Global Warming as an Info-Entropy Source of Fuel

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ABSTRACT

In 1823 Olbers formulated the problem of the dark night sky as a paradox of cosmological geometry, but its overriding significance to us as living beings is its functioning as an info-entropy engine. Landauer's seminal work (following Shannon and Brillouin teaches us that information has calculable entropy and obeys physical laws, while the introduction by Jaynes of maximum entropy (MaxEnt) as the basis of the rules of thermodynamics (for example, the determination of the partition function) is now recognized as far-reaching. The associated variational approach to entropy production first described by Onsager also provides critical insights into issues of thermodynamic reciprocity and symmetry in systems far from equilibrium. There are a huge number of alternative energy sources, from zero-emissions nuclear to solar and wind, and the world of renewable energy technology grows more diverse and advanced all the time. One of these alternative energies, however, may not be as clean or renewable as you may think.

Keywords: *The Paris climate agreement, the Intergovernmental Panel on Climate Change, global temperatures, worldwide carbon emissions, biofuel, fossil fuels, info-entropy fields forces, entropic action ("exertion"), the quantum exertion, the bivector info-entropy, formic acid.*

INTRODUCTION

It is a truth (almost) universally acknowledged that the world needs to stop consuming so many fossil fuels--and to do so in a big hurry--if we are to have any hope lowering global carbon emissions in time to curb catastrophic climate change and to meet the goals set by the Paris climate agreement. In fact, according to an alarming 2018 study by the Intergovernmental Panel on Climate Change, in order to prevent global temperatures from rising more than 1.5 degrees Celsius over pre-industrial averages within this century, worldwide carbon emissions need to decrease by 45 percent by 2030 and be slashed all the way down to zero by the middle of the century--no easy feat. (1, 2)

The Ugly Truth About Biofuels

Biofuel seems like an obvious replacement for fossil fuels. It can be easily substituted for traditional fossil fuels without the cumbersome necessity of revamping the energy systems we already have in place. Take ethanol, for example, which you have already been using to fuel your car, as it is required by the government to be mixed into your gasoline. This is the beauty of biofuel--it's so compatible with our current way of living, you may not even have known you were a biofuels user.

This is also, however, exactly what's wrong with biofuel. It doesn't change a system that is clearly broken, dirty, and unsustainable. In many ways it's just the same as the fossil fuels that we are so very problematically dependent upon. Like fossil fuels, biofuels need to be combusted, and therefore, like fossil fuels, biofuels (despite their very green-sounding name and eco-friendly connotation) create carbon emissions. (3)

Yes, biofuels create less carbon than traditional fuels when they are burned, but this is not the whole story of biofuels' carbon footprint. "Clean Technology" news site AZoCleantech reports that, " the production of biofuels often involves using land already being utilized as farmland. This leads to deforestation, as more land is sought in order to keep up with the increasing demand for food worldwide. Indirectly, the production of biofuels actually increases CO_2 levels because it reduces the number of trees transforming the toxic gas into oxygen. This is the first point which reveals biofuels to be a non-renewable source of energy."Furthermore, the biofuel supply chain largely relies on traditional fossil fuels, further rendering any emissions saved by the burning of the actual biofuels themselves moot. "From growth of ingredients through to transportation,"

AZoCleantech goes on to say, "non-renewable energy sources are key to biofuel manufacture. Further to this, greenhouse gases are emitted at different stages of production, due to the burning of fuel used in farming, the production of fertilizers used on the crops, burning fuel during transport, and more. Meaning that while biofuels may emit fewer greenhouse gases when burned and are that they are produced from renewable products (such as corn and soybeans), these positives are dramatically outweighed by the negative impact of greenhouse gases being produced as an indirect effect of biofuel production, as well as the dependence on fossil fuels along the supply chain." (4)

