Adaptive Tension Systems: Towards a Theory of Everything?

Heikki Hyötyniemi*
*Helsinki University of Technology
Control Engineering Laboratory
P.O. Box 5500, FIN-02015 TKK, Finland

Abstract

Assuming that there really exists some general theory of complex systems, one has strong guidelines for where to search for it. Such theory has to address the distributedness of the underlying actors in the absence of central control, and it has to explain emergence in terms of self-regulation and some kind of self-organization of higher-level structures. It is the neocybernetic framework of Adaptive Tension Systems (also known as "elastic systems") that is one candidate theory offering such visions, making it possible to make assumptions about the "Platonian Ideals" of complex interacting systems. As application examples, this methodology is here employed for analysis of *molecular orbitals* and *orbiting mass systems.*

1 Introduction

It is intuitively clear that there is something in common beyond different kinds of complex systems — is it not? At least in the complexity and chaos theory communities such belief has been loudly promoted. However, as the promises have never been redeemed, this "chaoplexity" research is seen as an icon of "ironic science". The complexity theory cannot be based merely on intuitions.

But the "theory of everything" should neither be based only on mathematics, as has been claimed by the quantum theorists (Ellis, 1986). Not everything can be expressed in formulas in a credible way — even though system hierarchies are finally reducible to the level of elementary physics, quantum theories do not offer the best modeling framefork for, say, cognitive systems. However good models for microscopic phenomena can be found, they have little to do with macroscopic systems; they are not the most economical way of describing the emergent-level phenomena, thus being no good models at that level.

What is a good compromize between the extremely heuristic visions and the utterly down-to-earth analyses? Mathematics is a necessary language, but intuition and heuristics should be guiding what kind of mathematical constructs are discussed; there are too many directions available, but only a few of the routes lead to directions addressing *relevance.* What, then, are the relevant issues to be emphasized?

The underlying realms beneath complex systems are very different. However, something is shared by all of them: They all consist of *distributed networks* where *local-level interactions* of more or less mindless actors with only very simple functionalities result in *self-regulation* and *self-organization* that is visible on the global level. The divergence of the models, in the spirit of the celebrated "butterfly effect" is just an illusion, as it is *conververgence* and *stability* that that are the key issues in surviving systems. It seems that the framework of *adaptive tension systems* based on the neocybernetic theory (also known as *elastic systems*) offers the necessary functionalities (Hyötyniemi, 2006). It turns out that the emerging structures can be studied in the framework of *principal components* (Basilevsky, 1994). How to detect the cybernetic nature of a system, then?

Traditionally, the similarities between complex systems are searched for in the static (fractal) surface patterns. However, the *deep structures* based on interactions and feedbacks are *dynamic* and they can only be captured by mathematical tools: the actual observed patterns are dynamic balances in the data space, and potential patterns are characterized by dynamic attractors. The similarities in underlying structures are *analogies between mathematical representations.* Or, being more than formal similarities, such analogies should perhaps be called *homologies.* Indeed, there exist some mathematical structures that can be seen as manifestations of the neocybernetic ordering principle.

Nothing very exotic takes place in neocybernetic mathematics – no "new science" is needed. Old science suffices, but the new interpretations spawn a

completely *new world*. Surprisingly, the resulting models are analogical with cognitive ones, so that the subjective and objective "everything" can perhaps be united once again.

In this paper, it is shown how the above view can be exploited in analysis of physical systems, small and big. As application examples, *modeling of molecules* and *modeling of celestial bodies*, are discussed.

2 Neocybernetics *in the small*

What if elementary physics were simpler than what has been believed, what if understanding molecules would not take a nuclear physicist? Below, the neocybernetic *analogy in cost criteria* is employed.

2.1 Standard theories of molecules

Atoms are already rather well understood. The contemporary theory of atom orbitals can explain their properties to sufficient degree. However, it seems that one needs new approaches to understand the emergent level, or the level of molecules. Molecular orbitals are interesting because the chemical properties of compounds are determined by their charge distribution — essentially these orbitals reveal how the molecule is seen by the outside world.

