Editorial

An introduction to M-theory and its application in biology

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Since its inception, there has been a controversy on what the letter M in M-theory stands for. M could stand for Magic, Mystery or even Madness (Duff 1997). It is a theory that digs deeper into reality and has the potential to unify separate fields of science. In our world, knowledge is often simplified and available for dissipated systems that are easier to observe and analyze. In cosmology, it is easy to monitor and attribute the behavior of a small set of asteroids using only Newtonian physics, Kepler's laws and Euclidian mathematics. However, in order to tackle more complex systems, we know that neither Newton's laws nor Euclidian mathematics is adequate. Democritus in 460 BC proposed that one cannot keep cutting an object in half forever. There is a point where matter cannot be cut in half. He called that the atom, which in Greek means undividable. Well, what is the quark then? His theory was correct for a long time, and even though today we know it is wrong, we still use it and find it helpful in our quest to understand the world. This also holds true for molecular biology and biochemistry. Vast information is available on reaction chemistry, transcription and translation in the molecular level. However, zoom out a bit and our knowledge comes into question.

It seems that sciences have been zooming too much into certain aspects and can thus, sometimes, miss the bigger picture. From cosmology to cellular processes and biochemistry to quantum mechanics, M-theory could play a pivotal role. First off, M-theory recognizes 11 dimensions, 7 more than classical sciences have addressed and human beings can feel. Height, width, depth and time are entities that we are all familiar with. So, what are the rest dimensions?

Many concepts in nature may not stand on their own, but complete a larger entity that groups other relative or distant concepts together. This is the story of quantum chemistry. The quantum paradox states that in order to see a certain object many photons, which not long ago left the sun, were scattered by hitting its surface and ended up in our eyes. That caused a neuron to ignite and send an electric pulse to our brain, which processed the image and recognized the object. In essence, what we see is the past. The image we saw took place a tiny, but still quantifiable, fraction of time earlier. By the moment we became aware of it, it was history. Imagine this; someone is shooting an arrow at a target which takes 5 seconds to hit the bull's eye. Now, let's rewind that tape and divide those 5 seconds by 5 trillion or zillion times. For that tiny amount of time, using Eucledian mathematics and classical physics you can prove that the arrow hovers in mid-air without moving. If we add all those frozen trillion fractions of time together we realize that the arrow never left the bow. But it did.

Let's work on that principle a bit more. Someone else is in the room with us. He moves towards the door and tells us something. We are having an everyday conversation with him. This person has a thought, he sends an electrical signal to his vocal cords, which vibrate, making the air that is in contact with them to vibrate too. The sound then travels with the speed of 1 Mach in the room and hits our ear drum, triggering an electrical signal that reaches the hearing center in our brain. All these steps took a certain amount of time. It may be a tiny fraction of a fraction of a millisecond but it still is a quantifiable amount of time, which, for the purposes of this example, we will call "10 units".

Rewinding the tape again, we go back to the point that this person was still making the thought. That is the beginning of the "10 units" period. Now let's play the tape for "5 units" and freeze it. The information of the person's thought is in mid air. For him it is history. He said it "5 units" ago. However, to us, it hasn't happened yet. It will happen in "5 units". To us, someone else's history is the future. And the most interesting fact about it is that we cannot alter it or even avoid it, unless we start running away from that person with an acceleration that will make us reach 1 Mach before the sound hits our eardrum. This way we will never hear it. However, we would never be able to tolerate such accelerations as mortal and fragile human beings. We cannot escape this situation and are destined to hear what the person said a few "units" ago. According to the general theory of relativity, a third observer, who is watching us both, may be closer to the person's past or even further in the future than we are, depending on where he is standing.

The matter is that "10 units" of time is an insignificant amount of time for human beings. It is too small an amount for our sensations to quantify. What happens to our cells in the micro-cosmos though? What happens to cases where selective transmembrane channels can carry 10^7 ions per second and cell transporters mediate the movement of 10^5 molecules per second? To our cells the period of "10 units" may not be such an insignificant amount of time. More importantly, if we go back to our "5 unit" frozen snapshot each of those transporters may be able to carry out its job thousands of times before the sound waves hit our ear drum. Therefore to our cells, where time runs relatively faster, the person's past and our future may be quite distinct points in time.

All atomic interactions are evaluated *in silico* using simple Newton laws throughout molecular dynamics simulations. This is fundamentally wrong. Atoms are not dimensionless single points in x,y,z space. We are aware of the fact that matter should be considered as wave rather than mass (Figure 1).