While biofuel has enjoyed a fair amount of support from the United States Environmental Protection Agency, the United Nations has actually already acknowledged that biofuel, in many cases, does more harm than good. In the past, the UN has even tried to discourage the United States to reduce the country's own biofuel production, which is itself a very sizeable industry backed by the country's powerful corn lobby, because it is exacerbating the global food crisis. As Forbes has reported in the past, "Biofuels increase food prices (plus the volatility of those prices) and therefore don't have many of the positive benefits for humanity claimed by proponents. In fact, the UN has asked the U.S. to suspend its biofuel mandates because it was exacerbating the food crisis: a child dies from hunger every 10 seconds. For the U.S. and the world, 48 million Americans live in poverty, and over 80% of the globe is undeveloped, so the rising competition between 'fuel and food' is a moral issue." (5)

Maximum Entropy as a Form of Energy

The ubiquity of double helical and logarithmic spirals in nature is well observed, but no explanation is ever offered for their prevalence. DNA and the Milky Way galaxy are examples of such structures, whose geometric entropy we study using an information-theoretic (Shannon entropy) complex-vector analysis to calculate, respectively, the Gibbs free energy difference between B-DNA and P-DNA, and the galactic virial mass. Both of these analytic calculations (without any free parameters) are consistent with observation to within the experimental uncertainties. We define conjugate hyperbolic space and entropic momentum co-ordinates to describe these spiral structures in Minkowski space-time, enabling a consistent and holographic Hamiltonian-Lagrangian system

that is completely isomorphic and complementary to that of conventional kinematics. Such double spirals therefore obey a maximum-entropy path-integral variational calculus ("the principle of least exertion", entirely comparable to the principle of least action), thereby making them the most likely geometry(also with maximal structural stability) to be adopted by any such system in space-time. These simple analytical calculations are quantitative examples of the application of the Second Law of Thermodynamics as expressed in geometric entropy terms. They are underpinned by a comprehensive entropic action ("exertion") principle based upon Boltzmann's constant as the quantum of exertion.

Today, the entropic treatment of information is standard in the analysis of the efficiency of communications networks in the presence of noise, and it has become clear that information and its transfer are associated with discontinuities, implying non-adiabatic (entropy changing) conditions.Indeed, Brillouin considered information (negative entropy, or negentropy) to be anti-correlated with entropy, and Bennett showed elegantly how information erasure has an entropy cost: note that perfect information copying is excluded by the "no-cloning theorem". Applying Landauer's Principle to a computation involves the transfer of information and therefore also results in a rise in entropy.We will show that certain geometrical structures with simple analytical representations – the double helix and the double logarithmic spiral – can be treated formally as holomorphic; and further, we calculate their geometric entropy with Lagrangian methods (based on a calculus of spatial gradients) showing that the appropriate Euler-Lagrange equations are satisfied, that is, they are maximum entropy structures. Then, to verify the formalism developed, we will calculate certain observable quantities conforming to the Hamiltonian and Lagrangian equations of state and show consistency with real observations. (6, 7)

Holomorphic Info-Entropy

The simplest meromorphic function is functionally equivalent to an isolated singularity, that we place in a Minkowski space-time, described by basis vectors ($\gamma\mu$, $\mu \in \{0, 1, 2, 3\}$) which obey a Clifford algebra that formally distinguishes the special behaviour of the time axis $\gamma 0$, being characterized by a real time axis and imaginary space axes (see Penrose, ch.18; we follow Penrose's choice of metric). An information

vector h can be defined in Minkowski 4-space, and can be shown to be obtained from the sum of the temporal residues h_n associated with each spatial basis vector γ_n, $n \in \{1, 2, 3\}$, given by:

$$h = k_B \ln(x_n) \sigma_n \quad n \in \{1,2,3\}; \text{Einstein summation convention}$$

Note that we use Einstein's summation convention in Eq. using tensor index notation where the lower index indicates the row and the upper the column. The bivectors $\sigma_n \equiv \gamma_n \gamma_0$ also represent unit vectors along the co-ordinate axes of the 3-dimensional space, forming a quaternion sub-algebra isomorphic to the Pauli spin vectors with the associated pseudoscalar $I = \sigma_1 \sigma_2 \sigma_3$, where $I^2 = -1$. Mathematically, this has transformed our starting Euclidean geometry into what will turn out to be a much more useful hyperbolic geometry.