The molecules have been a challenge for modern physics for a long time, and different kinds of frameworks have been proposed to tackle with them: First, there are the *valence bond theories*, where the individual atoms with their orbitals are seen as a construction kit for building up the molecules, molecule orbitals being just combinations of atom orbitals; later, different kinds of more ambitious *molecule orbital theories* have been proposed to explain the emergent properties of molecules. In both cases it is still the ideas of atom orbitals that have been extended to the molecules. Unfortunately it seems that very often some extra tricks are needed: for example, to explain the four identical bonds that carbon can have, peculiar "hybridizations" need to be employed; and still there are problems, a notorious example being *benzene* (and other aromatic compounds) where the "bottom up" combinations of atom orbitals simply seem to fail. And, unluckily, it is exactly carbon and its properties that one has to tackle with when trying to explain living systems and their building blocks.

When thinking of alternative approaches, it is encouraging that molecules have been studied applying discretized eigenvalues and eigenvectors, too: for example, Erich Hückel proposed an approach that is known as *Huckel's method*, also reducing the analysis of energy levels in molecules into essentially an eigenvalue problem (Berson, 1999). However, this method is still based on combinations of atom orbitals, and being based on crude simplifications, it is regarded as an approximation.

It is also quite commonplace that linear additivity of orbitals is assumed on the molecular level — normally it is atomic orbitals that are added together, now it is molecular orbitals directly. Indeed, basic physics *is* linear; the problems are normally caused by the huge dimensionality of the problems. This all — linearity, eigenvectors — sounds like very neocybernetics-looking.

The challenge here is to combine the neocybernetic model with current theories and models.

2.2 Cybernetic view of electrons

There is no central control among individual electrons, but the electron systems — atoms, molecules — still seem to be stable and organized. Either there is some yet unknown mechanism that is capable of maintaining the stability and the structures — or, it is the neocybernetic model that applies. The latter assumption is now applied, and the consequences are studied. It is assumed that "electron shells", etc., are just emergent manifestations of the underlying dynamic balances.

The starting point (set of electrons) and the goal (cybernetic model) are given, and the steps in between need to be motivated[1]. So, assume that the nuclei are fixed (according to the Born-Oppenheimer approximation), and drop the electrons in the system to freely search their places.

When studying the elementary particles, traditional thinking has to be turned upside down: For example, it seems that in that scale the discrete becomes continuous, and the continuous becomes discrete. Distinct electrons have to be seen as delocalized, continuous charge distributions; however, their interactions have to be seen not as continuous but discrete, being based on stochastic photons being transmitted among the interacting charge fields. This view needs to be functionalized.

First, study the macroscopic scale. Assume that there are two charge fields i and j, variables x_i and x_j representing their intensities. Energy that is stored in the potential fields can be calculated within a single

[1] Of course, "knowing" the end points and trying to fill the remaining gap, is a risky way to proceed!

charge field as

$$J_{i,i} = c \int_0^{x_i} \xi \, d\xi = \frac{1}{2} c \, x_i^2, \quad (1)$$

where c is a constant, and among overlapping fields as

$$J_{i,j} = c \int_0^{x_i} x_j \, d\xi = c \, x_i x_j. \quad (2)$$

If the charges of i and j have the same sign, the potential is positive, denoting repulsion; otherwise, there is attraction.

