Can you understand or describe God?

IF NOT...TEST THIS

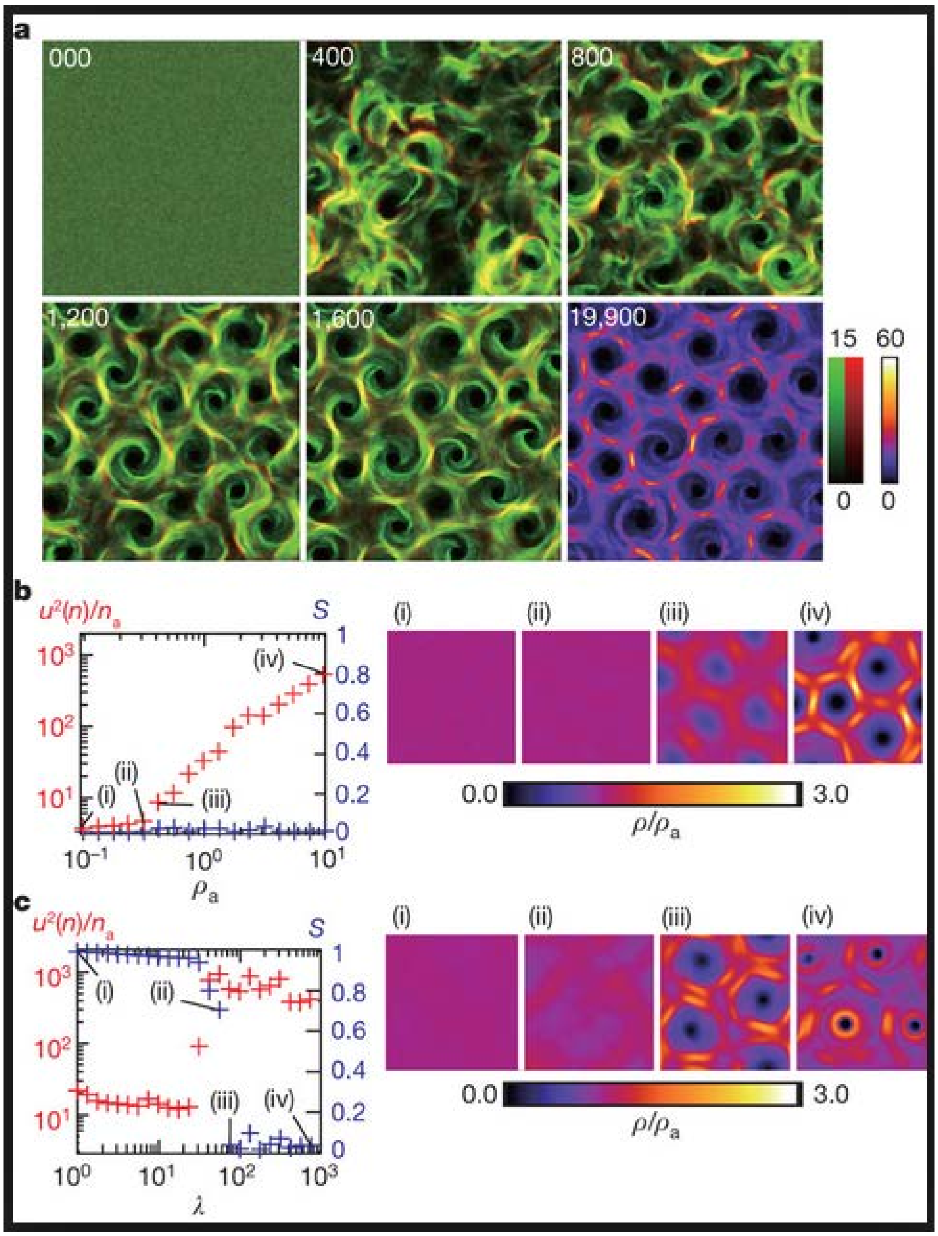
YOU MUST PASS IT...

If you intend to understand HELICAL GEOMETRODYNAMICS ,
The Unified Fields Theory, your mind must to be opened.

CAN YOU SEE THE "unusual" FLOW PATTERNS?(GOD) Is everywere!

TEST YOUR INTUITION BEFORE YOU READ THE FINAL THEORY

(below is about one of the four rule of ***Fundamental Code,*** a helical flow interaction rule!

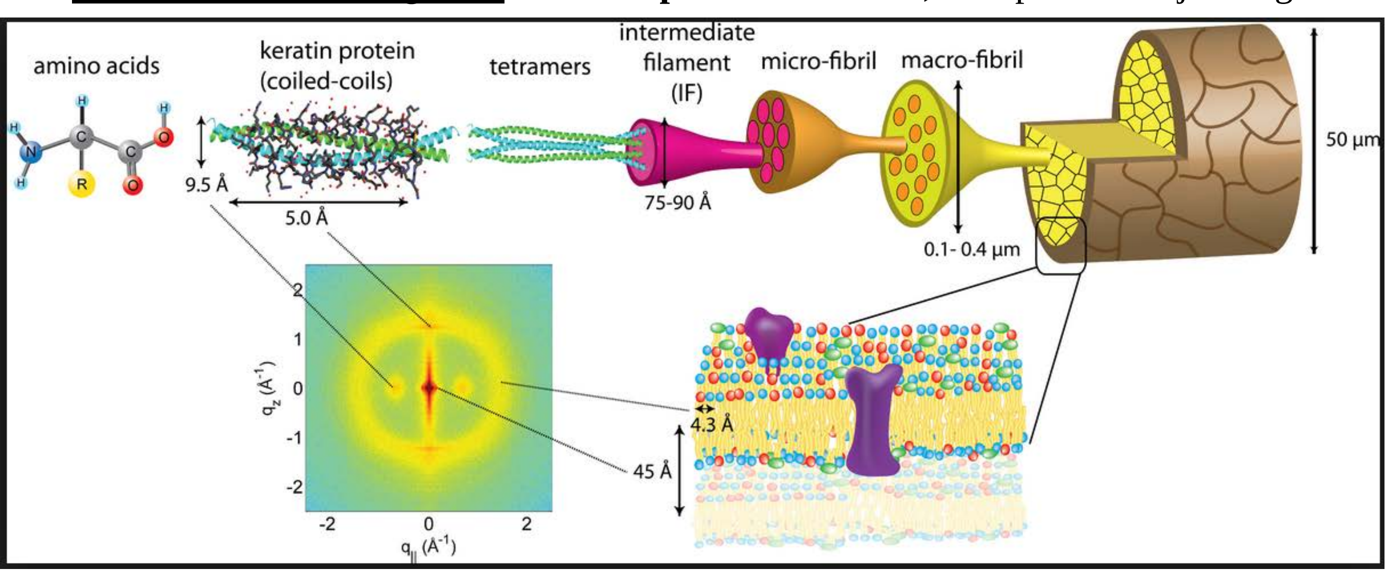


PUZZLE PIECE No_1 (internet source about flowing microuniverse)

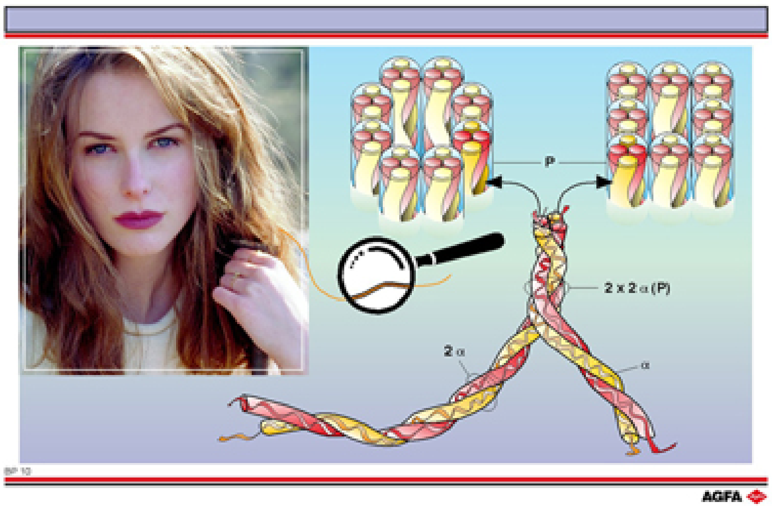
Spontaneous collective motion, as in some flocks of bird and schools of fish, is an example of an **emergent phenomenon**. Such phenomena are at present of great interest and physicists have put forward a number of theoretical results that so far lack experimental verification. In animal behaviour studies, large-scale data collection is now technologically possible, but data are still scarce and arise from observations rather than controlled experiments. Multicellular biological systems, such as bacterial colonies or tissues, allow more control, but may have many hidden variables and interactions, hindering proper tests of theoretical ideas. However, in systems on the subcellular scale such tests may be possible, particularly in in vitro experiments with only few purified components. Motility assays, in which protein filaments are driven by molecular motors grafted to a substrate in the presence of ATP, can show collective motion for high densities of motors and attached filaments. This was demonstrated recently for the actomyosin system, but a complete understanding of the mechanisms at work is still lacking. Here we report experiments in which microtubules are propelled by surface-bound dyneins. In this system it is possible to study the local interaction: we find that colliding microtubules align with each other with high probability. At high densities, this alignment results in **self-organization of the microtubules,** which are on average 15 μm long, **into vortices** with diameters of around 400 μm. **Inside the vortices, the microtubules circulate both clockwise and anticlockwise**. On longer timescales**, the vortices form a lattice structure.** **The emergence of these structures**, as verified by a mathematical model, is the result of the smooth, reptation-like motion of single microtubules in combination with local interactions (the nematic alignment due to collisions)—there is no need for long-range interactions. Apart from its potential relevance to cortical arrays in plant cells and other biological situations, **our study provides evidence for the existence of previously unsuspected universality classes of collective motion phenomena.**

