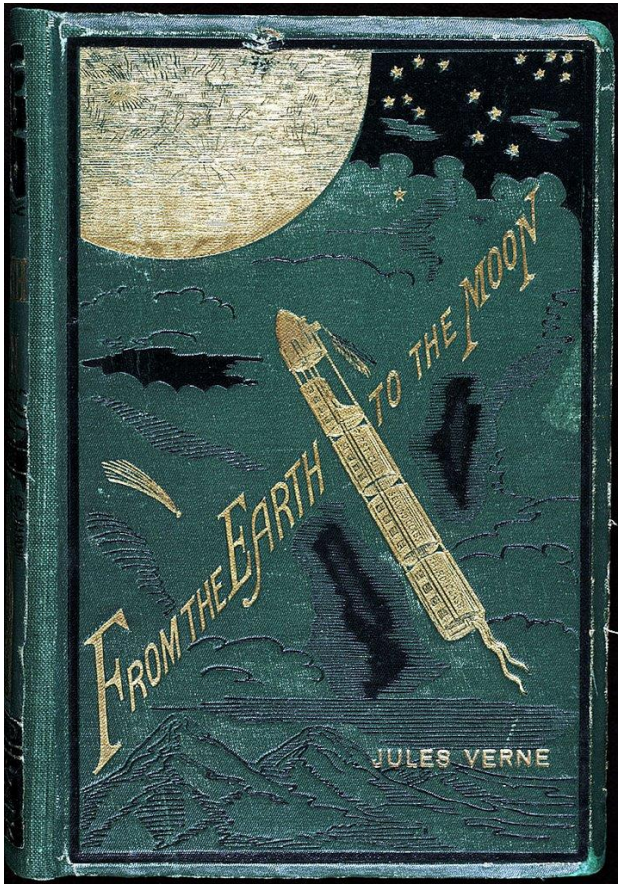
# What I like about the subject

- Touches up an important question
  - Where do we come from
  - How does life emerge
- Involves many disciplines
  - Astronomy
  - Biology
  - Chemistry
  - Geology
  - Physics

# *Can you think of examples, why?*

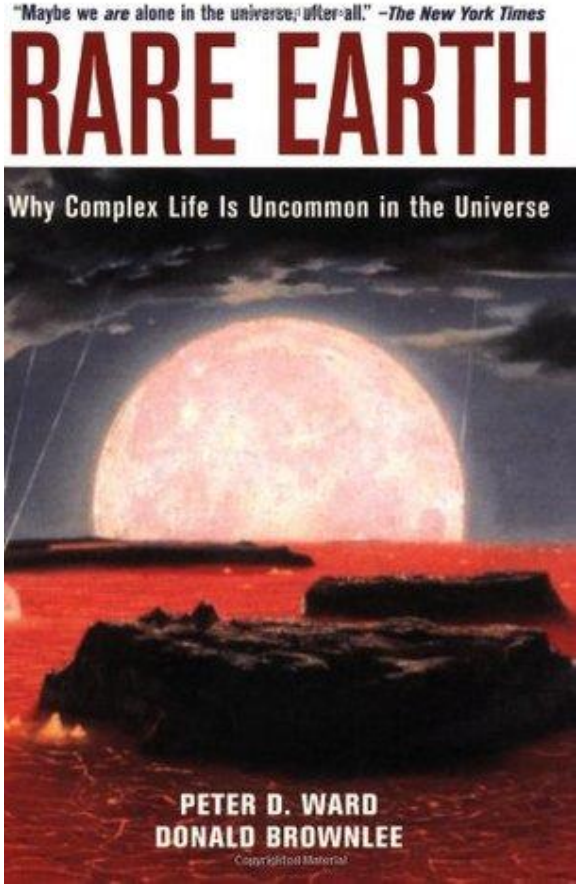
- Astronomy
- Biology
- Chemistry
- Geology
- Physics