However, the macroscopic phenomena are emergent and become analyzable only through statistical considerations; in microscopic scales, there are no charges to be observed, only interactions. For two fields i and j to intreract, the photons emitted by the fields need to meet — denote this probability by $p_{i,j}$. Then the *effective* potential is

$$J' = p_{1,1}J_{1,1} + p_{1,2}J_{1,2} + \cdots + p_{n,n}J_{n,n}. \quad (3)$$

The symbols x_i and x_j have dual interpretation: they constitute the charge distributions, but simultaneously they are probability distributions. As the photon transmission processes are independent, the interaction probability $p_{i,j}$ is proportional to the average product of the intensities, or $x_i x_j$, so that

$$p_{i,j} = \mathrm{E}\left\{x_i x_j\right\}. \quad (4)$$

Assume that the charge fields are divided into two classes, the negative ones into "internal" and the positive into "external" ones. Further, assume that the external fields are collected in the vector u, internal ones remaining in x. The sum of energies among the negative charge fields can be presented in matrix form as

$$J' = \frac{1}{2} x^T \mathrm{E}\left\{x x^T\right\} x, \quad (5)$$

and, correspondingly for positive charges,

$$J'' = -x^T \mathrm{E}\left\{x u^T\right\} u. \quad (6)$$

For the total energy one has

$$\begin{aligned} J(x,u) &= J' + J'' \\ &= \tfrac{1}{2} x^T \mathrm{E}\left\{x x^T\right\} x - x^T \mathrm{E}\left\{x u^T\right\} u. \end{aligned} \quad (7)$$

The above criterion $J(x,u)$ is exactly the same cost criterion that was derived for ordinary (neo)cybernetic systems (here it is assumed that the balance is found immediately, so that $\bar{x} \equiv x$). This means that when appropriate interpretations are employed, and when the cost criterion is minimized over time, the solutions for electron configurations implement the emergent neocybernetic structures (Hyötyniemi, 2006). If the assumptions hold, there is self-regulation and self-organization among the electrons, emerging through local attempts to reach potential minimum. Not all electrons can go to the lowest energy levels, and "electronic diversity" emerges automatically. Surprisingly, because of their delocalization, "overall presence" and mutual repulsion, the electron fields implement explicit feedback, following the model of "smart cybernetic agents" (see (Hyötyniemi, 2006)).

The result is that the charge distribution along the molecule (molecular orbital) is given by the *principal components of the interaction correlation matrix* that can be calculated when the organization of the nuclei is known. Because of the distinct nature of electrons, they cannot be located in various energy levels simultaneously and eigenvalues become distinguished.

When speaking of molecules, the "inputs" u_j denote the more or less fixed positive nuclei, whereas x_i denote the *molecular orbitals* within the molecule.

It is interesting to note that there are no kinetic energies involved in the energy criterion, and no velocities or accelerations are involved. As seen from the system perspective, the charges are just static "clouds". This means that some theoretical problems are now avoided: As there are no accelerating charges, there are no electrodynamic issues to be explained as no energy needs to be emitted, and the system can be in equilibrium. In contrast, such electrodynamic inconsistencies plagued the traditional atom models where it was assumed that the electrons revolved around the nucleus, experiencing constant centripetal acceleration, so that radiation of energy should take place.

What is the added value when studying the new view of molecules? Whereas the electrons are delocalized, the heavier nuclei can be assumed to be better localized. The key observation here is that the analysis of the continuous space — modeling of the charge distribution of electrons — changes into an analysis of a discrete, finite set of variables, or the nuclei. The idea of neocybernetic "mirror images" is essentially employed here: rather than studying the system itself, the electrons, its environment is analyzed. In this special case it is the environment that happens to be simpler to operate on.

Because of the properties of eigenvectors, the discrete orbitals are mutually orthogonal. Traditionally, it is assumed that there is just room for a unique electron in one orbit (or, indeed, for a pair of electrons with opposite spins). However, now there can be many electrons in the same orbital, and there is no

need to employ external constraints about the structures, like assumptions of spins, etc. The charge field can be expressed as $\psi_i = \sqrt{\lambda_i}\,\phi_i$, where λ_i is the eigenvalue corresponding to the orbital-eigenvector ϕ_i, so that the overall charge becomes $\psi_i^T \psi_i = \lambda_i$. The "variance" λ_i is the emergent measurable total charge in that field. This means that there are some conditions for the charge fields to match with the assumption of existence of distinct charge packets:

1. Eigenvalue λ_i has to be an integer times the elementary charge, this integer representing the number of electrons in that orbital.