PUZZLE PIECE No_2 (internet source about human "flows")

Even in the single hair shaft in the picture above, there is so much information behind it. First, it is important to understand that hair is 90% made out of a hard, fibrous protein called **keratin**. Keratin is made up of polypeptide chains of amino acids such as glycine, alanine, and cysteine. The individual amino acids are held together by polypeptide bonds, and there are multiple other complex bonds involved. The picture above shows the alpha helix which is the polypeptide chain that makes up human hair. In one single strand of hair, three **alpha helices are twisted together** to form a **protofibril**. Then, nine protofibril join together in a circle around two or more to form an 11 stranded cable that is called **microfibril**. Then, hundreds of these microfibrils are cemented into an

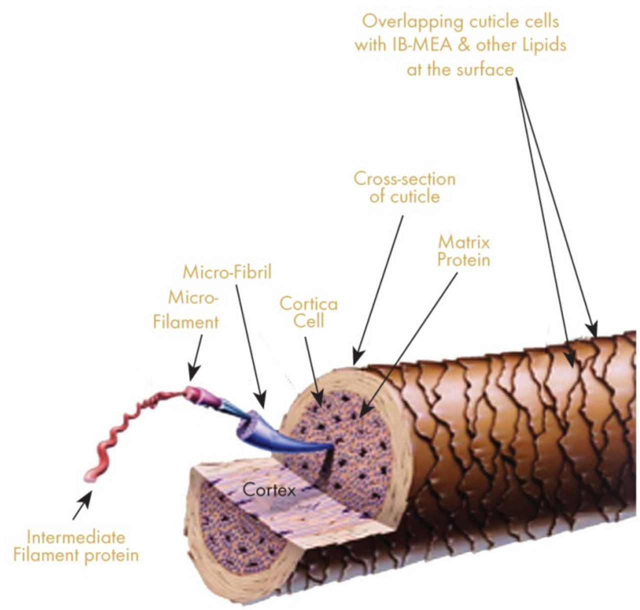


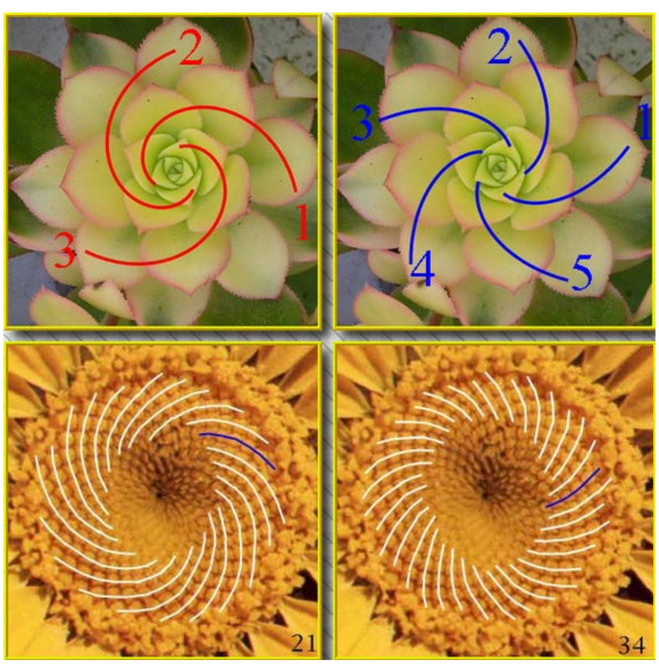
irregular fibrous bundle called **macrofibril**. These macrofibrils are then joined to make the **cortex** or main body of the hair.



Fibrous proteins distinguish themselves from globular proteins by their typical extended form. They play an important role in animal cells and tissues.

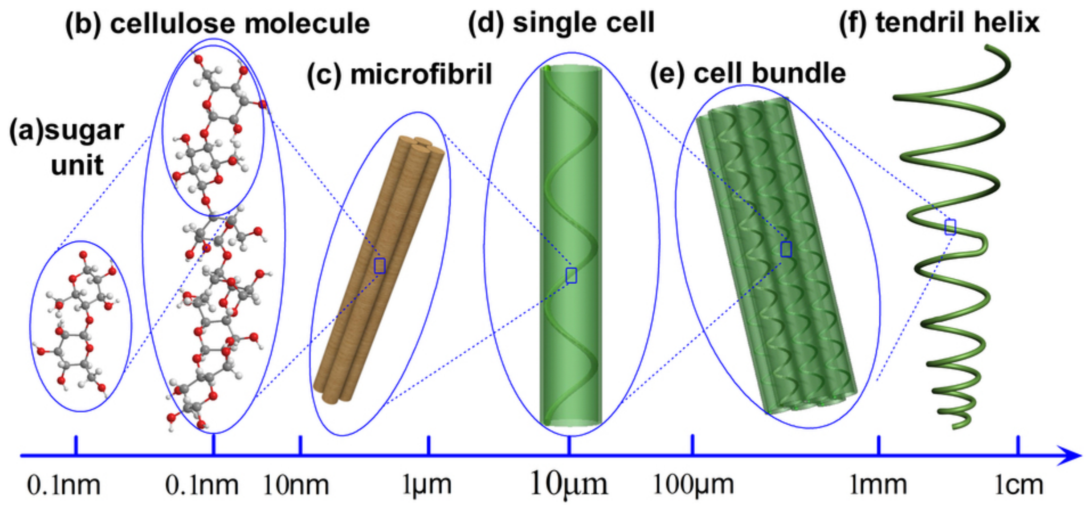
α-keratin is the most important protein in hair and finger nails. The amino acid sequence in α-keratin encourages the formation of long – more than 300 residues - α-helix domains. Two α-helixes (coloured red and yellow in the figure) twine around each other in a left-hand coil structure (2α in the figure) and then two of these new helices in turn form another left rotating helical fibre. This fibre, consisting of four molecules, is called protofibril (P in the figure). Eventually eight protofibrils form a circular or square structure, called a microfibril, that is the basis of the structure of hair. This structure is stretchy and flexible and can be compared to a rope containing various threads that are twined together.



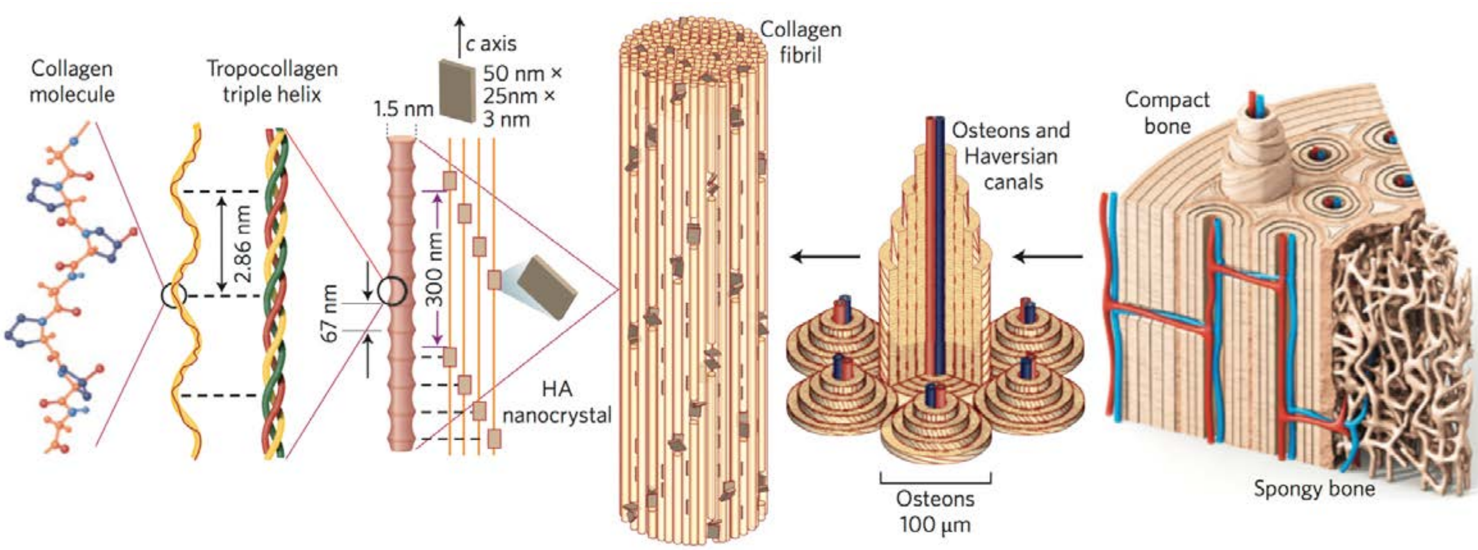


PUZZLE PIECE No_3 (internet source about living flow structures)