# *Science fiction → science hypothesis*




1865

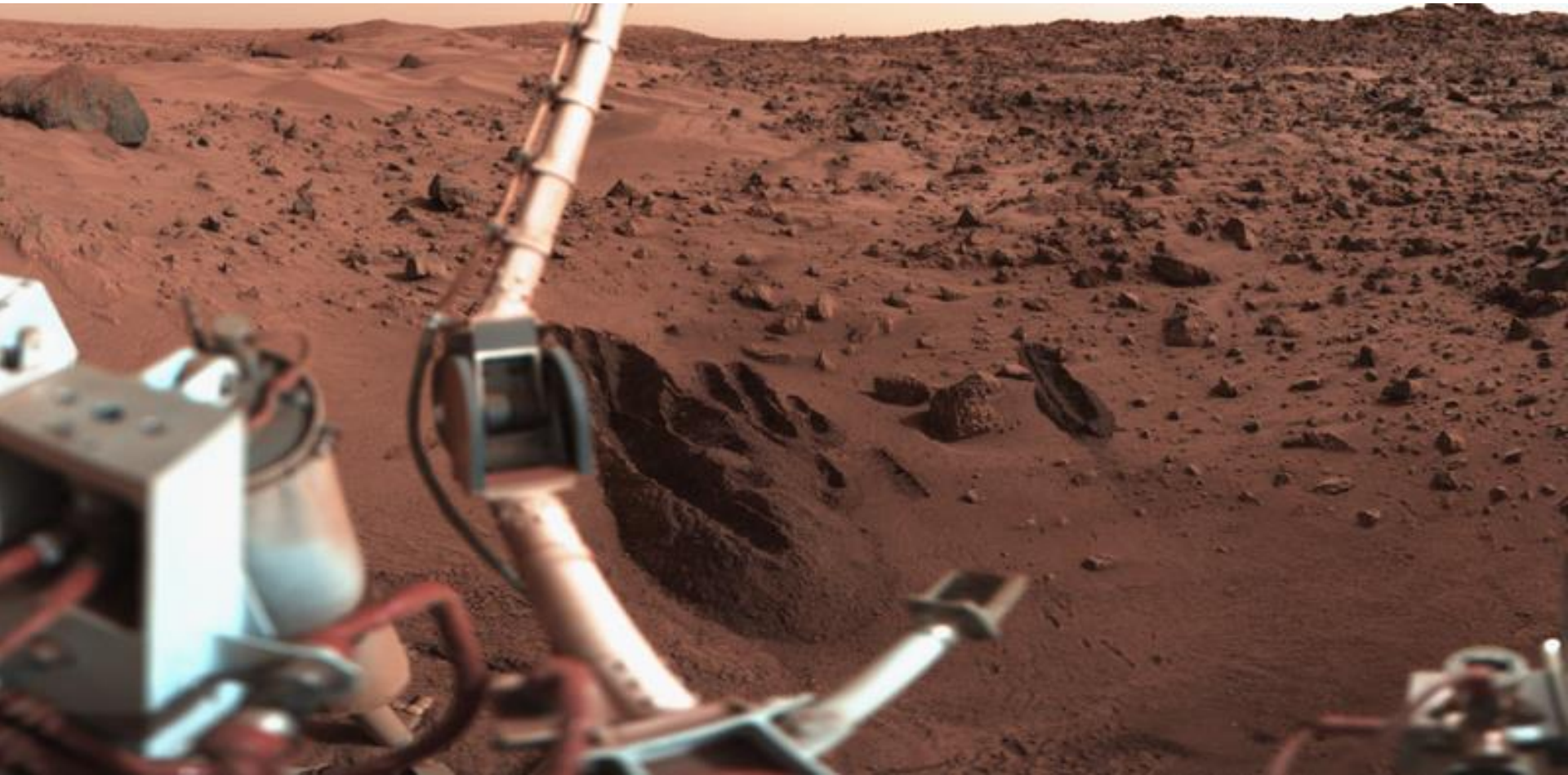

1951



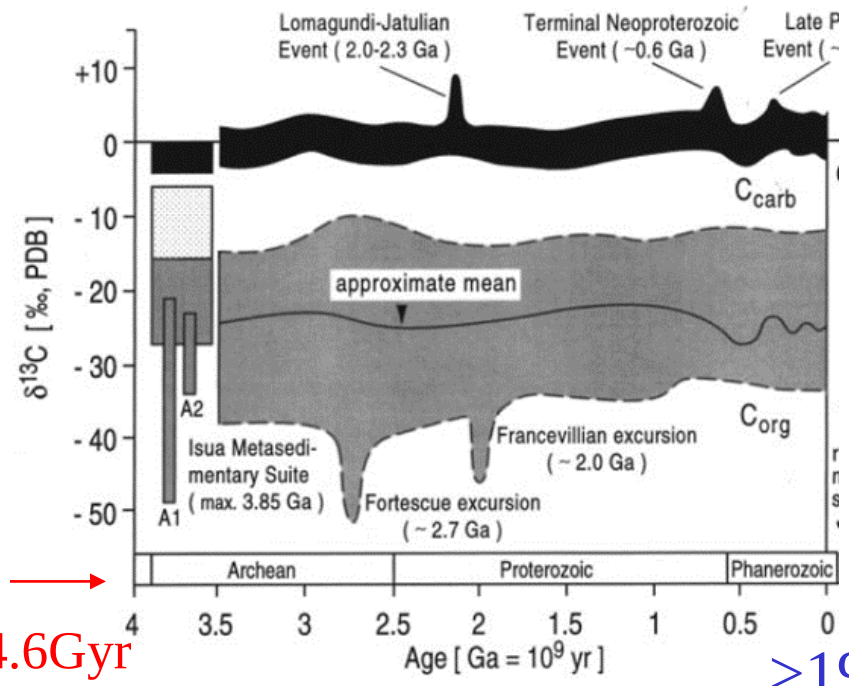

2000

# What happened since 1976?

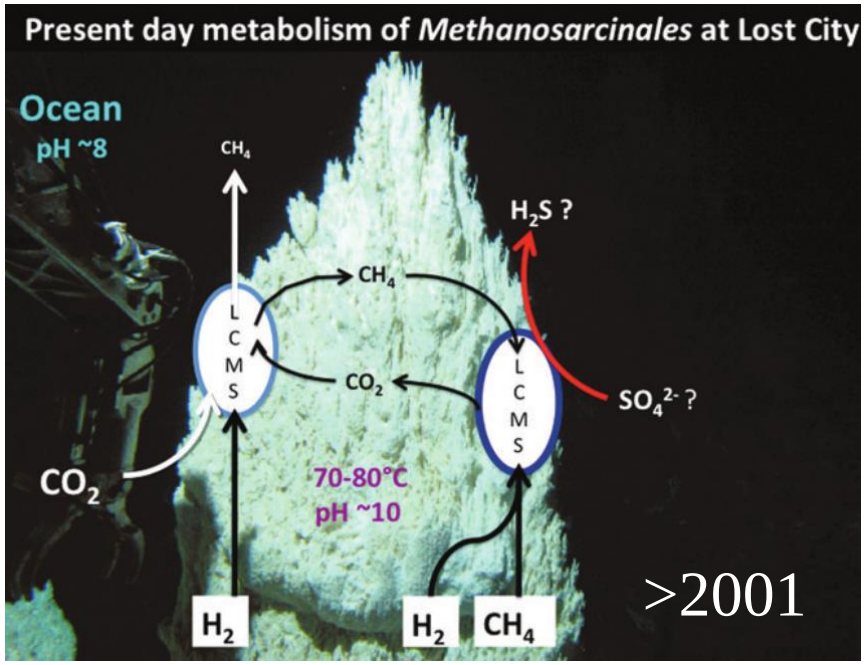
- Public lost interest after Viking 1 & 2 returned negative results
- NASA funded Astrobiology Institute in 1998 (also ALH84001)
- New insights & paradigm shifts in just the last 10-20 yr