2. The sum of all these integers has to equal the number of valence electrons, sum of all free electrons in the system.

These constraints give tools to determine the balance configuration among the nuclei.

How to quantize the continuous fields, and how to characterize the effects in the form $\mathrm{E}\{uu^T\}$, and how to determine the parameters? And how is this all related to established quantum theory? In short, how are the above discussions related to real physical systems?

2.3 Neocybernetic orbitals

It is the *time-independent Schrödinger equation* that offers a solid basis for all quantum-level analyses (Brehm and Mullin, 1989). It can be assumed to always hold, and it applies also to molecules (h is the Planck's constant, and m_e is the mass of an electron):

$$-\frac{h^2}{8\pi^2 m_\mathrm{e}}\frac{d^2}{dx^2}\psi(x) + V(x)\psi(x) = E\psi(x). \quad (8)$$

Here, $V(x)$ is the potential energy, and E is the *energy eigenvalue* corresponding to the *eigenfunction* $\psi(x)$ characterizing the orbital. As $\psi(x)$ is continuous, Schrödinger equation defines an infinite-dimensional problem, and as x is the spatial coordinate, in higher dimensions this becomes a partial differential equation. Normally this expression is far too complex to be solved explicitly, and different kinds of simplifications are needed. Traditional methods are based on reductionistically studying the complex system one part at a time, resulting in approaches based on the atom orbitals.

Now, start from the top: As studied in the previous section, assume that it is simply a non-controlled play among identical electrons that is taking place in a molecule. It is all "free" electrons that are on the outermost shell that are available for contributing in the orbitals, that is, for each carbon atom the number of valence electrons in the system is increased by the number $v_\mathrm{C} = 4$, for hydrogen $v_\mathrm{H} = 1$, and for oxygen $v_\mathrm{O} = 6$. What kind of simplifications to (8) are motivated?

The time-independent *discrete* Schrödinger equation that is studied can be seen as a quantized version of (8)

$$-V_0\phi_i + V\phi_i = E_i\phi_i, \quad (9)$$

where ϕ_i are now vectors, $1 \leq i \leq n$, dimensions equalling the number n of atoms in the molecule; because of the structure of the expression, these are the eigenvectors of the matrix $V - V_0$ corresponding to the eigenvalues E_i. In the framework of the eigenproblem, now there is a connection to the neocybernetic model structure. Comparing to the discussions in the previous section, there holds $E_i = \lambda_i^2$, the eigenvectors being the same. Rather than analysing the infinite dimensional distribution of electrons, study the finite-dimensional distribution of nuclei; one only needs to determine the $n \times n$ elements of the potential matrix $V - V_0$ to be able to calculate the orbitals (or the negative charge fields around the positive nuclei).

To determine the matrix of potential energies among the nuclei, the challenge is to determine the terms corresponding to the first term in (8). The diagonal entries of $V - V_0$ are easy: Because the "local potential" is assumedly not essentially affected by the other nuclei, the atoms can be thought to be driven completely apart, so that the non-diagonal entries vanish; the diagonal entries then represent free separate atoms, so that the electron count must equal the number of available valence electrons, that is, the i'th diagonal entry is proportional to v_i^2, where v_i presents the number of valence electrons in that atom. For non-diagonal entries, the sensitivity to changes to distant nuclei becomes small, so that the term with the second derivative practically vanishes, and the corresponding entry in the potential energy matrix is according to basic electrostatics approximately proportional to $v_i v_j / |r_{ij}|$, without normalization. Here, $|r_{ij}|$ stands for the distance between the nuclei i and j.

When the preliminary potential matrix has been constructed, elements of the matrix $V - V_0$ have to be justified so that the eigenvalues of the matrix become squares of integers, and the sum of those integers equals the total number of valence electrons.