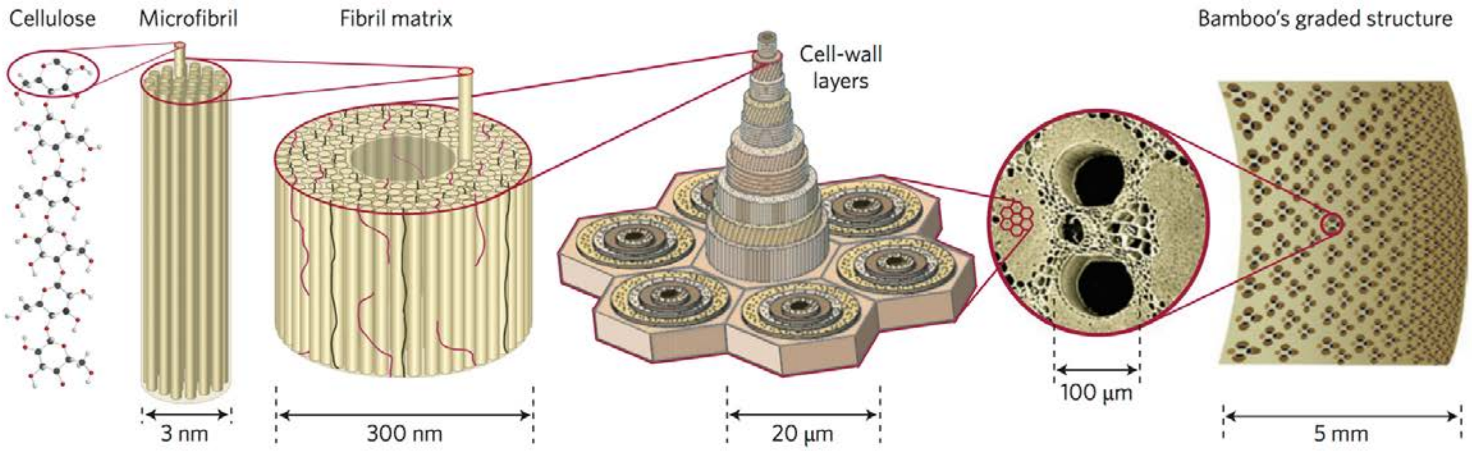
Chirality plays a significant role in the physical properties and biological functions of many biological materials, e.g., climbing tendrils **and twisted leaves**, which exhibit **chiral growth**. **However, the mechanisms underlying the chiral growth of biological materials remain unclear.** In this paper, we investigate how the *Towel Gourd* tendrils achieve their chiral growth. Our experiments reveal that the tendrils have a hierarchy of chirality, which transfers from the lower levels to the higher. The change in the helical angle of cellulose fibrils at the subcellular level induces an intrinsic torsion of tendrils, leading to the formation of the helical morphology of tendril filaments. A chirality transfer model is presented to elucidate the chiral growth of tendrils. This present study may help understand various chiral phenomena observed in biological materials. It also suggests that chirality transfer can be utilized in the development of hierarchically chiral materials having unique properties.



Now let's zoom into the crust of that bone baguette – the compact bone. It's made up of tiny tubes called osteons, each just 2 tenths of a millimeter across, with a blood vessel running down the middle. Zooming further into the walls of these osteons, we find that they're made out of tinier bundles called fibrils. Zoom further still, into one of these fibrils, and we see that they're really a bundle of fibers, and each fiber is really three interwoven strands. Pull these strands apart, and we've unweaved our bones into its most fundamental unit, a long chain-like molecule called collagen.

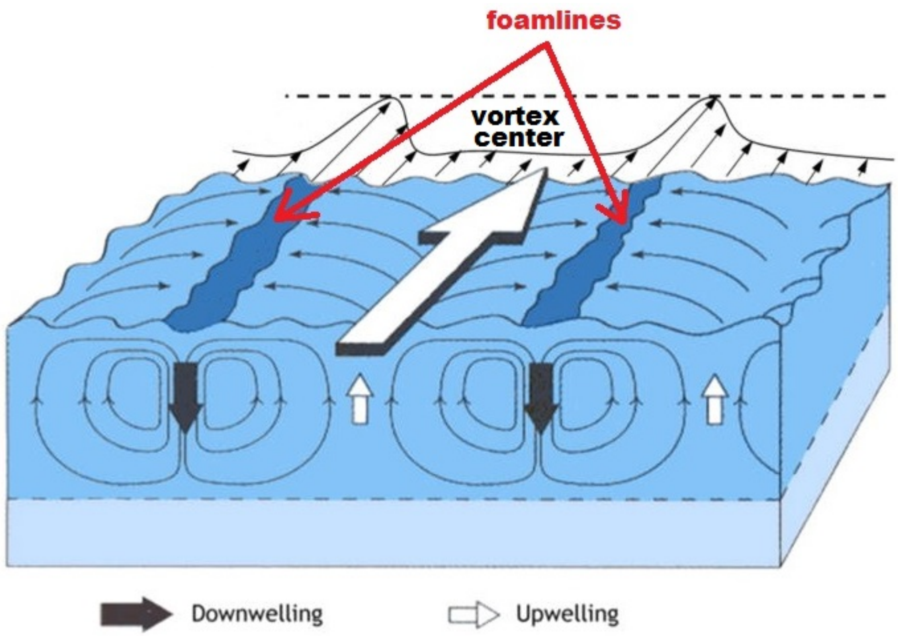


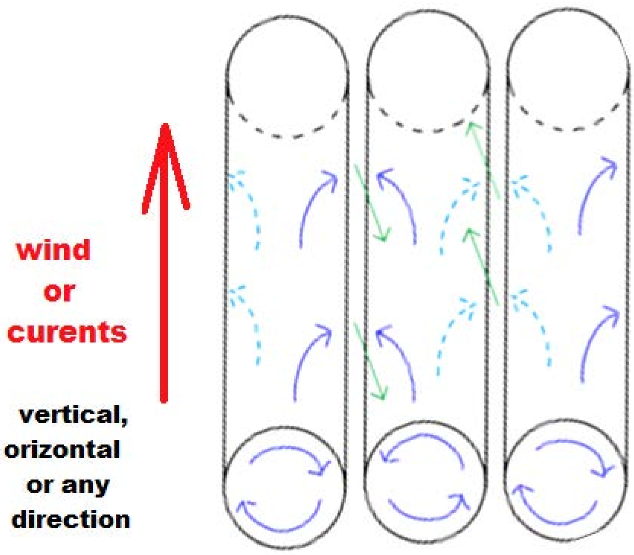
This **fractalesque way** of putting things together, building with materials that are self-similar as you keep zooming in, is known as *structural hierarchy*. And it's this structural hierarchy – tubes within tubes within tubes within tubes – that gives our bones their lightweight strength. (The spongy bone also has a fractalesque, self-similar design. If you look at a piece of it under an electron microscope, you'll find that it looks just as spongy.)



Bamboo exploits the same idea. This ultra-fast growing grass needs a **way to minimize material** and stay very light, so it can grow tall and not collapse under its own weight. Bamboo's hollow tube **shape is a very efficient** way to create stiffness. And like bone, bamboo is made out of tinier tubes, which in turn are made out of bundles of fibers, that are each made of out even smaller bundles of fibers, and so on. When you unweave a bamboo down to its tiniest thread, at the scale of a nanometer, you arrive at another long chain-like molecule – cellulose.Bamboo and bone are both natural nano-engineered materials that use structural hierarchy to achieve their lightness and strength.

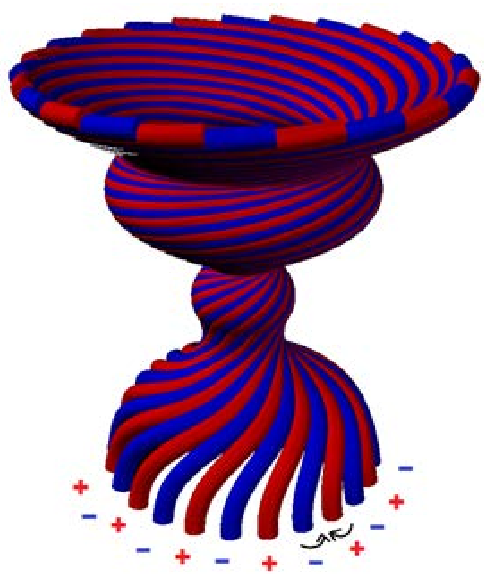
PUZZLE PIECE No_4 (internet source about fluids)





Windrows, wind slicks, wind streaks, whatever you may call them, you've probably seen them. Long rows of foam, debris, and flat or 'slick' water arranged parallel to the current and at a slight angle to the wind. On the Finger Lakes, such a streak is often seen downwind of a major point, too, and the effect is the same though the forcing mechanism is different. These "windrows" are actually areas of upwelling and downwelling. The foam, debris, and dirtiest water collect at the downwelling zones and the slicks form where water is upwelling. This is important! See a slick on a windy day? Stay away, chances are it's void of life. Fish the debris lines, not only are leaves and sticks collecting there but also phytoplankton, mysis shrimp, baitfish, and game fish!