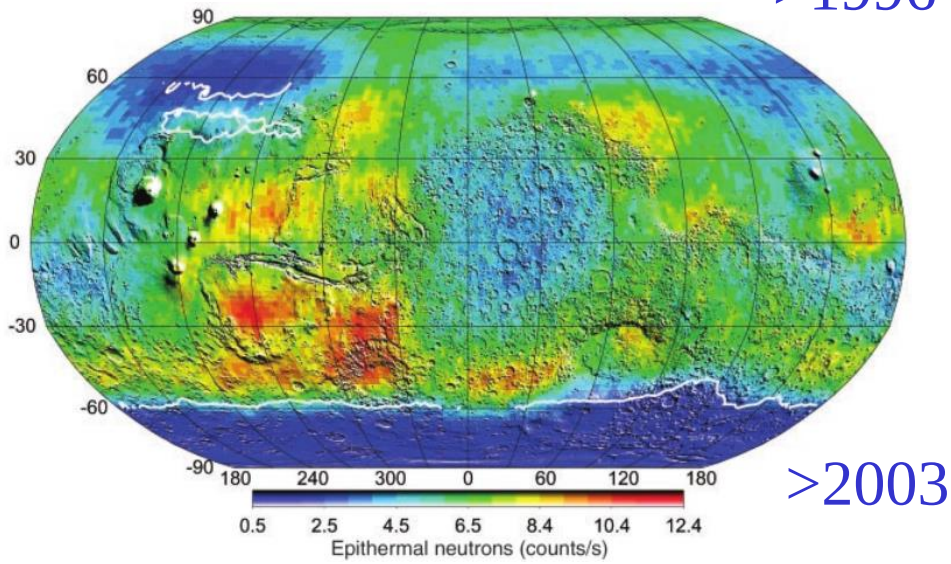
# The 4 cornerstones of astrobiology



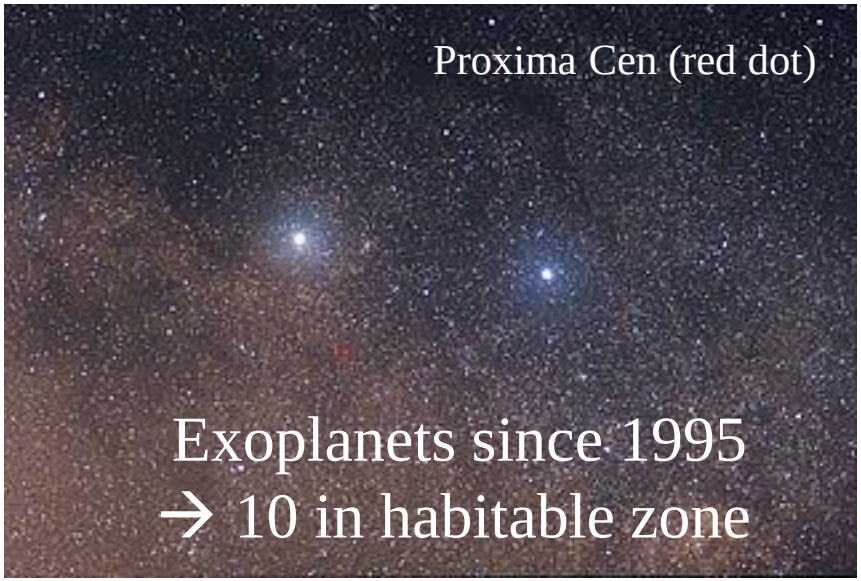

4.6Gyr




>1996




>2003



# *Syllabus*

- Weeks 1-4: Origin of life studies
  - Bottom up (chemistry)
  - Top down (biology)
- Weeks 5-7: Origin on Earth
  - Habitable zones (astronomy)
  - Geol. record (geology), extremoph (bio)
- Weeks 8-12: Mars, Europa, etc
  - Planetology, geology, chemistry
- Weeks 13+14: exoplanets, SETI

# *Fiske Planetarium*

- Friday 13 Oct
- Friday 17 Nov

# Books

**COURSE MATERIAL**

**Primary textbook (required):**

- *An Introduction to Astrobiology,* by David A. Rothery, Iain Gilmour, & Mark A. Sephton (Cambridge University Press, 2011):

**Recommended reading (see library):**

- *Astrobiology: An Introduction,* by Alan Longstaff (CRC Press, 2014), contains more detailed explanations
- *Life in the Universe,* by Jeffrey O. Bennett & Seth G. Shostak (Pearson, San Francisco, 2017), is entertaining and contains many other aspects, but is also expensive