Penrose emphasises that such a logarithmic representation is characteristic of hyperbolic geometry, and we see here its intimate relationship with entropic quantities.

We choose to define the entropy s as the Hodge-dual *h of the information since this definition can be shown to have the correct properties; note that Penrose points out that Maxwell's equations are self-dual in the orthogonal complement sense of the Hodge-dual operation, with $\sigma_m = *\sigma_n = I\sigma_n$:

$$s = k_B \ln(x_m) I \sigma_m \quad m \in \{1,2,3\}; \text{summation convention}$$

Thus we amplify Brillouin's assertion of the close relation of information with entropy by treating entropy mathematically as an orthogonal complement of information. We choose entropic structures exhibiting a transverse helical geometry, that is, $s_3 = h_3 = 0$, with a "trajectory" axis (plane waves travelling) in the γ_3 direction. Then, given that s and h are conjugate (that is, the orthogonal complements of each other), the entropy eigenvector can be written as

$$s = k_B (i \ln(x_1) I \sigma_1 - \ln(x_2) I \sigma_2)$$

and its (conjugate) information term similarly written as

$$h = k_B (\ln(x_1) \sigma_2 - i \ln(x_2) \sigma_1)$$

Note that above treat the generalised singularity of an isolated pole, whereas Eq. constrain this

singularity into a geometry isomorphic with the double-helix implied by Maxwell's equations.

Courant & Hilbert point out that the Maxwell equations are a hyperbolic version of the Cauchy-Riemann equations, and Salingaros points out that the vacuum electromagnetic (EM) field is holomorphic.

To form a holo-morphic info-entropy function we combine together the expressions in Eqs. for information and entropy in the same way (and for the same reason) that is done in the Riemann-Silberstein complex-vector (holomorphic) description of the EM field:

$$F_{\_} = (E_{\_} + icB_{\_})\gamma_0$$

where E and B are the 1-vector electric and magnetic fields; F is a bivector (see Penrose), hence the need for γ_0. The equivalent complex-vector for the bivector info-entropy case is:

$$f = s + Ih,$$

so that we have, from Eq.:

$$f = k_B \ln(x_1/x_2) I[i\sigma_1 + \sigma_2]$$

Note that the argument of the logarithm is now dimensionless, as is conventional. Note also that meromorphic functions are only piecewise holomorphic, so they can transmit information. (8, 9)

Just as Maxwell's equations have a complementary (dual, in a strong sense) helical structure of the electric and magnetic fields, we continue to choose a similar double-helical structure to the info-entropic geometry, such that the loci of the x1 and x2 co-ordinates of the info-entropic trajectory are related to each other by a pair of coupled differential equations:

$$x'_1 = -\kappa_0 x_2$$

$$x'_2 = \kappa_0 x_1$$

where the coupling parameter is given by $\kappa_0 \equiv 2\pi/\lambda_0$ with λ_0 being the helical pitch along the γ_3-axis (that is, the x3 direction) and the prime indicating the differential with respect to x3 (the trajectory axis) $x_n' \equiv dx_n/dx_3$ as usual. (10) In the entropic domain the x3 co-ordinate plays a role analogous to that normally played by time t in conventional kinematics:

to amplify this point, note that $x_0 \equiv ct$ and x3 are also commensurate conjugates in the Pauli algebra. Considering only the functional part of the complex-vector, Eq. allows us to write the 'local' geometric entropy for a double-helical structure as:

$s = kB\ln(x'n\kappa 0 xn) \equiv kB\ln Wn \in \{1,2\}$; summation convention $s = kB\ln(x'n\kappa 0 xn) \equiv kB\ln Wn \in \{1,2\}$; summation convention

which is functionally equivalent to Boltzmann's equation for entropy; where the quantity $Wn \equiv xn'/\kappa 0\, xn$ therefore represents the number of states available for the nth plane wave.