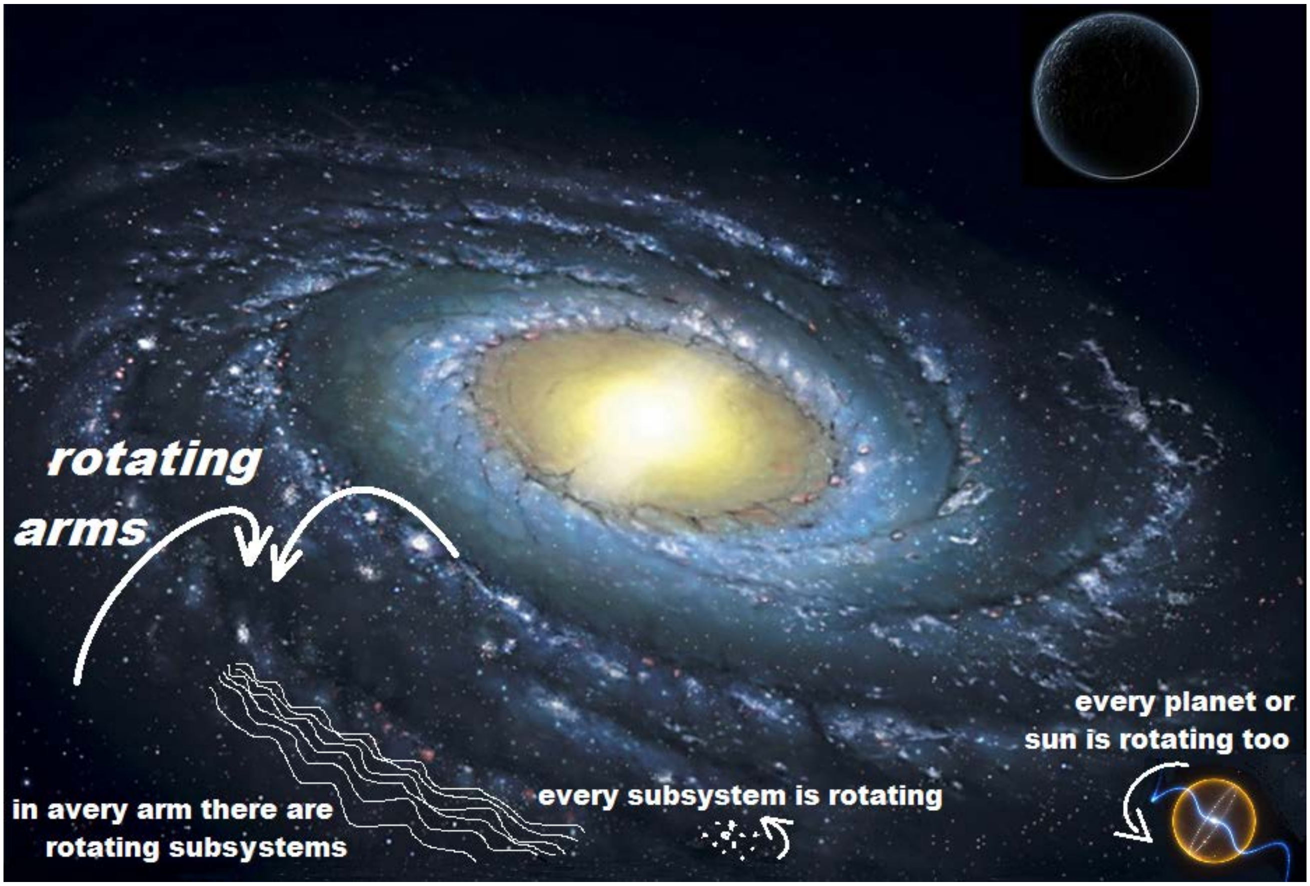
Long helical currents form these windrows. The water blown downwind begins moving in a spiral, and where two opposing spirals meet a slick or windrow is formed. When both spirals rotate down, the windrow is formed. (Where the center and left-hand currents meet in the pic at right. Each of the three "logs" represents one of these spiral currents.) A line of foam, leaves, sticks or other debris gathers at the intersection of these downward moving spirals. This downward motion collects all sorts of organic matter, including the trout and salmon!



When the currents meet and rotate upwards, slicks are formed, usually seen as a relatively waveless line in the lake. (The intersection of the center and right-hand currents in the diagram.) Just like downstream from a plunge pool or below an eddy, this is an area where water is pushing to the surface. Fish elsewhere! Chances are you won't find any fish in an upwelling area.

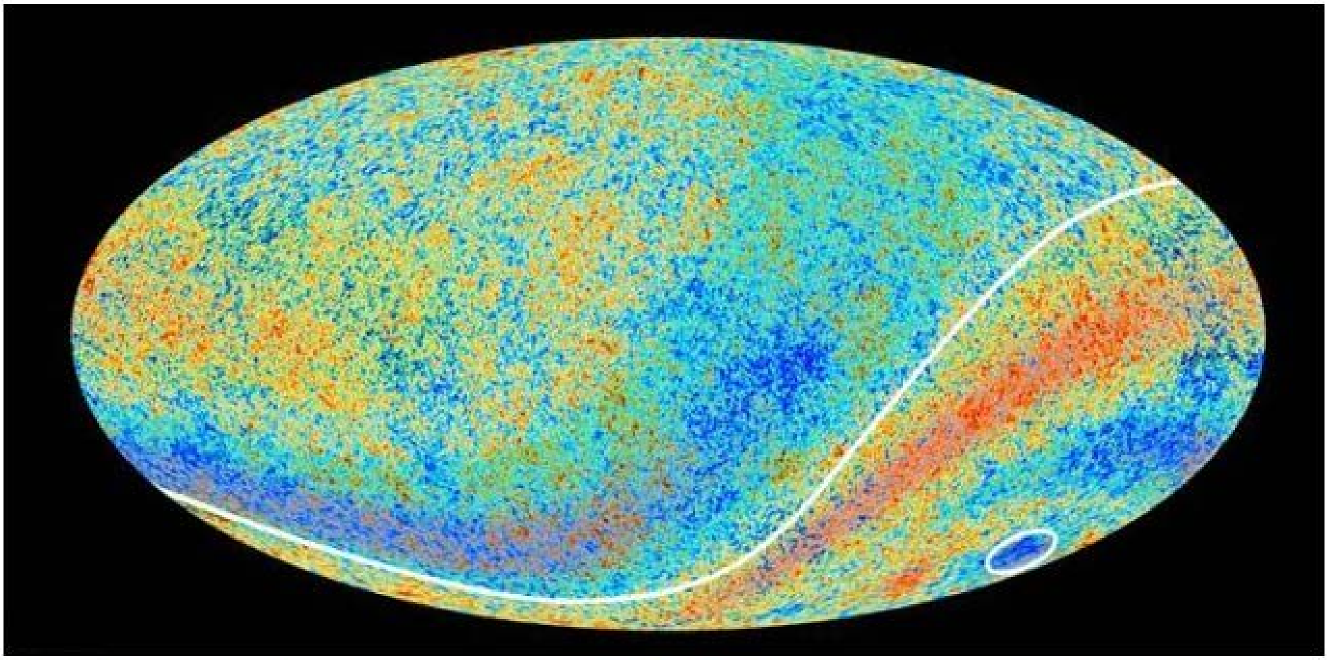
PUZZLE PIECE No_5
(internet source about micruniverse and macrouniverse)

Physicists and astronomers have long believed that the universe has mirror symmetry, like a basketball. But recent findings from the University of Michigan suggest that the shape of the Big Bang might be more complicated than previously thought, and that the early universe spun on an axis.
To test for the assumed mirror symmetry, physics professor Michael Longo and a team of five



undergraduates catalogued the **<u>rotation direction of tens of thousands of spiral galaxies photographed in the Sloan Digital Sky Survey.</u>**
The mirror image of a counter-clockwise rotating galaxy would have clockwise rotation. More of one type than the other would be evidence for a breakdown of symmetry, or, in physics speak, a parity violation on cosmic scales, Longo said.
The researchers found evidence that galaxies tend to rotate in a preferred direction. They uncovered an excess of left-handed, or counter-clockwise rotating, spirals in the part of the sky toward the north pole of the Milky Way. The effect extended beyond 600 million light years away.
"The excess is small, about 7 percent, but the chance that it could be a cosmic accident is something like one in a million," Longo said. "These results are extremely important because they appear to contradict the almost universally accepted notion that on sufficiently large scales the universe is isotropic, with no special direction."
The work provides new insights about the shape of the Big Bang. A symmetric and isotropic universe would have begun with a spherically symmetric explosion shaped like a basketball.

