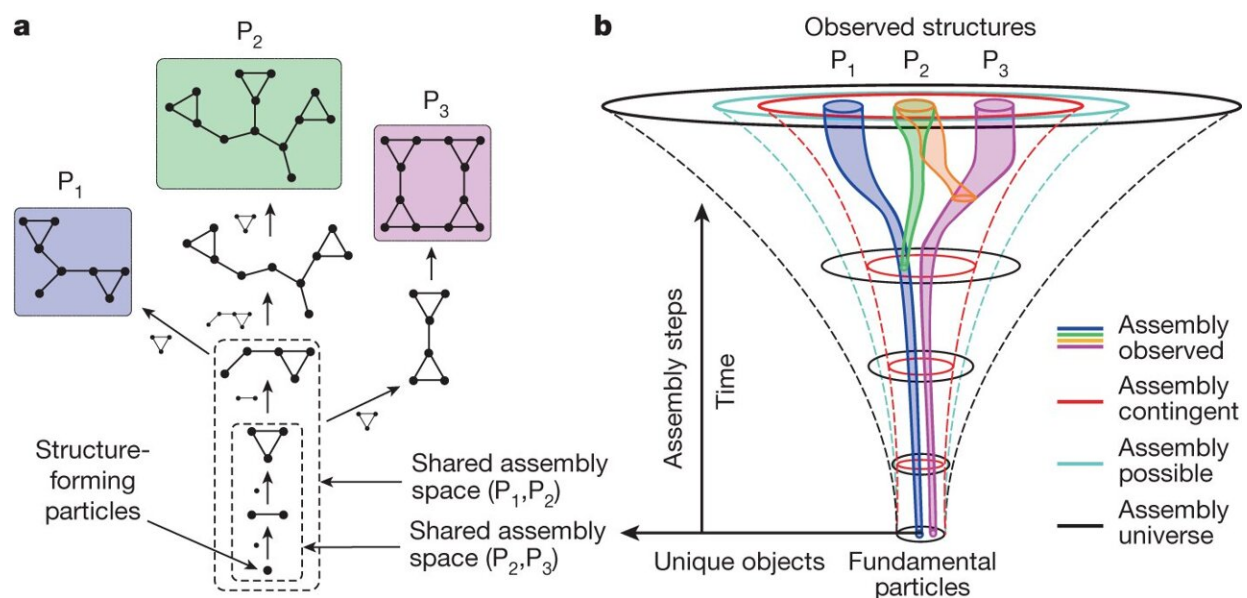


A new theory linking evolution and physics has scientists baffled—but is it solving a problem that doesn't exist?

November 11 2023, by Bill Bateman



Assembly spaces. Credit:*Nature* (2023). DOI: 10.1038/s41586-023-06600-9

In October, a paper titled "[Assembly theory explains and quantifies selection and evolution](#)" appeared in the journal *Nature*. The authors—a team led by Lee Cronin at the University of Glasgow and Sara Walker at Arizona State University—claim their theory is an "interface between physics and biology" which explains how complex biological forms can evolve.

The paper provoked strong responses. On the one hand were headlines like "[Bold New 'Theory of Everything' Could Unite Physics And Evolution](#)".

On the other were reactions from scientists. One [evolutionary biologist tweeted](#) "after multiple reads I still have absolutely no idea what [this paper] is doing." Another [said](#) "I read the paper and I feel more confused [...] I think reading that paper has made me forget my own name."

As a biologist who studies evolution, I felt I had to read the paper myself. Was assembly theory really the radical new paradigm its authors suggested? Or was it the "[object wankwaffle](#)" its critics decried?

Hackle-raising claims

When I sat down to read the paper, the very first sentence of the abstract had my hackles up:

"Scientists have grappled with reconciling biological evolution with the immutable laws of the universe defined by physics."

I had no idea we scientists grappled with this. No biologist I know has a problem with the [laws of physics](#) or sees any problem with reconciling them with evolution.

The abstract goes on to note that the laws of physics do not predict "life's origin, evolution and the development of human culture and technology," and claims we need a "new approach" to understand "how diverse, open-ended forms can emerge from physics without an inherent design blueprint."

The complaint that [biological evolution](#) seems incompatible with the laws of physics, taken with the use of loaded terms like "design

blueprint," is reminiscent of creationist arguments against evolution. No wonder the blood pressure of evolutionary biologists was spiking.

In the words of [one Nature commenter](#): "Why so many creationist tropes in the first few sentences?"

Biology and physics

Before I go further, I should note that I may, along with some of scientists quoted above, not fully understand the aim of the paper. But I have problems with what I do understand of it.

First of all, the claim that evolution is at odds with the immutable laws of physics does not seem to be supported.

The paper says "the open-ended generation of novelty does not fit cleanly in the paradigmatic frameworks of either biology or physics," which doesn't seem to make much sense.

In the paradigm of biology, we understand there is a variation in biological forms through genetic drift, mutation and selection. Does this need to "fit the paradigm of physics," as long as it doesn't break any laws of physics?

Another troubling statement: "To comprehend how diverse, open-ended forms can emerge from physics without an inherent design blueprint, a new approach to understanding and quantifying selection is necessary."

Is it? One of the tenets of evolutionary theory is that there is no "teleology"—no goal or aimed-for endpoint—in the process. So how could there be a "design blueprint"? Why would its absence need to be explained?

Putting numbers on the odds of evolution

So what is assembly theory trying to do? [According to Cronin](#), it "aims to explain selection & evolution before biology"; as such its goal is a theory that unifies inert and living matter and seeks to explain their complexity or otherwise, in the same way.

The paper itself says it is a "framework that does not alter the laws of physics, but redefines the concept of an 'object' on which these laws act."

"[Assembly theory] conceptualizes objects not as point particles, but as entities defined by their possible formation histories. This allows objects to show evidence of selection, within well-defined boundaries of individuals or selected units."

The "object" in assembly theory is then what "laws of physics" act on. For any object, we can calculate its "assembly index," a number that measures how complex the object would be to make.

Any object that is both abundant and has a high assembly index is unlikely to have arisen by chance, so it must be a product of evolution and selection. This, in itself, is neither problematic nor new—apart from this calculated "index."

How do we figure out that assembly index? We count the number of steps it would take to build a molecule, say, or a bodily organ, or a whole organism. The higher the index, the more likely it is to have evolved.

So assembly theory is an attempt to quantify the complexity of something and the likelihood of it having evolved.

A problem that doesn't exist?

Is this useful? It's hard to say.

For one thing, it implies there is only one pathway to produce a complicated (high assembly index) object such as a biochemical molecule, which is simply not the case.

Also, as [another scientist pointed out](#), "it's obvious that if a molecule is complex and there are lots of copies of it, then it likely emerged from some process of evolution. And most chemists could spot such cases without the need for assembly theory. Although trying to put numbers on it is very neat."

My own feeling is that this is a poorly written paper, as evidenced by the inability of many biologists to understand what it is trying to do, and much of the negative reaction to the work springs from the hard-to-follow framing and use of phrases that echo creationist talking points.

As for assembly theory itself, it seems to have been [developed](#) in the course of Cronin and Walker's efforts to find a general way to [recognize signs of life on alien planets](#), and even [create artificial life](#). And perhaps, in those contexts, it may prove useful.

However, as a sweeping new paradigm aiming to unify [evolution](#) and [physics](#), assembly theory appears—to me and many others—to be addressing a problem that does not exist.

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