We now consider the case of the double helix in more detail, and in particular as exhibited by the structure of DNA (which is naturally right-handed). Without loss of generality, we define the locus in space $l1$ of the first information-bearing helix of DNA with its axis aligned to the $\gamma 3$ direction:

$l1(x3) = \gamma 1 R0\cos\kappa 0 x3 + \gamma 2 R0\sin\kappa 0 x3\, l1(x3) = \gamma 1 R0\cos\kappa 0 x3 + \gamma 2 R0\sin\kappa 0 x3$

where $R0$, $\kappa 0$ and $x3$ represent respectively the radius, pitch, and axial co-ordinate of the helix. The second helix $l2$, with its complementary base-pairing and anti-parallel (C2 space group) symmetry contains the same entropic information content as $l1$, but $\pi/2$ phase-shifted and propagating in the opposite (i.e. negative) $\gamma 3$ direction:

$l2(x3) = \gamma 1 R0\sin\kappa 0 x3 - \gamma 2 R0\cos\kappa 0 x3\, l2(x3) = \gamma 1 R0\sin\kappa 0 x3 - \gamma 2 R0\cos\kappa 0 x3$

These expressions are mathematically equivalent to those for the electric and magnetic fields of an EM wave, with $l1$ and $l2$ being complementary. Equivalent to Eqs., we now express the double-helix as the complex-vector $\sum = l1 + il2$ to describe a single holomorphic trajectory in Euclidean coordinates with spatial basis vectors γn ($n \in \{1, 2\}$):

$\Sigma = \gamma 1 R0 e^{i\kappa 0 x3} - \gamma 2 i R0 e^{i\kappa 0 x3}\, \Sigma = \gamma 1 R0 e^{i\kappa 0 x3} - \gamma 2 i R0 e^{i\kappa 0 x3}$

We therefore see in Eq. the functionals represented by $x1 = R0 \exp(i\kappa 0 x3)$ and $x2 = -iR0 \exp(i\kappa 0 x3)$, from Eq., where the phase and sign difference between $x1$ and $x2$ are typical for a pair of coupled mode equations, and which together form a holomorphic function.

Hyperbolic Geometry & Entropic Momentum

We now exploit Penrose's assertion that there is a "hyperbolic overall geometry of the spatial universe … the space of velocities … is certainly a three-dimensional hyperbolic geometry" (his italics; this assertion is underpinned by extensive observations of the cosmic microwave background). So we define for our helix the "hyperbolic position" vectors qn in the simplest possible way that involves the logarithm characteristic of the hyperbolic geometry (see Eqs.), where the logarithm is kept dimensionless by the normalising (Euclidean) metric Rn:

hyperbolic position: $qn \equiv Rn\ln(xn/Rn)\, n \in \{1,2\}$ hyperbolic position: $qn \equiv Rn\ln(xn/Rn)\, n \in \{1,2\}$

For small geometry ($xn \ll Rn$) and for xn having its origin at Rn such that xn tends to $Rn + xn$ (that is, where xn is localised in the vicinity of Rn) the hyperbolic geometry is approximately Euclidean, $qn \approx xn$, and also independent of the metric Rn. For the double helix geometry we take $Rn = R0$ for $n \in \{1, 2\}$.