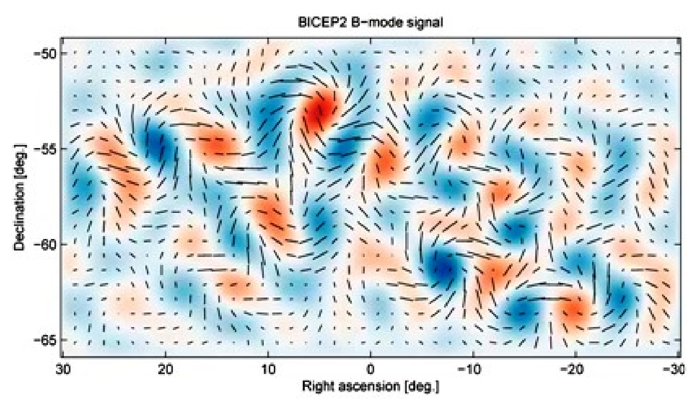
<u>If the universe was born rotating, like a spinning basketball, Longo said, it would have a preferred axis, and galaxies would have retained that initial motion.</u>



Researchers combined their data with measurements of temperature variation within the cosmic microwave background (CMB) radiation to reveal information about the expansion of the universe. Pictured here is a map that shows how CMB varies in our curved universe

But because the precision of Planck's map **is so high, it also reveals some peculiar unexplained features that may well require new physics to be understood**. Amongst the most surprising findings are that the fluctuations in the CMB over large scales do not match those predicted by the standard model. This anomaly adds to those observed by previous experiments, and confirmed by Planck, including an asymmetry in the average temperatures on opposite hemispheres of the sky, and a cold spot that extends over a patch of sky that is much larger than expected.
One way to explain the **<u>anomalies</u>** is to propose that the Universe is in fact not the same in all directions on a larger scale than we can observe. In this scenario, the light rays from the CMB may have taken a more complicated route through the Universe than previously understood, resulting in some of the **<u>unusual patterns</u>** observed today.

‘The <u>observed anomalies in the cosmic microwave background are intriguing</u> — they may just be a statistical fluke, but they might be an indication of new physical processes at play in the early universe,’ researcher Andrew Liddle told Inside Science

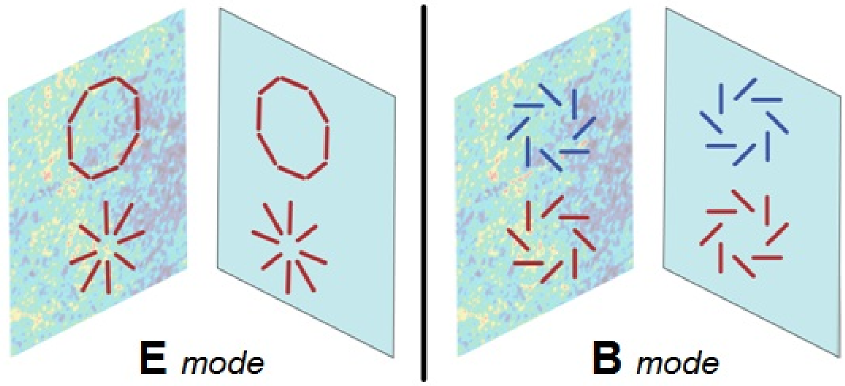


The BICEP2 polarization map, showing B-mode (“twist”) patterns.

Is there any other property of the Cosmic Microwave Background that might be measured? Is there any other physical imprint that might tell us something about the early days of the Cosmos? Of course there is! It is called ***polarization***. Light is known to scientists by its proper name, “*electromagnetic radiation*.” As the name suggests, it has an electric part and a magnetic part, **called “fields.”** The way we visualize light is as a wave of electric fields and magnetic fields travelling together, at right angles to each other. For any light you receive, the direction the electric field is waving defines **the *polarization* of the wave.....**

Polarization encodes many kinds of information, related to how light and matter interact with one another......

As we noted last time, gravitational waves interact with matter very weakly, so they propagate through the slowly evolving soup of the Cosmos, pushing matter here and their until the formation of the Cosmic Microwave Background. What is the net result? The net result is that gravitational waves leave a ***polarization imprint*** *in the microwave light. Just as with the expected polarization from electron scattering, there is a pattern to the polarization made by the gravitational waves. Astronomers call this pattern "B-modes" — they have a* ***twist*** *to them. You can recognize a B-mode pattern, a twist, because in a mirror the pattern appears reversed.*



(Left) E-mode polarization patterns look identical if viewed in a mirror.

(Right) B-mode polarization has a "twist." If the twist is clockwise, then when viewed in a mirror the twist is counter-clockwise, and vice versa.

Which brings us back to the story of BICEP2. Astronomers have been looking for the tell-tale twist of polarization in the Cosmic Microwave Background for some time. Major experiments have been slowly gearing up to look for and characterize the unique, gravitational-wave signature of inflation. The science team at BICEP2 won the race. What has all of us so excited is the measured value is larger than we anticipated, indicating the relative importance of the gravitational waves is large. This has provided sudden and unexpected guidance for theoretical physicists trying to model inflation, and for future experimenters attempting to build new experiments to probe the early Universe.

âGAUGE THEORY OF GRAVITATION ON A SPACE-TIME WITH TORSION

_GHEORGHE ZET, _CRISTIAN-DAN OPRISAN, and _SIMONA BABETI

....

6. Concluding remarks.We obtained the Schwarzschild solution within the teleparallel theory (TG) of gravity which is formulated in a space-time **with torsion only**. This can be interpreted as an indication that source of the torsion can be also the mass of the bodies that create the gravitational field, not only the spin. Therefore **the torsion and curvature of the space-time is determined by the mater distribution in the considered region.** The TG theory can be used also to **unify the gravitational field with other fundamental interactions** (electromagnetic, weak and strong). Some results about this problem are given in our paper.

Technical University "Gh.Asachi" Iasi, Department of Physics

Politehnica University of Timisoara, Department of Physics

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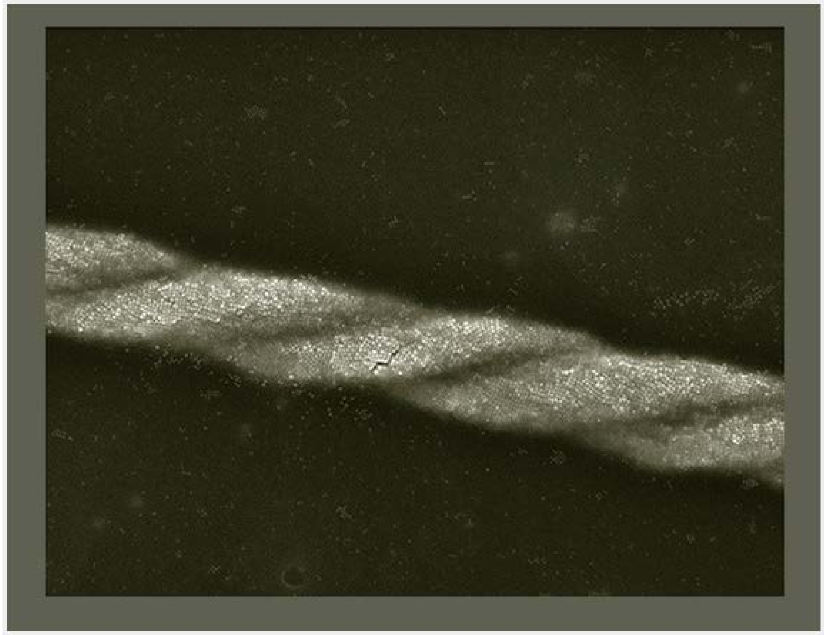
Nanoparticles of magnetite, the most abundant magnetic material on earth, are found in living organisms from bacteria to birds. Nanocrystals of magnetite self-assemble into fine compass needles in the organism that help it to navigate.

