



Archaeology is one of the many fields to which complex-systems analysis can be applied.

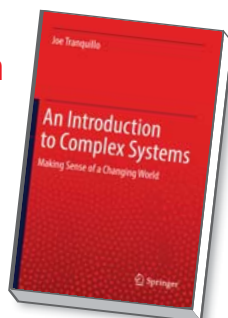
An encyclopedia of complex systems

The field of complex systems has formally existed for several decades, and many of its founders, including Nobel Prize winner Murray Gell-Mann, came from physics. Yet the field has recently flourished; it is experiencing a rise in practitioners, an expanding number of intriguing problems to address, and a commensurate increase in high-impact publications. In his new book *An Introduction to Complex Systems: Making Sense of a Changing World*, Joe Tranquillo joins a growing body of authors aiming to define complex systems and disseminate the field's most important conclusions to the greater world. The text provides a useful overview of complex systems, with enough detail to allow a reader unfamiliar with the topic to understand the basics. The book stands out for its comprehensiveness and approachability. It will be particularly useful as a text for introductory physics courses.

Tranquillo's strength is in delivering a vast amount of information in a succinct manner. Unlike Geoffrey West's *Scale: The Universal Laws of Growth, Innovation, Sustainability, and the Pace of Life in Organisms,*

**An Introduction
to Complex
Systems**
**Making Sense of a
Changing World**

Joe Tranquillo
Springer, 2019.
\$109.99



Cities, Economies, and Companies (2017), Tranquillo's book is not for general audiences. It does not dive deeply into individual subjects the way Mark Newman's *Networks* (2nd edition, 2018) does, nor does it provide a how-to on a specific method, as Steven Railsback and Volker Grimm do in *Agent-Based and Individual-Based Modeling: A Practical Introduction* (2nd edition, 2019). Instead, Tranquillo has written a thorough textbook that gives a useful introduction to complex adaptive systems as a whole field. It can also serve as a quick reference for seasoned practitioners who need a refresher on a particular subject.

The field of complex systems does not fall within any one discipline. Its techniques and concepts are useful for various sciences and for making order out

of seemingly disorderly structures and have been applied in physics, economics, biological systems, computer science, mathematics, and my own field of archaeology. Tranquillo, whose background is in engineering, touches on each of those applications in his text and demonstrates that to be a true scholar of complexity one needs to embrace interdisciplinarity. "It is not always clear where one discipline ends and the field of complex systems picks up," he writes in the first chapter. "As an interdisciplinarity field... it has inherited tools, processes, ways of thinking, histories, tensions, and world views from other disciplines."

The book is an excellent reference for many of the mathematical formalizations that provide the backbone for complex-systems study. Tranquillo's text displays those formalizations seamlessly, in a way that will be useful for teaching students about the underlying thought processes. Yet, even though math is well-integrated into the text, a reader could skim over the equations and focus instead on the prose without losing much. Tranquillo's presentation will allow math-phobes to be slowly exposed to equations—alongside good explanations—without being forced to read through proofs line by line; thus the book is a useful text for mixed-population undergraduate courses. Those who are looking for a more advanced text that delves

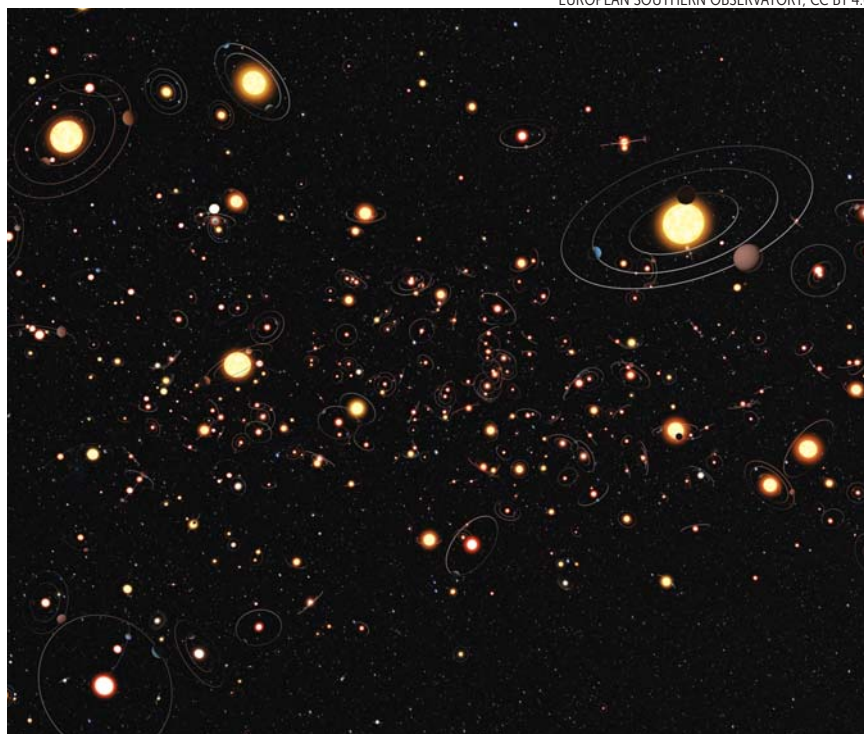
deeply into a certain area of complex adaptive systems are likely to find *An Introduction to Complex Systems* a bit thin. However, it is not meant to be an in-depth guide, but rather a survey of the field.