# Grading

- 6 homeworks, best 5 will be graded
- Midterm exam , 2 quizzes
- In-class engagement, clicker grades

The final grade will be assembled from the following components:

| | |
|---|---|
| 6 Homework Sets | 25% |
| Quizzes | 20% |
| Midterm Exam | 20% |
| Final Exam | 25% |
| In-Class Engagement | 10% |
| Total | 10% |

# General remarks

- Office hours in D230 (in Duane)
- Wednesdays 11-12, + by appointment
- Erika: Astronomy help room D142 (Erika: W 2-4, D239 W 1-2)
- Help room: TWTh: 2-6

- This week: let me know about special accommodations etc (email or talk to me)
  - Notetaker (?): volunteers?

## ACADEMIC INTEGRITY

All students at CU Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion).

For this course, I encourage you to discuss the assignments and topics with your fellow students. However, everything that is written up and submitted must be your own independent work. If you do collaborate with other students, a good time to split off from the group is when you start to write up your answers. If someone were to ask you questions about your work, you should be able to explain everything about how & why you did it the way you did.

## STUDENTS WITH DISABILITIES

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities, and they can be contacted at 303-492-8671, by e-mail (dsinfo@colorado.edu), or on the web (disabilityservices.colorado.edu).

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Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. If you have religious obligations that result in schedule conflicts, please contact me in the first two weeks of class to make alternate arrangements.

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CU Boulder is committed to maintaining a positive learning, working, and living environment. The University of Colorado does not discriminate on the basis of race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status in admission and access to, and treatment and employment in, its educational programs and activities. CU Boulder will not tolerate acts of discrimination or harassment based upon protected classes or related retaliation against or by any employee or student. For purposes of this CU Boulder policy, "protected classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, or veteran status. Individuals who believe they have been discriminated against should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Student Conduct (OSC) at 303-492-5550.

## CLASSROOM BEHAVIOR

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

# Other remarks

- Teaching assistant:
  - Erika Zetterlund
- Broad background in class
  - astro, engl, anthrop, marketing, busin, chem&bio eng, archit, aerosp, ling, phil, phys, geol, evol bio, psych, hist, journ, …
- Cell-phones/laptop use distracts others

# *About myself*

- Why I'm here as 3-yr visiting professor
- Why I'm interested in Space & the Sun
- What else I did
- …..
- Sorry, what did you just say?

Sept 16, 1975

## Die 1oo. Rakete

Die Zirkon 1 ist eine zweistufige Rakete. Die erste Stufe besteht aus drei Monopause-Boosterstufen (Tripause), die zweite Stufe ist eine Monopause.
Am Mittwoch (1o.9.75) wurden Adapter gebaut. Am Donnerstag bzw. Freitag wurden die Tripause bzw. die Monopause gebaut. Am Samstag war die Rakete dann startbereit. Der Wind ließ jedoch einen Start erst am Dienstag (16.) zu. Bereits am Vorabend zeichnete sich eine wetterbesserung ab. Somit wurden beauftragt Hendrikje Steffen zum fotografieren des Starts (s.u.) Ingrid Schreiber zum Aufnehmen von Serienaufnahmen des Starts, SFB zur Flughöhen-messung,andere Personen zur Beobachtung der Flugbahn. Das Foto links zeigt den Start der Zirkon. Der Tri - x - Film wurde mit einem sehr hart arbeitenden Astroentwickler entwickelt. Daher sind leider keine Einzelheiten auf der Rakete sichtbar.