The conjugate quantity for position q is the momentum p, so that moving towards a Lagrangian formalism, we therefore also define the "entropic momentum" pn vectors in terms of an "entropic mass" mS and the velocity qn', where as before $qn' \equiv dqn/dx3$. Note that qn' is dimensionless, so that either qn' or its inverse $1/qn'$ can be used as a "velocity" (this ambiguity is a feature of hyperbolic velocities). It turns out that the inverse definition is more fruitful:

entropic momentum: $pn \equiv mS/q'n\, n \in \{1,2\}$ entropic momentum: $pn \equiv mS/q'n\, n \in \{1,2\}$

where the entropic mass mS is defined as: entropic mass: $mS \equiv i\kappa 0 kB$ entropic mass: $mS \equiv i\kappa 0 kB$ and the Boltzmann constant kB is introduced on dimensional grounds as the entropic analogue to Planck's constant in kinematics. We use the subscript 'S' as a reminder that a quantity is entropic. Clearly $i\kappa 0 kB$ is a geometric quantity intrinsically based upon the pitch of the double helix. Simple calculus on Eq. allows us to create the useful auxiliary identity $qn' = Rn \cdot xn'/xn$, again highlighting the intimate relationship between Eqs and; we will show elsewhere how Liouville's theorem allows the conjugate variables p and q to be used to calculate the entropy of the geometry. (11)

We will use Eqs. as the basis for a set of Hamiltonian and Lagrangian equations. We consider first the entropic equivalent to kinetic energy, i.e. 'kinetic entropy' (KE) TS, based upon the conventional definition of kinetic energy:

$TS(q') = -\int p\,dq' = -mS\ln q'\, TS(q') = -\int p\,dq' = -mS\ln q'$

where the additional negative sign accounts for the inverse velocity. For the three spatial directions, we therefore have:

$TS = \sum_n -mS \ln q'_n = -1/2mS \ln(q'_n q'_n)$ summation convention, $n \in \{1,2,3\}$ $TS = \sum_n -mS \ln q'_n = -1/2mS \ln(q'_n q'_n)$ summation convention, $n \in \{1,2,3\}$

We also define an entropic potential field VS(q) as a function of hyperbolic position q (the 'potential entropy'). However, for the present case of a double helix, Eq. 8 clearly represents a pair of plane waves travelling in space; which is analogous to the kinematic "free-particle" situation, such that there is therefore no associated entropic potential field, VS = 0. The entropic Hamiltonian HS(q(x3), p(x3), x3) is defined as usual as HS = TS + VS, and is also a conserved quantity in hyperbolic space. (12)

Using the canonical Legendre transformation, the entropic Lagrangian is given by Eq.): $LS == q'_n p_n$

$-HS$ summation convention, $n \in \{1,2,3\}$ $3mS-HS$ $LS = q'_n p_n - HS$ summation convention, $n \in \{1,2,3\} = 3mS - HS$

such that the required canonical equations of state are obeyed: $\partial LS/\partial x3 = -\partial HS/\partial x3$, as well as $p'_n = \partial LS/\partial q_n$ $p'_n = \partial LS/\partial q_n$ and $q'_n = -\partial LS/\partial p_n$ $q'_n = -\partial LS/\partial p_n$.

The Exertion

In analogy to the action integral (with units of J·s) we now define the exertion X (units of J/K) as the integration of the entropic Lagrangian LS along the spiralling double-helical trajectory:

$X = \int LS dl = \sqrt{1+\kappa_0^2 R_0^2} \int LS(q,q',x3)dx3$ $X = \int LS dl = \sqrt{1+\kappa_0^2 R_0^2} \int LS(q,q',x3)dx3$

where we note the Pythagoras relationship $dl/dx3 = \sqrt{1+\kappa_0^2 R_0^2} \equiv \chi$ $dl/dx3 = \sqrt{1+\kappa_0^2 R_0^2} \equiv \chi$ due to the helical geometry.

For the double-helix plane-waves description of, the associated entropic Lagrangian LS has no entropic potential term (that is, VS = 0) since such a system is equivalent to that of a free particle.