So, given the physical outlook of the molecule in equilibrium, one simply carries out principal component analysis for the "interaction matrix" $V - V_0$, finding the set of "discrete orbitals", or orbital vectors

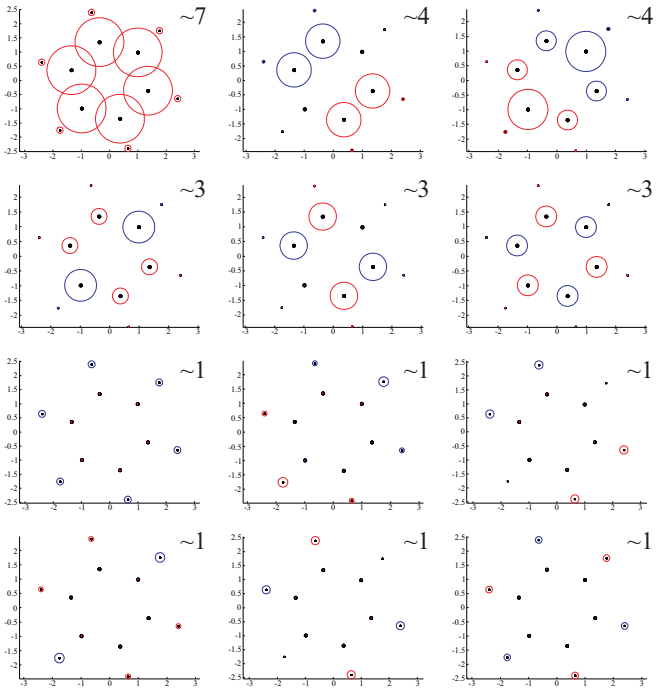

Figure 1: "Cybernetic orbitals" ψ_i in the benzene molecule (see text). The larger dots denote carbon nuclei and the smaller ones hydrogen nuclei, distances shown in Ångströms (1 Å = 10^{-10} m). The orbitals, shown as circles around the nuclei, have been scaled by the corresponding λ_i to visualize their relevances. The circle colours (red or blue) illustrate the correlation structures of electron occurrences among the nuclei (the colors are to be compared only within a single orbital at a time). There is a fascinating similarity with benzene orbitals as proposed in literature (for example, see Morrison and Boyd (1987))

ψ_i and the corresponding eigenvalues E_i and electron counts λ_i. The elements of the vectors ψ_i reveal around which nuclei the orbital mostly resides; the overlap probability p_{ij} is spatial rather than temporal.

For illustration, study the benzene molecule: benzene is the prototype of aromatic compounds, consisting of six carbon atoms and six hydrogen atoms in a carbon-ring. Altogether there are 30 valence electrons (6 times 4 for carbon, and 6 times 1 for hydrogen). The results of applying the neocybernetic approach are shown in Fig. 1. It seems that the three first orbitals have essentially the same outlook as orbitals proposed in literature — for example, see (Morrison and Boyd, 1987) — but now there are altogether 7 electrons on the lowest energy level! All orbitals extend over the whole molecule; the hydrogen orbitals are also delocalized, and such delocalization applies to all molecules, not only benzene. Note that the orbitals having the same energy levels are not unique, but any orthogonal linear combinations of them can be selected; such behavior is typical to symmetric molecules. The "bonding energy" is the drop in total energy, or the difference between the energies in the molecule as compared to the free atoms; possible values of this energy are discretized, now it (without scaling) is $1 \cdot 7^2 + 2 \cdot 4^2 + 3 \cdot 3^2 + 6 \cdot 1^2 - (6 \cdot 4^2 + 6 \cdot 1^2) = 12$.

The presented approach is general and robust: For example, the unsaturated double and triple bonds as well as aromatic structures are automatically taken care of as the emerging orbitals only depend on the balance distances between nuclei: If the nuclei remain nearer to each other than what is normally the case, there also must exist more electrons around them. Spin considerations are not needed now, as there is no need for external structures (orbitals of "two-only capacity") to keep the system stable and organized. However, no exhaustive testing has been carried out for evaluating the fit with reality. In any case, the objective here is only to illustrate the new horizons there can be available when employing non-centralized model structures.