What makes *An Introduction to Complex Systems* stand out is its thoroughness. The book is basically an encyclopedia of complex-systems studies. Need to quickly reference the equation for the first law of thermodynamics? Section

7.1.3. How about measures of information? Section 6.1.4. A reader can find information quickly and efficiently—that is, in my opinion, the book’s greatest value. If Tranquillo’s text ends up on your shelf, you’ll find that you thumb through it regularly for a pithy description of a particular complex-systems approach.

Stefani Crabtree
Santa Fe Institute
New Mexico

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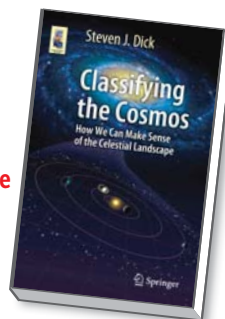


A Linnaean system for the stars

In 1735 Swedish botanist, zoologist, and physician Carl Linnaeus published his 12-page tract *Systema Naturae*. In it, he laid out a system for organizing life forms into a helpful hierarchy of categories—the roots of our modern kingdoms, phyla, families, and species. Astronomy, however, did not benefit from such a definitive moment; its systems for naming and classifying objects developed in fits and starts as new technologies revealed ever more marvelous denizens of the universe. In *Classifying the Cosmos: How We Can Make Sense of the Celestial Landscape*, astronomer and former NASA historian Steven Dick endeavors to bring

Classifying the Cosmos
How We Can Make Sense of the Celestial Landscape

Steven J. Dick
Springer, 2019.
\$34.99 (paper)



some order to the cosmic menagerie as we know it today. The result is an important and revelatory work that can be used by researchers, educators, and enthusiasts alike.

In one sense, *Classifying the Cosmos* offers a comprehensive encyclopedia of celestial objects. Dick adds greater value, however, by providing a thematic architecture for the known inhabitants of the cosmos. His celestial empire consists of three kingdoms—planets, stars, and galaxies—broken down into 18 families, 82 classes, and unnumbered types. Gravity, the key organizing principle, weaves everything together. The more speculative topics of dark matter and dark energy are left to others.

Dick’s explanation of planets exemplifies how the classification system works: Planets are fully described in the planets kingdom section, but are also cited as circumstellar objects in the stars kingdom section. Stars, in turn, have their own kingdom but also play key roles in the galaxies kingdom. That sort of overlap makes explicit the hierarchy of matter in our universe. From planets, to stars with planetary systems, to galaxies and their groupings on ever grander scales, Dick unfolds our observable cosmos like the nested, connected, and evolving ecosystem it is.

The author also provides fascinating historical backstories to many of the classes and how they were discovered. For example, he recounts how the ice giant planet Uranus was observed several times in the century that preceded William Herschel’s written account in 1781 and how Herschel first described it as a comet rather than a planet. Even more amazing, Galileo Galilei accidentally observed Neptune a whopping 234 years before its official discovery by Urbain Jean Joseph Leverrier in 1846. It then took *Voyager 2*’s flybys of Uranus in 1986 and Neptune in 1989 to generate sufficient data for astronomers to conclude that those two planets belonged to a new class of ice giants that differ in size and composition from the gas giants of Jupiter and Saturn.

Dick also wades into continuing controversies, such as the kerfuffle surrounding Pluto’s demotion to dwarf planet. He notes the proposal to designate Pluto’s similarly massive kinfolk in the Kuiper belt as “Plutoids,” a classification that I have been championing in my own writings but, alas, has yet to catch on. Consequently, Dick places Pluto in the dwarf planet class as part of the subplanetary family that includes meteoroids, asteroids, comets, and other small bodies of the solar system.