$LS = 3mS + \sum_{n=1,2,3} mS \ln q'_n = 3mS - \sum_{n=1,2,3} mS \ln(p_n/mS)$ $LS = 3mS + \sum_{n=1,2,3} mS \ln q'_n = 3mS - \sum_{n=1,2,3} mS \ln(p_n/mS)$ as employed in Eq. satisfies the Euler-Lagrange equations

$\frac{d}{dx3}\partial LS \partial q'_n - \partial LS \partial q_n = 0 (n \in \{1,2,3\})$ $\frac{d}{dx3}\partial LS \partial q'_n - \partial LS \partial q_n = 0 (n \in \{1,2,3\})$

demonstrating that the exertion X is at an extremum (or at least stationary) at any point along the length of the double helix since $\delta(\int LS dx3) = 0$ $\delta(\int LS dx3) = 0$. Also, shows that the entropic Lagrangian for a double helix can

be given by LS $= 3mS - \pi\kappa_0 kB$ LS $= 3mS - \pi\kappa_0 kB$; that is, in this case LS is indeed a constant (invariant with x3). Note also that the exertion X is scaled by the quantum of entropy, Boltzmann's constant, just as the Lagrangian itself is. (13)

Entropy

Having defined the exertion integral, Eq., we can also now see that the equivalent space-trajectory integral of the entropic Hamiltonian HS yields a quantity directly proportional to the entropy:

$S = \int HS dl = \chi \int HS(q,p,x3)dx3$ $S = \int HS dl = \chi \int HS(q,p,x3)dx3$

Whereas Eq. describes a 'local' entropy s, the integrated quantity S can be considered as the 'global' or the overall system entropy. Eq. indicates that the overall entropy S depends not only on the centroidal trajectory of the double helix axis as described by x3, but principally upon the spiralling path described by l with its radial dependency such that the entropy is a function of the full spatial extent (in all spatial dimensions) of the double helix structure. For convenience, we offset the entropic Hamiltonian HS by the constant term $mS \ln(\kappa_0 R_0)$, which is an invariant for a double helical geometry – any Hamiltonian can be offset by a fixed (constant) amount to enable more convenient manipulation – such that the entropic Hamiltonian for a double helix can therefore be given as HS $= \pi\kappa_0 kB$; that is, each KE component (n = 1, 2) of the double helix contributes $\frac{1}{2}\pi\kappa_0 kB$. We can also exploit the Fourier (periodic) nature of S along the double helix as characterized by the parameter $i\kappa_0$ to write the Fourier differential operator as:

$\frac{d}{dx3} \equiv i\kappa_0$ $\frac{d}{dx3} \equiv i\kappa_0$

Since the Lagrangian and Hamiltonian are inversely related (through the Legendre transformation) and the exertion integral X is at an extremum, $\delta X = 0$, then the closely connected Hamiltonian trajectory integral Eq. (that is, the entropy S) must also be at an extremum, $\delta S = 0$. Given that the double helix of DNA represents a highly stable structure we infer from the Second Law that the entropy S is at a maximum; ergo the exertion X is at a minimum and the double helix topology represents a MaxEnt (most likely) trajectory in space. In summary, the overall entropy S of the double helix is given by:

$S = \sqrt{(1+\kappa_0^2 R_0^2)}\pi\kappa_0 LkB$ $S = \sqrt{(1+\kappa_0^2 R_0^2)}\pi\kappa_0 LkB$

It is clear that the entropy S is proportional to the length L of the double helix. However, in the case of a photon its proper length is actually zero relativistically, since it travels at the speed of light: $L = 0$, therefore $S = 0$. Applying this temperature to SMW to obtain the energy (given by the product of entropy and temperature expressed as a mass through $E = mc2$) we naturally recover MBH. (14, 15)