3 Neocybernetics *in the large*

Above, analyses were applied in the microscale — but it turns out that there are minor actors when looking at larger systems, too. Here, the neocybernetic approaches are applied in cosmic dimensions. After all, the galaxes as well as solar systems seem to be self-organized stable structures. The domain field is very different as compared to the previous one, and, similarly, the approaches need to be different. One thing that remains is that, again, one needs to extensively employ intuitions and analogies. However, rather than exploiting the analogy in *forms*, as above, *analogy in functions* is applied this time.

3.1 From *constraints* to *freedoms*

As explained in (Hyötyniemi, 2006), neocybernetic models can be interpreted as seeing *variation as information.* They try to search for the directions in the data space where there is maximum visible (co)variation; as seen from above, this means that such systems orientate towards *freedoms* in the data space. As exploitation means exhaustion, feedbacks that are constituted by neocybernetic systems "suck out" this variation from the environment. Along the axes of freedom, forces cause deformations: the system *yields* as a reaction to environmental tensions, to bounce back after the outside pressure is relieved — exactly this phenomenon is seen as *elasticity* in the system. When the system adapts, freedoms become better controlled, meaning that the system becomes *stiffer,* or less elastic.

The challenge here is that such freedoms-oriented modeling is less natural for human thinking than modeling that is based on *constraints.*

Indeed, all of our more complex mental models are based on *natural language,* and human languages are tools to define couplings among concepts, or, really, constraints that eliminate variability in the chaos around us. As Ludwig Wittgenstein put it, "world is the totality of states of affairs", or the observed reality is the sum of facts binding variables together. What is more acute, is Wittgenstein's observation that *all consistent logical reasoning consists only of tautologies.* Similarly in all mathematical domains: axioms determine the closure of trivialities, and it takes mathematical intuition to reach outside the boundaries, finding the freedoms where the "life" is. In a way, one is to find the truths that cannot be deduced from the axioms — in the Gödelian sense!

When the natural languages set the standard of how to see the world, also natural laws are seen as constraints: one searches for *invariances,* or formulas revealing how physical constants are bound together. In practice, such invariances are equations — when the other variables in the formula are fixed, the last one is uniquely determined, so that its freedom is lost.

In the neocybernetic spirit, this all can be seen in another perspective again. There is a duality of interpretations: whereas traditionally one searches for *invariants,* now search for *covariants.* The idea is to apply the elasticity analogy: the same phenomena can be represented, just the point of view changes. Emmy Noether first observed that all symmetries in nature correspond to conservation laws; is it so that all conservation laws can further be written as an elastic pairs of variables?

3.2 Another view at classical physics[2]

When exploiting the above idea of employing degrees of freedom in a new area, one first has to select an appropriate set of variables — such that they together carry *emergy* in that domain. When speaking of mechanical systems in a central force field, it turns out that one can select *momentum* to represent the internal state of the mass point system, and *force* can be seen as external input:

$$x = p = mv \qquad \text{and} \qquad u = F = \frac{c}{r^2}, \tag{10}$$

where m is the mass of the mass point, v is its velocity, r is its distance from the mass center, and c is some constant. The central force is assumed to be relative to inverse of the squared distance; this holds for gravitational fields, for example.