Collaborating with nanochemists led by Rafal Klajn at the Weizmann Institute of Science in Israel, who found that magnetite nanocubes can **self-assemble into helical superstructures** under certain conditions, University of Illinois at Chicago theoretical chemist Petr Kral and his students simulated the phenomenon and explained the conditions under which it can occur. The joint study is online in *Science Express* in advance of print in the 05.sept .2014 issue of *Science*. The Weizmann researchers dissolved the nanocrystals and exposed the solution to an external magnetic field. As the solution evaporated, helical chains of nanoparticles formed. Surprisingly, the spiral helices were chiral—that is, either left- or right-handed—despite the fact that the nanoparticles themselves are not chiral. Densely packed assemblies of helices tended to adopt the same handedness. .....**Neighboring helices within their densely packed ensembles tended to adopt the same handedness in order to maximize packing, thus revealing a novel mechanism of symmetry breaking and chirality amplification.**



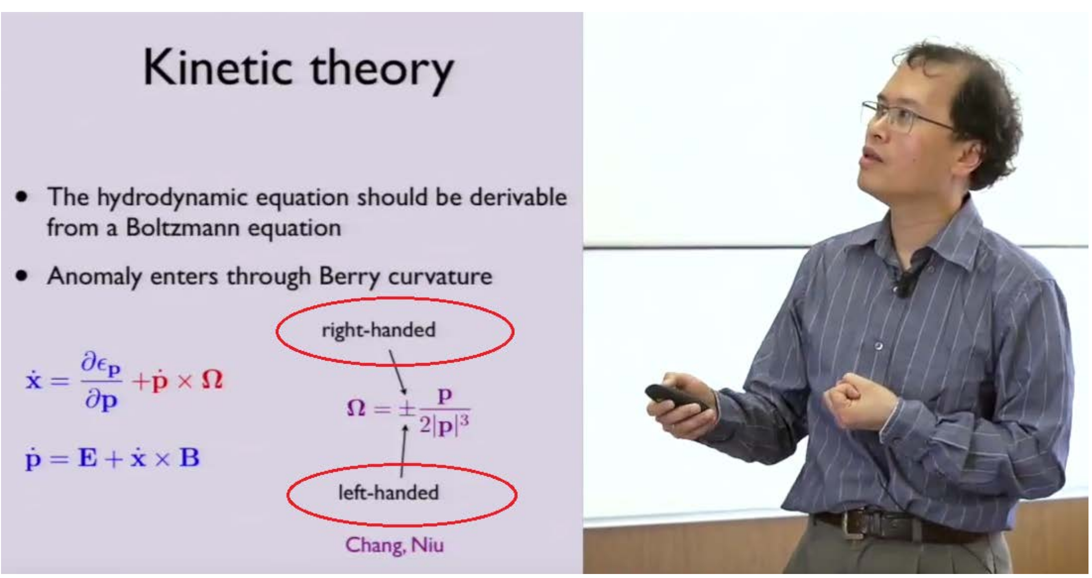
SEM image of a well-defined double helix. Credit: Weizmann Institute of Science

"We had to write a new, efficient Monte Carlo computer code describing all the necessary terms, all the values, and then explain how the highly unusual behavior that Klajn observed – the helices' self-assembly – happens," Kral said.

..

Đàm Thanh Sơn is a University Professor at the University of Chicago. His vast research interests span atomic, condensed matter, particle, and black hole physics. He is famous for his successful application of ideas from string theory to the understanding of nuclear matter in high-temperature and high-density regimes

Hydrodynamics, the theory describing collective behaviors of fluids and gases, is usually considered as a classical theory. In recent years, it has been found that hydrodynamics can be influenced by quantum **anomalies**. We will see how this interplay **between quantum and classical physics** has been discovered, **unexpectedly**, using the method of gauge/gravity duality. I will mention the possible relevance of the new findings to the physics of the quark gluon plasma.



PUZZLE PIECE No_6
(internet source about helicity and equivalent principle)

Quantum Emulation of Gravitational Waves
Relationship between gravitational
waves and electromagnetic waves in flat spacetime

Gravitational waves, as predicted by Einstein's general relativity theory, appear as ripples in the fabric of spacetime traveling at the speed of light. We prove that the propagation of small amplitude gravitational waves in a curved spacetime <u>*is equivalent*</u> *to the propagation of a subspace of electromagnetic states. We use this result to propose the use of entangled photons to emulate the evolution of gravitational waves in curved spacetimes by means of experimental electromagnetic setups featuring metamaterials.*

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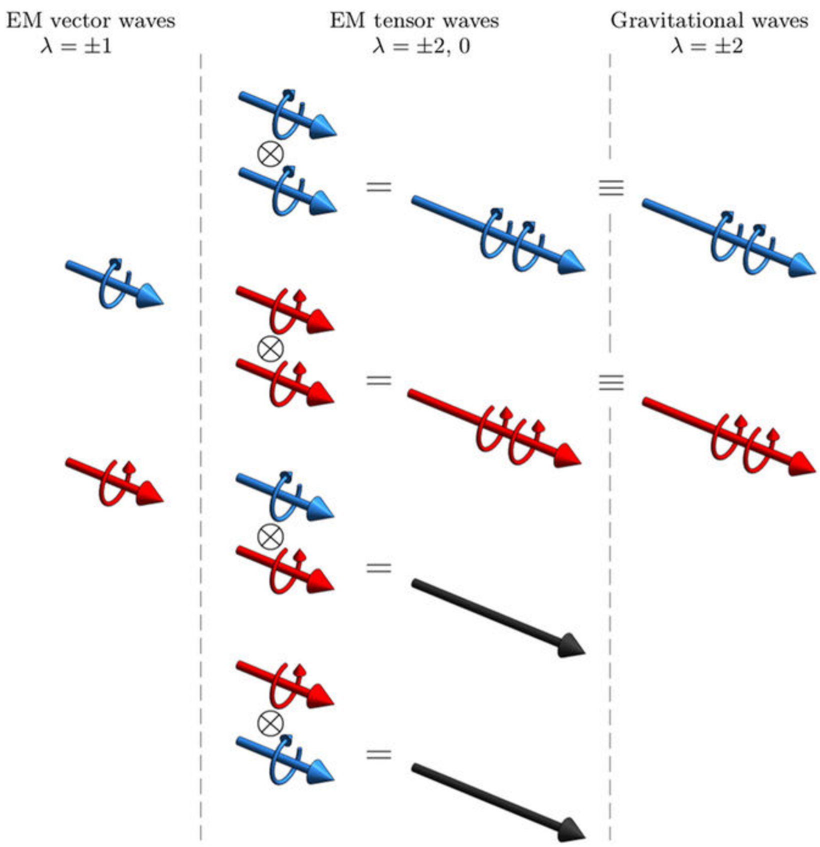

The different tensor products of electromagnetic plane waves of well-defined helicity equal to ±1 (in the left panel) result in electromagnetic tensor waves of helicity ±2 and 0 (middle panel), see Eq. (14). Only the first two have a gravitational wave equivalent (right panel). The momenta of the two electromagnetic plane waves do not need to be equal (as is depicted): parallel momenta is enough to ensure that the tensor product will have a gravitational wave equivalent.

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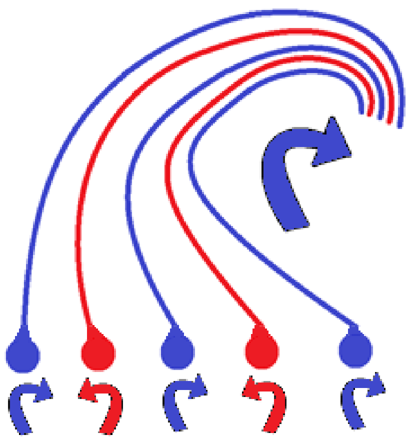
In conclusion, we have shown that the propagation of gravitational waves in a curved spacetime background <u>is equivalent</u> to the propagation of a restricted set of electromagnetic tensor product waves. The defining characteristics of gravitational waves, zero mass and possible helicities equal to ±2, select the appropriate subspace of electromagnetic states. They turn out to be the tensor products of two electromagnetic waves of the same helicity and parallel momentum. Therefore, any linearly or elliptically polarized gravitational wave can be expanded as the sum of two electromagnetic tensor waves, one for each circular polarization handedness. <u>**The consideration of helicity eigenstates of both the gravitational and the electromagnetic waves has been crucial:**</u> A linearly polarized gravitational wave cannot be formally factorized as a tensor product of two electromagnetic waves, while a circularly polarized gravitational wave can. Our analysis is restricted to gravitational waves of small amplitude that vary rapidly with respect to the spacetime background and propagate in empty space. <u>**As far as we know, this equivalence has not been reported before.**</u>

THE INTUITION OF HUMANITY ALWAYS READ THIS INFORMATION (GEOMETRY) EVEN IF NOBODY HAS A CONECTION WITH THEIR RATIONAL MIND!

IT'S TIME TO CONECT YOUR INTUITION WITH YOUR RATIONAL MIND!
IT'S TIME TO UNDERSTAND ...100% of informations exists... ON INTERNET!

I JUST FOUND THE KEY AND MADE THE PUZZLE, I COMPLETED THE PHOTO!

