Planetary Habitability

The First New Science of the Renaissance

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FORWARD

This book is accessible to those without scientific training. That is, science as a liberal art or equivalently science appreciation in analogy to art and music appreciation. It is for anyone with an interest in basic questions like the origin of life and whether life exists elsewhere in the universe. I am glad to live in a time of history where I have been able to productively address these topics as a working scientist. I address the history of science from that viewpoint.

I make allusions to Shakespeare to establish an aura of the late Renaissance. Originally, Renaissance meant rebirth, the driven attempt to recover the lost knowledge

of Antiquity. In the late Renaissance, the learned veered from exhuming knowledge to extending it with their own observations. I follow the path of astrobiology from its troubled beginning as the first new science to its place in our high-tech world.

The trials and tribulations of astrobiology illustrate the feedback between science and worldview. The idea that the Earth is merely one of an innumerable number of inhabited planets shaped Giordano Bruno's views against personal deities. Traditional Catholics responded by burning Bruno to the stake in 1600. By 1700, the concepts that the Sun is but one of a vast number of stars and the Earth is one of a vast number of planets shaped the Enlightenment. Darwin's theory of evolution jolted the concept that mankind is special after 1859. Today, the finite (but huge about 13.8 billion years) age of the universe pleases those who like creation from nothing and disquiets others.

This book is not a tirade against religion. Religion is an option in a free society that often promotes good works. Yet, a history of science that expunged religion would be sterile, like a recounting of the Crusades that failed to mention Christians and Muslims. Moreover, the longevity of technological societies is a subfield of astrobiology where we have only our planet as a brief example. Many individuals and some organized religions cling tenaciously to dangerous medieval worldviews. The Damoclean potentially self-fulfilling prophecy that we do not have to take care of the Earth because we are near the End of Days hangs over humanity. As the French revolutionary Robespierre (1758-1794) said but did not put into practice, "Personne n'aime les missionaires armées." Today armed with the juicy fruits of modern technology, such zealots can inflict far greater harm than locally imposing local medieval squalor.

One must understand pre-scientific and medieval worldviews to see how they evolved into modern science and how modern science functions in practice. Nature is impersonal to the modern scientist. She draws tentative generalizations from data using logic. Impersonal and tentative are the salient features. As discussed in Chapter 1, pre-scientific and medieval societies also observed nature and drew conclusions for their own benefit. However, they tended to take nature personally. Wrathful and benevolent deities, spirits and demons caused events for individual and collective benefit or chastisement. In the case of the classical Greek religion, deities amused themselves beleaguering mankind. Well functioning science does not unquestioningly impose dogma, the centerpiece of traditional religion, when it has no evidence. It does not adhere to dogma in the face of contradictory data and logic. Apologetic statements in the theological meaning of the word like, "The ways of DNA are strange," have no place in science. They can explain away any conceivable observation and therefore explain nothing.

One can best see how science works in practice and how it self-corrects when the level of ignorance is high. This book concentrates on astrobiological topics at the time in history when scientists raised the basic issues and attempted with limited data to winnow out testable inferences often starting with medieval premises. The discussion, for example, the advent of astronomy as a modern science in Chapter 2 is far longer than an explanation of how astronomers determine the distances to planets in our Solar System and distances to other stars with their brand-new high-tech equipment.

PRESENTATION

Boxes and Primers. This work is NOT intended to be the primary textbook for large non-major classes that present just the results of modern astrobiology. In fact, anyone with a visceral objection to the mention of history, philosophy, and literature in a science book will not like this work.

Still results need to come into any discussion of how science functions. Readers will differ in their levels of sophistication. An explanation that is necessary for some may insult others. I have placed moderately long explanations of topics in boxes within the text of chapters. The reader who is familiar with them can skip or skim without loss of continuity. Long explanations are Primers and appear as colored text at the end of chapters.

Personal pronouns. The validity of a scientific hypothesis does not depend the gender of the person making it. I use both "he" and "she" as gender pronouns for generic modern or future persons. I stick to "he" in past times when there were few women in science. I avoid "he or she" and awkward plurals. I use personal grammar with ET and with fictional intelligent octopi in Chapter 15. I use first person narrative to avoid passive case; rather than, the passive case is used to avoid first person pronouns. I also use collective "we" meaning society and "you" meaning collective reader and also collective "one."

Figurative language. I use figurative language in places. I also use somewhat archaic words like "dearth." My intent is to make the discussion attractive to non-scientists. I need to bring in some technical issues like DNA and ribose. I have attempted to write so that the less technical reader can follow the intent and basic implications of

the work. I make the point of personal stories clear. This is not a memoir but I have been around long enough to see science functions and fails to function.

Use as text. The book includes features that facilitate its use as a textbook. Chapter titles and internal headings make the topic obvious there and in the table of contents. A second more figurative part of some headings makes a literary allusion. There is executive summary for each chapter and it is variously labeled. It is not the point-by-point study guide found in high school science books. Rather, it reiterates key points from the chapter and draws general implications of the chapter to astrobiology,

Color typeface separates Notes, Primers, Boxes, and Exercises from main text. The exercises include essay topics as well as doable experiments. It is intentional that some readers will be satisfied that they could do the experiments if they chose to do so, but not want do them. A key point of the book is that you can see many scientific results for yourself.

Birth and death dates appear at the first significant mention of historical persons to maintain context. Birthdates of modern living persons are supplied for some but not all individuals. I use the well-known form of names, even where it violates proper naming practice like with Da Vinci. I give alternative forms where confusion may result, like with Simplicio in Italian and Simplicius in Latin. My intent is to aid web searches by the historically minded readers.

Technical words aid the reader in finding additional information. Practicing scientists become familiar with technical words that arise frequently in their work. Rote

memorization of terminology is a boring and highly ineffective way to learn about science. Hence there are no lists of words at the end of chapters.

Typography and graphics. This work is not currently under contract for a hard copy version with a publisher. I have I attempted to achieve a reasonably professionally looking work without making it impossible to modify. Many things are done more efficiently done by the copyeditor and/or by production.

This .pdf version comes from Word.doc files. The Word file figures are mostly .jpg. I have not spent time on formatting pages and figures. There is white space on many pages. The captions are single-spaced and 10-point font to distinguish them from text. I have color-balanced photos and scans but not made a lot of effort at it. There are both figures with captions and dingbat-like figures that start paragraphs. I presume any publisher can format to indent the text around small figures. I keep credits in captions to aid my editing and maybe copyediting. Photo credits to the author are to keep track of the source, **not vanity**. It would be grossly expensive for the author to pay for figures and photos already in copyright with a published hardcopy.

Most of the spelling is U.S. I have not been consistent on plural verb agreement with collective nouns (faculty as group of individuals versus faculty as a collective unit) and with abstract nouns like tectonics. I have used present tense for general truth or valid concept presented in the past: “Galileo contended that the Earth orbits the Sun.” I use past tense for dubious concepts. “Ancient mystics believed that one opened a goat and looked at its guts to predict weather.”

Word makes all URL's into links. Cross-references are for the most part not links. A publisher should have software for URL's in text. I have checked URL's just before I placed the .pdf on the web page, but they can vanish at any time beyond my control.