How about the assumed covariation of the selected variables? — For a mass point orbiting a mass center, assuming that one only studies the angular movements, *angular momentum* can be defined as (Alonso and Finn, 1980)

$$L = mv\,r. \tag{11}$$

If there is no external torque, this quantity L remains constant, or invariant, no matter how v and r vary. Applying the invariance of angular momentum, it is evident that there is a coupling between the selected variables x and u, so that

$$x/\sqrt{u} = p/\sqrt{F} = constant. \tag{12}$$

The variables are also covariants even though the manifested elasticity relationship is now nonlinear. Now, following the steel plate analogy (Hyötyniemi,

[2]The derivations here (as in the previous case, too) are somewhat sloppy, guided by the strong intuition, hoping that applying some more advanced analysis the loopholes can be somehow fixed

2006), there is *internal energy* and *external energy* that should be determined within the elasticity framework. From (10) one can solve for the stored internal and external energies, respectively:

$$\begin{aligned} W_{\text{int}} &= \int_0^v m\nu \, d\nu = \frac{1}{2} m v^2 \\ &= \frac{1}{2} \, m r^2 \, \frac{v^2}{r^2} = \frac{1}{2} \, I \omega^2 \qquad (13) \\ W_{\text{ext}} &= -\int_\rho^\infty \frac{c}{\rho^2} \, d\rho = \frac{c}{r}, \end{aligned}$$

where I is the *inertia momentum* of the rotating pointwise body, and $\omega = v/r$ is its angular velocity. It is clear that these expressions stand for cumulated *kinetic energy* and *potential energy*, respectively, so that $W_{\text{int}} = W_{\text{kin}}$ and $W_{\text{ext}} = W_{\text{pot}}$. Thus, one can see that the difference between internal and external energies in this system transforms into a difference between kinetic and potential energies — neocybernetic minimization of the deformation energy thus changes into the *Lagrangian functional that is known to govern the dynamics of a mechanical system*. Surpisingly, the Lagrangian that was found applies not only to circular orbits but also to more general non-cyclic motions; the circular orbit represents the (hypothetic) final balance.

The Lagrangian mechanics has exploited the Lagrangians for a long time — is there some added value available here? Applying the neocybernetic intuition, one can see that global behavior is an emergent phenomenon resulting directly from local low-level actions that one does not (and needs not) know. What is perhaps more interesting is that in the neocybernetic framework there is possibility to say something about the adaptation, or *evolution* of the system.

On the local scale, minimization of the average deformation energy means maximization[3] of

$$\mathrm{E}\{xu\} = \mathrm{E}\{pF\} = c\,\mathrm{E}\left\{\frac{mv}{r^2}\right\}. \qquad (14)$$

What does this mean? The system evolution really tries to maximize the product of the covariant variables: evidently, a mass point tries to align its movement in the force direction — on average, applying force means acceleration in that direction. Newton's second law (there holds $F = m\dot{v}$ for for aligned vectors) could be reformulated in a sloppy way as *momentum tries to increase if there is force acting*, abstracting away exact representations characterizing individual accelerations of particles along their trajectories.

There is no real long-term evolution, or "memory" in the system if there is just one mass point orbiting the mass center. But in a system of various mass points the situation changes, and $\mathrm{E}\{xu\}$ can be maximized. For example, in an early star / planet system, collisions make the system lose energy, as do the tidal effects – average $1/r^2$ and v go down, meaning that the rotating bodies gradually get farther from the center, and their velocity drops. On the Earth, this can be seen in the lunar orbiting taking place ever slower. On the other hand, less circular orbits are more vulnerable to collisions, average orbits becoming more spherical. As seen in observation data, variables seem to become more constant – and the system becomes "stiffer". Thus, cosmic systems truly "learn" towards being more and more cybernetic-looking.

Various mass points can be put in the same model, so that $m_i v_i$ are the state variables and F_i (in *any direction!*) are the forces acting on them, $1 \leq i \leq n$. When the principal component structure of this cybernetic many-point system is studied, it turns out that the model is more or less redundant: not all directions in the n dimensional data space of the n mass points carry the same amount of information, many particles in the system behaving essentially in the same way. Assume that the multi-body kinetic energy term $\frac{1}{2}\,\omega^T I \omega$ with the angular velocity vector ω and (originally diagonal) inertia matrix I, is compressed so that the dimension is dropped from n by ignoring the directions with least variation. This essentially means that one is no more speaking of mere mass points but some kind of conglomerates with more complicated internal inertial structure. One has "emergent inertia" – galaxies, etc., can be seen as virtually rigid bodies.

