A Roadmap for Universal Life

29 October – 2 November 2018 @ Oort

Science:

Description and aims:
(1) To put together a roadmap for future research at the interface of astronomy, geology, chemistry and biology that can be addressed experimentally and/or theoretically within the next few years, that
will help the astronomer rank which exoplanets in the liquid water habitable zone are most likely to harbor life.
(2) To apply knowledge from exoplanet observations and modeling, and from planetary science, to inform the range of possible environments that can be explored experimentally by chemists and biologists, and can explore the range of planetary conditions under which life might arise, as well as a more comprehensive range of geological, hydrological and atmospheric conditions that may be encountered on the Early Earth.

Tangible outcome:
A whitepaper describing the roadmap will be written and submitted Origins of Life and Evolution of the Biosphere. This peer reviewed scientific journal serves the scientific community that we aim to target with the roadmap. We aim to submit the paper before the summer of 2019.

(beginning) Scientific breakthrough?
No direct scientific breakthroughs resulted from the workshop, but the groundwork was laid out for future scientific breakthroughs (see Aha Moments for further details).

"Aha" moments:
Groups that previously did not collaborate left the workshop planning collaborative
research by sharing students. There are plans for new experiments to be performed on the interface between different groups. For example, between synthetic biology and prebiotic chemistry, there is now fruitful collaboration toward a combined experiment. The synthetic biologists design simplified cells that can perform many of the functions of modern cells with far less molecular machinery, but the molecular machinery they use is taken from modern cells. The prebiotic chemists have discovered
possible alternative prebiotic ways of performing some of the functions in modern cells. There is now a plan to substitute the modern cellular machinery with these prebiotic solutions to see how well the simplified cell can function. At the same time, many of the prebiotic experiments are undertaken in very clean laboratory conditions that are unlikely to be achieved on the Early Earth. Geologists are informing the prebiotic chemists about more realistic 'dirty' conditions, and are working on a strategy
with the chemists for an upcoming 'dirty' chemistry experiment ('chemistry in olivine flasks'), incorporating these conditions, to see how well the chemistry still works, if new avenues for the chemistry are opened up, and new mechanisms discovered, that can help constrain in what geochemical environments the prebiotic chemistry can take place. A very exciting development was in the realization that hydrogen cyanide, a key feedstock molecule for prebiotic chemistry, is a major constituent of comets, and that the delivery of cyanide can be constrained for other planetary systems
given the disk chemistry and planet formation and evolution scenarios. A project between chemical physicists, prebiotic chemists and astronomers is underway to investigate this, and a grant application
is presently being written to fund this work.

Organization/Format:
How did you experience the format of the workshop (the structure of the program, lectures vs discussion time etc.)? Did you try something new (different kind of discussions for instance)? If so, how did it work out? Would you do it again or advise it to others?

Interdisciplinary workshops are always slow-going at the beginning, because it takes time for people in different fields to get used to talking to each other. One of the ways we tried to address this problem
was to have an ice-breaker session at the beginning of the conference where we engaged in scientific 'speed dating', everyone getting to talk with everyone else for a short amount of time, introducing themselves and their research. We then had standard lectures to start the days, with the strong repeated encouragement to ask lots of basic questions when terms are used that people in other fields
don't understand. Both of these formats helped prepare the participants for the breakout discussions.
The discussions were centered around topics at the interfaces of astronomy, geology, chemistry and biology. The goal was to identify questions at these interfaces, and then group them into questions that can be answered now (and for which new experiments and models are presently being worked on in collaboration), questions that can be answered in the near future and questions that can be answered in the long term (which will provide the outline content for the white paper).

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