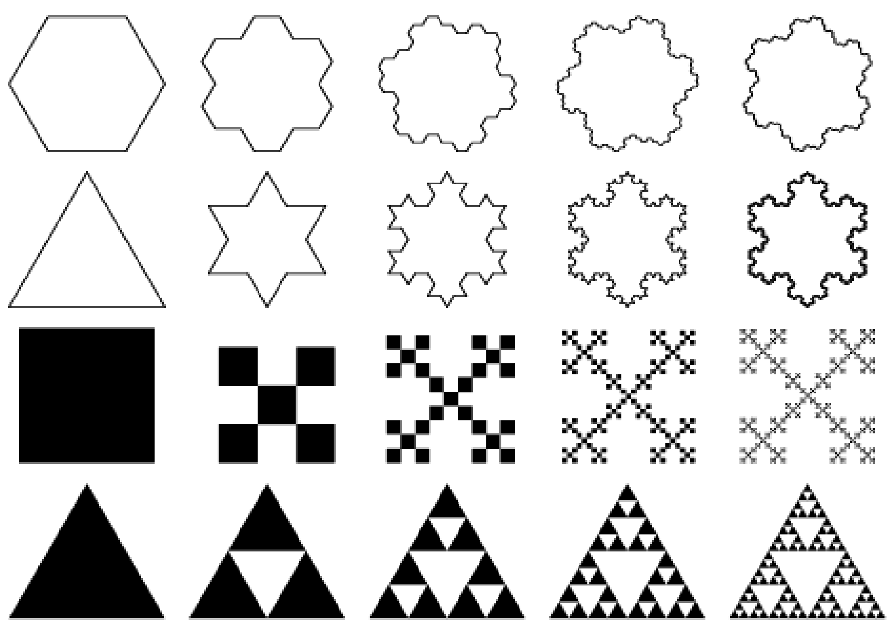


In left image is one of 4 rules of Fundamental Code!

CAN YOU SEE "THE FUNDAMENTAL RULE" READING THE DIFFERENT POINTS ...ABOVE? (self-organized universe)

IF YOU CAN...
YOU CAN PASS HEAVEN'S DOOR!...

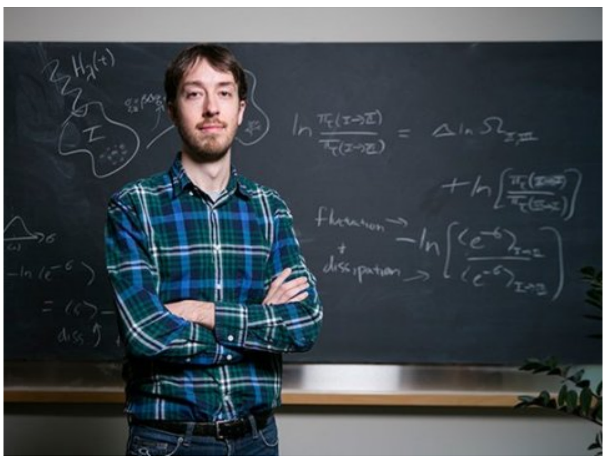
NOW READ
UNIFIED FIELDS THEORY & PRACTICE!



AN EXAMPLE OF BAD SCIENCE...
BUT ALMOST THERE!

Science More: Quanta Magazine Physics

This Physicist Has A Groundbreaking Idea About Why Life Exists



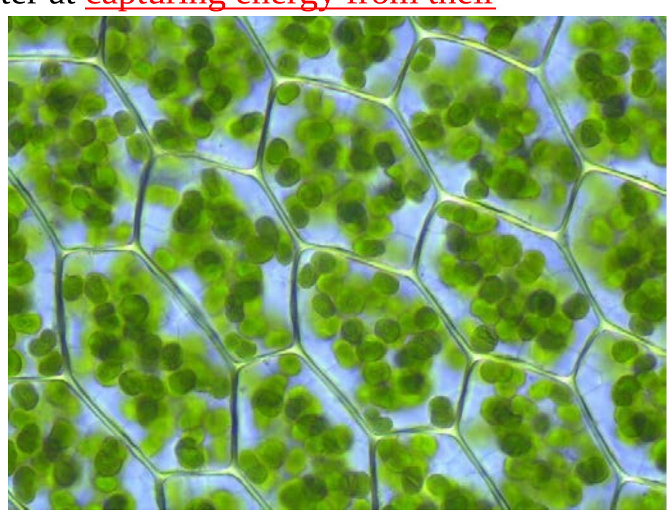
Katherine Taylor for Quanta MagazineJeremy England, a 31-year-old physicist at MIT, thinks he has found the underlying physics driving the origin and evolution of life.

Why does life exist?

Popular hypotheses credit a primordial soup, a bolt of lightning, and a colossal stroke of luck.

But if a provocative new theory is correct, luck may have little to do with it. Instead, according to the physicist proposing the idea, the origin and subsequent evolution of life follow from the fundamental laws of nature and "should be as unsurprising as rocks rolling downhill."

From the standpoint of physics, there is one essential difference between living things and inanimate clumps of carbon atoms: The former tend to be much better at capturing energy from their environment and dissipating that energy as heat.



Jeremy England, a 31-year-old assistant professor at the Massachusetts Institute of Technology, has derived a mathematical formula that he believes explains this capacity. The formula, based on established physics, indicates that when a group of atoms is driven by an external source of energy (like the sun or chemical fuel) and surrounded by a heat bath (like the ocean or atmosphere), it will often gradually restructure itself in order to dissipate increasingly more energy. This could mean that under certain conditions, matter inexorably acquires the key physical attribute associated with life.

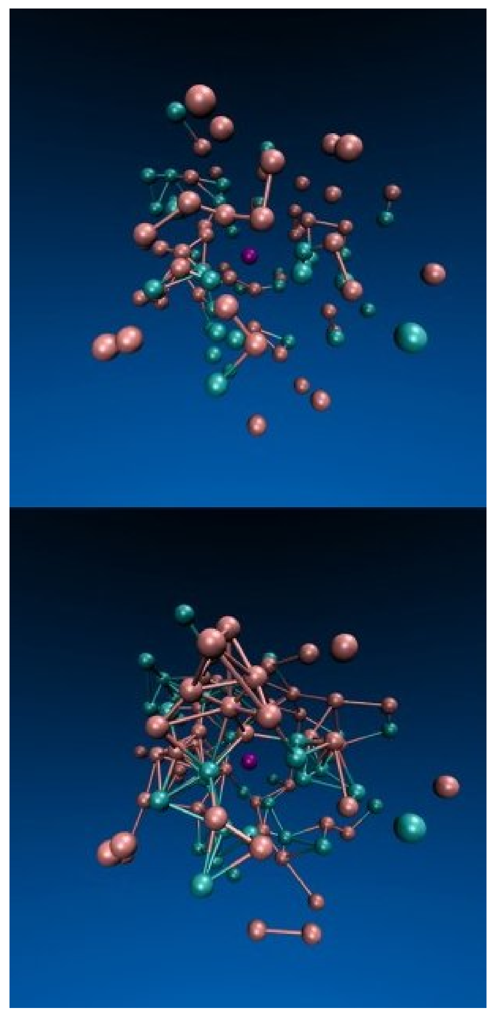
Kristian PetersCells from the moss Plagiomnium affine with visible chloroplasts, organelles that conduct photosynthesis by capturing sunlight.

“You start with a random clump of atoms, and if you shine light on it for long enough, it should not be so surprising that you get a plant,” England said.

England’s theory is meant to underlie, rather than replace, Darwin’s theory of evolution by natural selection, which provides a powerful description of life at the level of genes and populations. “I am certainly not saying that Darwinian ideas are wrong,” he explained. “On the contrary, I am just saying that from the perspective of the physics, you might call Darwinian evolution a special case of a more general phenomenon.”

His idea, detailed in a paper and further elaborated in a talk he is delivering at universities around the world, has sparked controversy among his colleagues, who see it as either tenuous or a potential breakthrough, or both.

England has taken “a very brave and very important step,” said Alexander Grosberg, a professor of physics at New York University who has followed England’s work since its early stages. **The “big hope” is that he has identified the underlying physical principle driving the origin and evolution of life, Grosberg said.**



“Jeremy is just about the brightest young scientist I ever came across,” said Attila Szabo, a biophysicist in the Laboratory of Chemical Physics at the National Institutes of Health who corresponded with England about his theory after meeting him at a conference. “I was struck by the originality of the ideas.”

Others, such as Eugene Shakhnovich, a professor of chemistry, chemical biology and biophysics at Harvard University, are not convinced. “Jeremy’s ideas are interesting and potentially promising, but at this point are extremely speculative, especially as applied to life phenomena,” Shakhnovich said.

England’s theoretical results are generally considered valid. It is his interpretation — that his formula represents the driving force behind a class of phenomena in nature that includes life — that remains unproven. But already, there are ideas about how to test that interpretation in the lab.

“He’s trying something radically different,” said Mara Prentiss, a professor of physics at Harvard who is contemplating such an experiment after learning about England’s work. “As an organizing lens, I think he has a fabulous idea. Right or wrong, it’s going to be very much worth the investigation.”

Courtesy of Jeremy EnglandA computer simulation by Jeremy England and colleagues shows a system of particles confined inside **a viscous fluid** in which the turquoise particles are driven by an oscillating force. Over time (from top to bottom), the force triggers the formation of more bonds among the particles.

At the heart of England’s idea is the second law of thermodynamics, also known as the law of increasing entropy or the “arrow of time.” Hot things cool down, gas diffuses through air, eggs scramble but never spontaneously unscramble; in short, energy tends to disperse or spread out as time progresses. Entropy is a measure of this tendency, quantifying how dispersed the energy is among the particles in a system, and how diffuse those particles are throughout space. It increases as a simple matter of probability: There are more ways for energy to be spread out than for it to be concentrated.