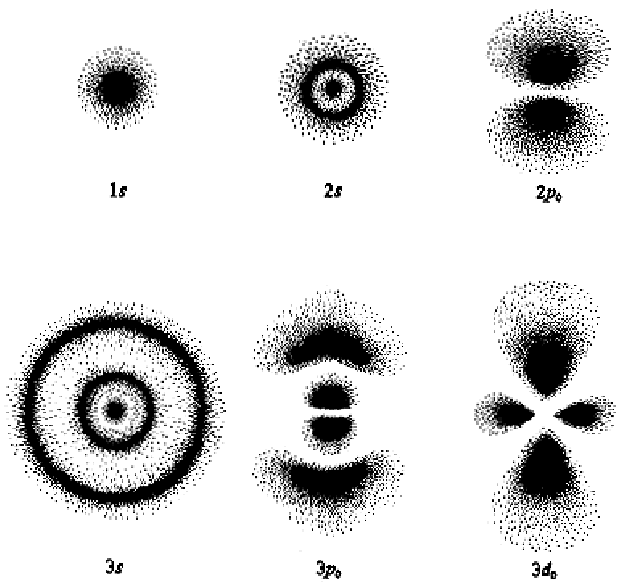

Figure 1. Hydrogen atomic orbitals represented as probability density plots. The darker the regional orbital, the higher the probability of finding an electron in that area. (Figure adopted from Hawking & Mlodinow 2010).

String theory, bosons and fermions should have been used to describe molecular systems, based on Erwin Schrödinger' s equation and laws that he developed 87 years ago:

$$i\hbar\frac{\partial}{\partial t}\psi(\mathbf{r},t) = -\frac{\hbar^2}{2m}\nabla^2\psi(\mathbf{r},t) + V(\mathbf{r},t)\psi(\mathbf{r},t)$$

Where,
i is the imaginary number: $\sqrt{-1}$
h is Plank's constant. Divided by 2π $1.05459x10^{-34}$ joule x second.
ψ (r,t) is the wave function. In this case defined over space and time.
m is the mass of the particle.
∇^2 is the Laplacian operator: $\theta^2/\theta\chi^2+\theta^2/\theta y^2+\theta^2/\theta z^2$.
V (r,t) is the potential energy influencing the particle.

Particles in quantum theory are not considered to be single mass points but highly sophisticated waves. Schrödinger's differential equation describes just that, based on the mathematical evolution of wave functions. Quantum scientists in molecular mechanics use this mathematical formula to solve wave functions for a given atomic set or system. The downside is that using differential formulas usually requires the scientist to make certain assumptions that can sometimes affect the solution for the wave problem under study.

Bosons push on the theory of fermions that are solely based on Fermi statistics, by enabling multiple bosons with the same energies to occupy the same time -space. Fermi statistics cannot accept this, since the same quantum state cannot be accommodated by more than one fermion. Fermions are therefore associated closer to classical physics and matter, whereas bosons are thought to be force particles. Of course, based on the special theory of relativity there is not much difference between matter and energy in quantum theory. So the real conceivable difference between bosons and fermions is the statistical laws they follow. The Bose statistics attribute integer spin to bosons, while Fermi statistics use half-integer statistics. This difference has been included in the modern relativistic quantum field theory, as a rule to distinguish bosons from fermions. So, what is the biological significance of bosons and fermions? Mass related fermions and energy carrying bosons are the actual interacting elementary particles that establish the so-called fundamental interactions, which result in the atomic forces that we observe. The theory of supersymmetry suggests that for every energy-related boson there is a corresponding mass-related fermion and this hypothesis provides the link to string theory. Recent evidence for high energy supersymmetry in particle accelerators confirms that string theory is a very good and accurate model for small distance scaling of atomic interactions between various atoms in life (Gauntlett *et al.* 2011, Lebedev *et al.* 2007).

How can we interpret life, if we keep on studying the "far" cellular and biochemical past? In crystallography we freeze time and motion for each molecule and we observe only a snapshot of a trillion snapshot story. In molecular biology and biochemistry we take measurements of an ongoing process in a similar manner. By the time we quantify our measurements, the actual molecular system under investigation has "moved on" and rendered these measurements history.

Science has always been trying to untangle the mysteries of our world by breaking down complex chunks of the unknown into chewable bits that can be conventionally processed. This trend has led to extreme specialization of the subject under investigation, which has blinded scientists to all other disciplines. Nature did not plan for this separation and may refuse to answer our questions about life and the cosmos. Maybe, it is time to reshuffle the cards in a more unified manner. One that addresses it all, by being complex and broad enough to engulf both the micro- and macro-cosmos: M-theory or, better, a model-dependent realism (Hawking SW and Mlodinow L, 2010).

Conflicts of Interest

The authors declare no conflicts of interest.

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