On the other hand, the inertia of 3-dimensional objects can be seen as an emergent phenomenon. For example, the velocities of sub-atomic particles in electric fields are so high that when looking at everyday objects, one only can see the emergent global behaviors that follow the laws of classical physics. In the cosmic scale, however, the adaptation towards the gravitational asymptotic structures still continues.

3.3 Further intuitions

Elasticity seems to be rather powerful idea also in basic physics: beyond the observations, in super string theories, the elementary particles are seen as vibrating strings. Perhaps elasticity analogy applies there, too?

[3] Counterintuitively, local emergy maximization in adaptation results in global system "laziness", or deformation energy minimization, similarly as local pursuit towards variation results in global system "equalization" and variation minimization

But regardless of the form of the final theories, it seems that thinking of the universe as an elastic self-balanced shell reacting to external pressures, this "shell" being distributed in matter particles, offers a useful framework for studying matter. The Heisenbergian thinking is to be extended, as it is all interactions (not only measurements) that affect the system, the effective variables being reflections of the emergent balance among the system and the environment. Measurable variables are "interaction channels", each interaction mechanism introducing a string of its own. The natural constants are not predetermined, but they are the visible manifestation of stiffness, balance ratios between reaction and action. The modern theories employ some 11 dimensions where there are some "collapsed dimensions" among them; it is easy to think of these vanishing degrees of freedom as being tightly coupled to others through the cybernetic feedback controls. The constants of physics should not be seen as predetermined quantities: there are propositions that the natural constants are gradually changing as the universe gets older. One of such propositions is by Paul Dirac, who claims that cosmology should be based on some dimensionless ratios of constants.

If the cybernetic thinking universally applies, one can exploit the understanding concerning such systems: Perhaps universe as a cybernetic whole is *optimizing* some criterion?

It has been estimated that to have a stable, nontrivial and long-living universe that can maintain life, the natural constants have to be tuned with $1/10^{55}$ accuracy. Such astonishing coincidence has to be explained somehow, and different families of theories have been proposed. First, there are the *anthropic* theories, where it is observed that the world just has to be as it is, otherwise we would not be there to observe it, thus making humans the centers of the universe; the other theories are based on the idea of *multiverses*, where it is assumed that there is an infinite number of "proto-universes" in addition to our own where physics is different. However, in each case it seems that physics reduces to metaphysics, where there are never verifiable or falsifiable hypotheses.

If the universe is (neo)cybernetic, each particle maximizes the share of power it receives, resulting in the whole universe becoming structured according to the incoming energy flows. Then there is no need for multiverses, as it is only the best alternative that really incarnates in the continuous competition of alternative universes. It is as it is with simple subsystems: Fermat's principle says that light beams "optimize" selecting the fastest route; it is the group speed that determines the wave propagation, the emerging behavior representing the statistically most relevant alternative. Similarly, the only realized universe is where the optimality of energy transfer is reached.

4 Conclusion: Neocybernetics *everywhere*

To conclude the neocybernetic lessons: *everything is information; visible matter/energy is just conglomerations of information, or attractors of dynamic processes governed by entropy pursuit.*

Neocybernetic models pop up in very different cases, not only in those domains that were discussed above. Many systems can be characterized in terms of optimization, models being derived applying calculus of variations, the explicit formulas (constraints) being the emergent outcomes of underlying tensions. When all behaviors are finally implemented by uncoordinated low-level actors, it seems evident that such models could be studied also from the neocybernetic point of view.

The clasical "theories of everything" study a rather narrow view of *everything.* It can be claimed that a theory that does not address cognitive phenomena cannot truly be called a theory for everything. The subjective world needs to be addressed as well as the objective one, the theory needs to couple *epistemology* with *ontology.* In this sense, being applicable also to cognitive systems, it can be claimed that neocybernetics is a very potential candidate for such a "general reality theory".

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