Isomorphism between Mechanics and Entropy

Table 1 shows the multiple isomorphisms that exist between kinematic and entropic quantities revealed by our treatment. There has been significant recent interest in comparable methods. Baez & Pollard argue for an "analogy" between thermodynamics and quantum mechanics, giving rise to a quantity they call "quantropy" (quantum entropy, which they call "mysterious"). They also give a Table of "analogies" between statistical and quantum dynamics comparable to our Table of isomorphisms. We believe that our results confirm and extend this approach. Velazquez has also tabulated some consequences of the complementarity of the Planck and Boltzmann constants. Dixit et al., have reviewed the use of "Maximum-Caliber" to characterise trajectories ("world-lines") in non-equilibrium thermodynamics (where "caliber" is a term introduced to characterise the evolution in space-time of the ensemble of trajectories of microstates; it is proportional to our "Exertion").

Considering Table 1, we have already observed that the hyperbolic Minkowski space (generated through the normalising Euclidean metric, Rn) is the entropic analogue to the Euclidean Minkowski space of kinematics, with consequent del operators; that Boltzmann's constant is the entropic quantum analogue to Planck's quantum of action (also pointed out by Córdoba et al.) with consequently analogous definitions for momentum; and that the helical pitch (or wavelength) implies the space-like entropic analogue of time in kinematics.

As we have seen, this latter also implies holographic properties of the treatment (that is, properties of an area being fully equivalent to parameters of a volume). (16)

Both mass and its entropic equivalent mS have natural units of inverse length, but mS is imaginary as a consequence of the holomorphism. The parameter Λ describing a logarithmic spiral contributes to the entropic (hyperbolic)

acceleration Γ as a consequence of an entropic force, in analogy to Newton's 2nd Law; and the double-helix can be seen as a special case ($\Lambda = 0$) of the double-armed logarithmic spiral. The Hamiltonian and Lagrangian formulations then follow equivalently for both energy and entropy, with the Exertion integral equivalent to the classical Action integral, both obeying the principle of stationary "action".

SUMMARY

Formal mathematics establishes tautologies which are frequently very surprising, and we have used well-established formal methods in a properly quantitative treatment of entropy, revealing that measurable (and measured) quantities from the molecular to the galactic scale can be readily calculated in a simple analytical treatment. We have considered systems of high symmetry which are amenable to our simplified analytical approach, but we expect the method to be readily generalisable to more complex systems. (17)

The computational demands of conformational chemistry are very severe; perhaps this approach will stimulate algorithmic advances to speed the calculations for static problems, or even to address dynamic geometrical problems (like protein folding) in new ways?

We have used a "toy" model of the Milky Way, which ignores the central "bulge" and multiple arms, but a more realistic model already available would simply take a linear combination of a spherical central feature and multiple double-spiral arms. The difficulty here is not in the modelling but in the choice of realistic observational data for the model parameters.

Energy From Entropy Through Weather Control Technologies

"It isn't just conspiracy theorists who are concerned about HAARP. The European Union called the project a global concern and passed a resolution calling for more information on its health and environmental risks. Despite those concerns, officials at HAARP insist the project is nothing more sinister thana radio science research facility." -- From documentary on HAARP weather control capabilities by Canada's CBC

HAARP (High Frequency Active Auroral Research Program) was a little-known, yet critically important U.S. military defense project which generated quite a bit of controversy over

its alleged weather control capabilities and much more. (18)

The project was shuttered by the military in 2013 after attracting large amounts of negative publicity, though HAARP-like research undoubtedly continues in other secret projects. This essay reveals major deception promulgated by those involved to lead the public to believe HAARP was simply a research facility with little practical military value.

Though denied by HAARP project officials, some respected researchers allege that the electromagnetic warfare capabilities of the project were designed to forward the US military's stated goal of achieving "Full-spectrum Dominance" by the year 2020 and of "Owning the Weather in 2025" (see USAF document summary here). Others go so far as to claim that HAARP technologies have been and continue to be used for weather control, to cause earthquakes, hurricanes, tsunamis, to disrupt global communications systems, and more.