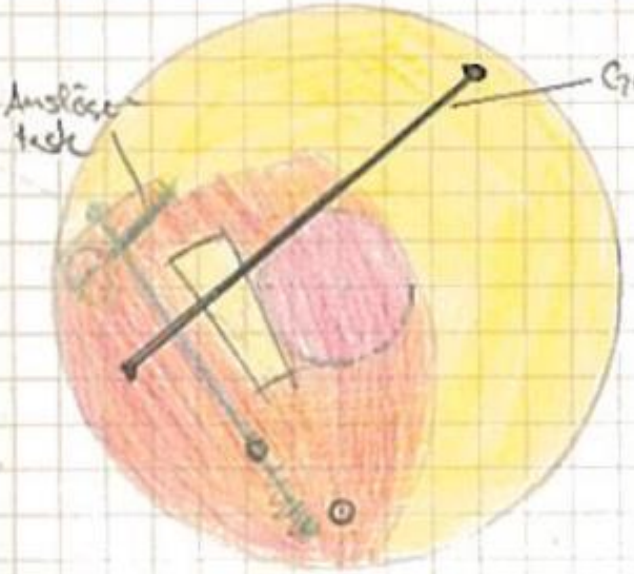
Die Stufentrennung der Zirkon nach 6.5 s in etwa 3oo m Höhe über Heide.

Der atemberaubende Anblick im Feldstecher kommt dieser Fotografie schon recht nahe. Wulf hat von der Bodenstation aus fotografiert. Ob die Flugbahn in der Tat in solchen Schlangenlienien verlief ist nicht ganz gewiß!