Thus, **as particles in a system move around and interact**, they will, through sheer chance, tend to adopt configurations in which the energy is spread out. Eventually, the system arrives at a state of maximum entropy called “thermodynamic equilibrium,” in which energy is uniformly distributed. A cup of coffee and the room it sits in become the same temperature, for example.

As long as the cup and the room are left alone, this process is irreversible. The coffee never spontaneously heats up again because the odds are overwhelmingly stacked against so much of the room’s energy randomly concentrating in its atoms.

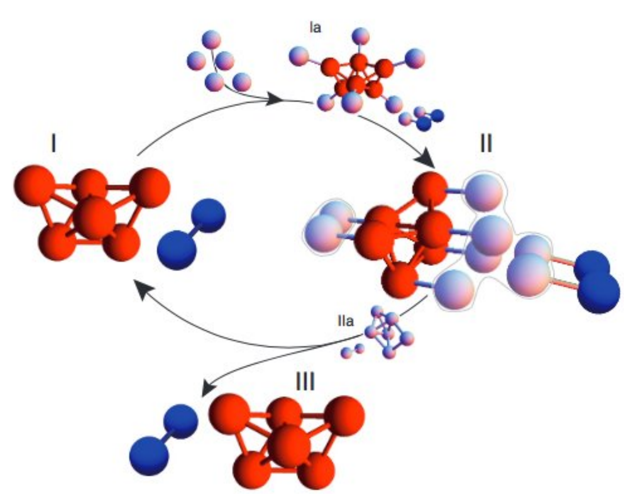
Although entropy must increase over time in an isolated or “closed” system, an “open” system can keep its entropy low — that is, divide energy unevenly among its atoms — by greatly increasing the entropy of its surroundings. In his influential 1944 monograph “What Is Life?” the eminent quantum physicist Erwin Schrödinger argued that this is what living things must do. A plant, for example, absorbs extremely energetic sunlight, uses it to build sugars, and ejects infrared light, a much less concentrated form of energy. The overall entropy of the universe increases during photosynthesis as the sunlight dissipates, even as the plant prevents itself from decaying by maintaining an orderly internal structure.

Life does not violate the second law of thermodynamics, but until recently, physicists were unable to use thermodynamics to explain why it should arise in the first place. In Schrödinger’s day, they could solve the equations of thermodynamics only for closed systems in equilibrium. In the 1960s, the Belgian physicist Ilya Prigogine made progress on predicting the behavior of **open systems weakly driven by external energy sources (**for which he won the 1977 Nobel Prize in chemistry). But the behavior of systems that are far from equilibrium, **which are connected to the outside environment and strongly driven by external sources of energy,** could not be predicted.

This situation changed in the late 1990s, due primarily to the work of Chris Jarzynski, now at the University of Maryland, and Gavin Crooks, now at Lawrence Berkeley National Laboratory. Jarzynski and Crooks showed that the entropy produced by a thermodynamic process, such as the cooling of a cup of coffee, corresponds to a simple ratio: the probability that the atoms will undergo that process divided by their probability of undergoing the reverse process (that is, spontaneously interacting in such a way that the coffee warms up). As entropy production increases, so does this ratio: A system's behavior becomes more and more "irreversible." The simple yet rigorous formula could in principle be applied to any thermodynamic process, no matter how fast or far from equilibrium. "Our understanding of far-from-equilibrium statistical mechanics greatly improved," Grosberg said. England, who is trained in both biochemistry and physics, started his own lab at MIT two years ago and decided to apply the new knowledge of statistical physics to biology.

Using Jarzynski and Crooks' formulation, he derived a generalization of the second law of thermodynamics that holds for systems of particles with certain characteristics: The systems are strongly driven by an external energy source such as an electromagnetic wave, and they can dump heat into a surrounding bath. This class of systems includes all living things. England then determined how such systems tend to evolve over time as they increase their irreversibility. "We can show very simply from the formula that the more likely evolutionary outcomes are going to be the ones that absorbed and dissipated more energy from the environment's external drives on the way to getting there," he said. The finding makes intuitive sense: Particles tend to dissipate more energy when they resonate with a driving force, or move in the direction it is pushing them, and they are more likely to move in that direction than any other at any given moment.

"This means clumps of atoms surrounded by a bath at some temperature, like the atmosphere or the ocean, should tend over time **to arrange themselves to resonate better and better with the sources of mechanical, electromagnetic or chemical work in their environments**," England explained.



Courtesy of Michael Brenner/Proceedings of the National Academy of Sciences Self-Replicating Sphere Clusters: According to new research at Harvard, coating the surfaces of microspheres can cause them to **spontaneously assemble into a chosen structure, such as a polytetrahedron (red), which then triggers nearby spheres into forming an identical structure.**

Self-replication (or reproduction, in biological terms), the process that drives the evolution of life on Earth, is one such mechanism by which a system might dissipate an increasing amount of energy over time.

As England put it, “A great way of dissipating more is to make more copies of yourself.”

In a September paper in the Journal of Chemical Physics, he reported the theoretical minimum amount of dissipation that can occur during the self-replication of **RNA molecules and bacterial cells**, and showed that it is very close to the actual amounts these systems dissipate when replicating.

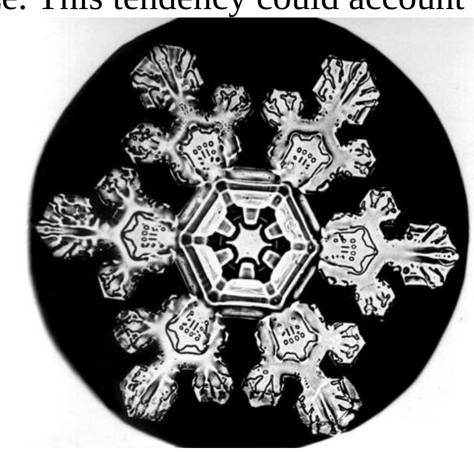
He also showed that **RNA, the nucleic acid that many scientists believe served as the precursor to DNA-based life**, is a particularly cheap building material. Once RNA arose, he argues, its “Darwinian takeover” was perhaps not surprising.

The chemistry of the primordial soup, random mutations, geography, catastrophic events and countless other factors have contributed to the fine details of Earth’s diverse flora and fauna. But according to England’s theory, the underlying principle driving the whole process is dissipation-driven adaptation of matter.

This principle would apply to inanimate matter as well. “It is very tempting to speculate about what phenomena in nature we can now fit under this big tent of dissipation-driven **adaptive organization**,” England said. “Many examples could just be right under our nose, but because we haven’t been looking for them we haven’t noticed them.”

Scientists have already observed self-replication in nonliving systems. According to new research led by Philip Marcus of the University of California, Berkeley, and reported in Physical Review Letters in August, **vortices in turbulent fluids spontaneously replicate themselves** by drawing energy from shear in the surrounding fluid. And in a paper in Proceedings of the National Academy of Sciences, Michael Brenner, a professor of applied mathematics and physics at Harvard, and his collaborators present theoretical models and simulations of microstructures that self-replicate. These clusters of specially coated microspheres dissipate energy by roping nearby spheres into forming identical clusters. “This connects very much to what Jeremy is saying,” Brenner said.

Besides **self-replication**, greater structural organization is another means by which strongly driven systems ramp up their ability to dissipate energy. A plant, for example, is much better at capturing and routing solar energy through itself than an unstructured heap of carbon atoms. Thus, England argues that under certain conditions, matter will spontaneously self-organize. This tendency could account for the internal order of living things and of many inanimate structures as well. “**Snowflakes, sand dunes and turbulent vortices all have in common that they are strikingly patterned structures that emerge in many-particle systems driven by some dissipative process,**” he said. Condensation, wind and viscous drag are the relevant processes in these particular cases.



“He is making me think that the distinction between living and nonliving matter is not sharp,” said Carl Franck, a biological physicist at Cornell University, in an email. "I'm particularly impressed by this notion when one considers systems as small as chemical circuits involving a few biomolecules."

If a new theory is correct, the same physics it identifies as responsible for the origin of living things could explain the formation of many other patterned structures in nature. Snowflakes, sand dunes and **self-replicating vortices in the protoplanetary disk may all be examples of dissipation-driven adaptation**.

England's bold idea will likely face close scrutiny in the coming years.

He is currently running computer simulations to test his theory that systems of particles adapt their structures to become better at dissipating energy. The next step will be to run experiments on living systems.

Prentiss, who runs an experimental biophysics lab at Harvard, says England's theory could be tested by comparing cells with different mutations and looking for a correlation between the amount of energy the cells dissipate and their replication rates.

"One has to be careful because any mutation might do many things," she said. "But if one kept doing many of these experiments on different systems and if [dissipation and replication success] are indeed correlated, **that would suggest this is the correct organizing principle."**

Brenner said he hopes to connect England's theory to his own microsphere constructions and determine whether the theory correctly predicts which **self-replication and self-assembly processes can occur — "a fundamental question in science,"** he said.

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