6.6.73

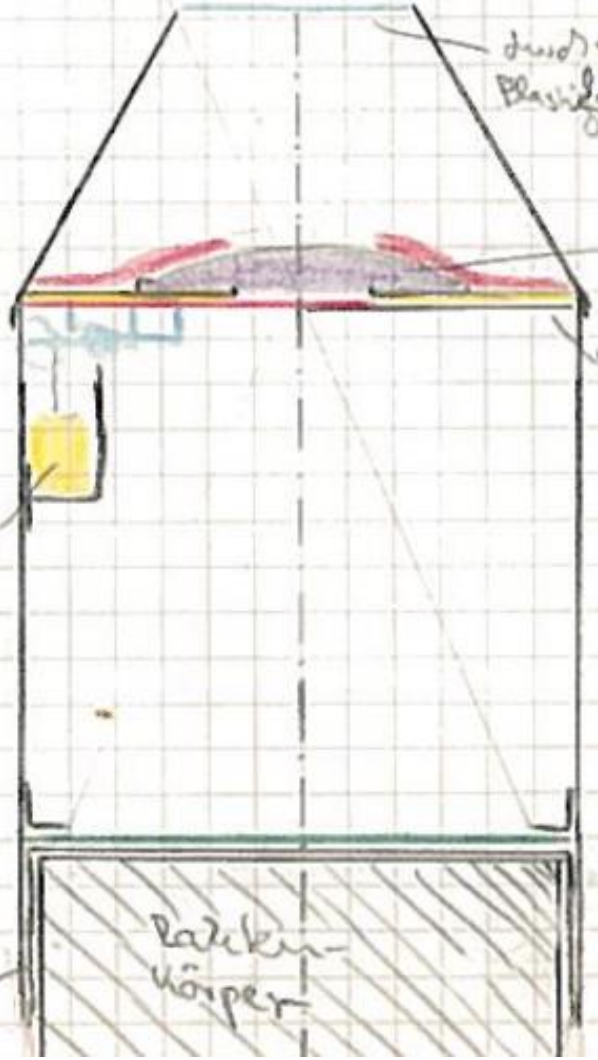
II RAFLA II-Fotosonde

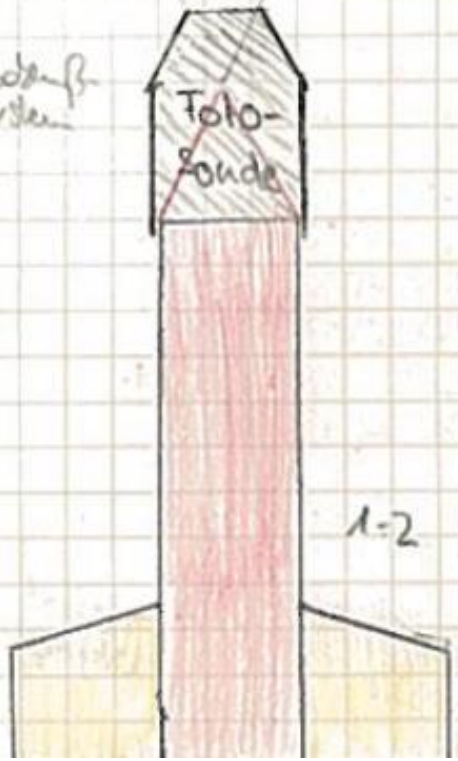
Maßstab 2:1




Verschluß von innen gesehen

Objektiv 1:5/30 mm



Die

R A F L A M

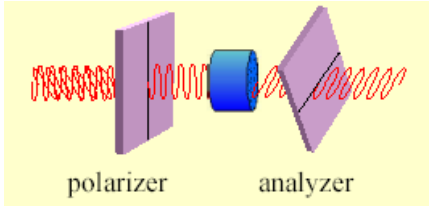
stellt mit ihrem Fotosondenprojekt eins der interessantesten und erfolgreichsten Pläne vor. Es mußten zwar noch 8 Monate vergehen, bis wir tatsächlich eine echte Fotosonde an dieser Stelle begutachten konnten.

Die Nutzlst einer Rakete ist doch eigentlich immer das einzige, war ihr einen Sinn geben könnte. Diese Fotosonde erfüllt diese Aufgabe geradezu vorzüglich. Es standen

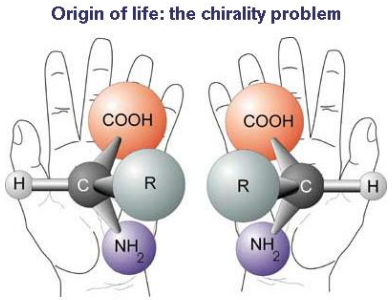
# …then, what did I do?

| Where | Age | New things |
|---|---|---|
| School | 7-19 | Age 14-16 ***rockets***, electronics, 14-18 astronomy |
| Alternate service | 19-21 | astrophotography |
| Hamburg University | 21-27 | Convection, linear theory, interest in aurora |
| Helsinki University | 27-31 | PhD, magnetic fields, 3-D simulations |
| Nordita in Copenhagen | 31-33 | Accretion discs, supervised student |
| Newton Institute Camb. | 33 | In-depth exposure to many scientists |
| ***NCAR, Boulder, Colorado*** | 33-35 | Galactic magnetic fields, turbulence |
| Nordita, (assistant prof) | 35-37 | Early Universe, organized school, … |
| Newcastle (professor) | 37-41 | Teaching courses, project + PhD students |
| Nordita (professor) | 41-47 | ***Astrobiology***, Pencil Code |
| Nordita (Stockholm) | 47-56 | Big European grant, own group, visitors |
| ***CU Boulder (vis faculty)*** | 56-59 | ***Solar physics, more astrobio, meteorology*** |

*International Journal of Astrobiology* 3 (3): 209–219 (2004) Printed in the United Kingdom
DOI: 10.1017/S1473550404001983 




# How long can left and right handed life forms coexist?

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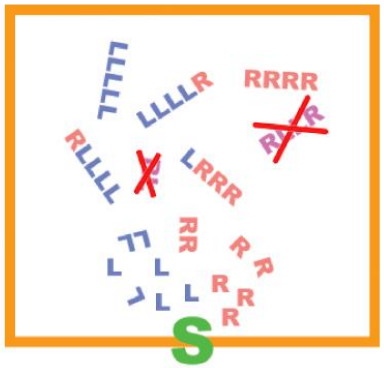
igins of Life and Evolution of Biospheres (2005) 35: 225–241
)I: 10.1007/s11084-005-0656-9 

## HOMOCHIRAL GROWTH THROUGH ENANTIOMERIC CROSS-INHIBITION

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*phone: +45 353 25228; fax: +45 353 89157)*

# Homochirality in an Early Peptide World

AXEL BRANDENBURG,[1,2] HARRY J. LEHTO,[1,3] and KIRSI M. LEHTO[1,4]

# *What we talked about*

- Definition of life
  - Darwinian evolution, natural selection
  - & self-replication
- Next time:
  - Why carbon, & not silicon-based
  - Why water?
  - pp. 3-8, Sects. 1.1 & 1.2