These researchers point to major aspects of the program which are still kept secret for alleged reasons of "national security." The U.S. patent of a key developer of HAARP and other documentary evidence support these claims. And there is no doubt that electromagnetic weapons capable of being used in warfare do exist. The HAARP project's $300 million price tag also suggests more was going on than meets the eye. (19)

According to the original HAARP website, "HAARP is a scientific endeavor aimed at studying the properties and behavior of the ionosphere, with particular emphasis on being able to understand and use it to enhance communications and surveillance systems for both civilian and defense purposes." The ionosphere is the delicate upper layer of our atmosphere which ranges from about 30 miles (50 km) to 600 miles (1,000 km) above the Earth's surface. The HAARP project website acknowledged that experiments were conducted which used electromagnetic frequencies to fire pulsed, directed energy beams in order to "temporarily excite a limited area of the ionosphere." Some scientists state that purposefully disturbing this sensitive layer could have major and even disastrous consequences.

Concerned HAARP researchers like Dr. Michel Chossudovsky of the University of Ottawa and Alaska's Dr. Nick Begich (son of a US Congressman) present evidence suggesting that

these disturbances can even be used to trigger earthquakes, affect hurricanes, and for weather control.

Dr. Bernard Eastlund is the scientist whose name is most associated with the creation and development of the HAARP project. His revealing website provides reliable information on his involvement with the project. A 1987 patent issued to Dr. Eastlund is titled "Method and apparatus for altering a region in the earth's atmosphere, ionosphere, and/or magnetosphere."

For those with any background in science, you might find it quite revealing to explore this patent in more detail. And remember that since the time of this patent, in which Alaska is mentioned several times as the ideal location, the government fully acknowledges that it built a massive array of antennas in Alaska with the capability of disturbing the ionosphere exactly as described in Eastlund's patent. (20) Two key major media documentaries, one by Canada's public broadcasting network CBC and the other by the History Channel, reveal the inner workings of the HAARP project in a most powerful way. The very well researched CBC documentary includes this key quote:

"It isn't just conspiracy theorists who are concerned about HAARP. In January of 1999, the European Union called the project a global concern and passed a resolution calling for more information on its health and environmental risks. Despite those concerns, officials at HAARP insist the project is nothing more sinister than a radio science research facility."

The European Union (EU) document which brings HAARP and similar electromagnetic weapons into question can be verified here. The actual wording at bullet point 24 in this telling document states that the EU "considers HAARP by virtue of its far-reaching impact on the environment to be a global concern and calls for its legal, ecological and ethical implications to be examined by an international independent body before any further research and testing." This revealing document further states that the EU regrets the repeated refusal of the U.S. government to give evidence on the project.

This engaging 15-minute CBC documentary is available for free viewing. An even more detailed and revealing 45-minute History Channel documentary on HAARP and other secret weapons used for electromagnetic warfare is available here. Here are two quotes from the History Channel documentary:

Electromagnetic weapons are pack an invisible wallop hundreds of times more powerful than the electrical current in a lightning bolt. One can blast enemy missiles out of the sky, another could be used to blind soldiers on the battlefield, still another to control an unruly crowd by burning the surface of their skin. If detonated over a large city, an electromagnetic weapon could destroy all electronics in seconds. They all use directed energy to create a powerful electromagnetic pulse.

Directed energy is such a powerful technology it could be used to heat the ionosphere to turn weather into a weapon of war. Imagine using a flood to destroy a city or tornadoes to decimate an approaching army in the desert. If an electromagnetic pulse went off over a city, basically all the electronic things in your home would wink and go out, and they would be permanently destroyed. The military has spent a huge amount of time on weather modification as a concept for battle environments.

Another video along similar lines, the excellent History Channel documentary titled "The Invisible Machine: Electromagnetic Warfare," is available here. For those who still doubt that such devastating secret weapons have been developed, here is an intriguing quote from an article in New Zealand's leading newspaper, the New Zealand Herald.

CONCLUSIONS

The temperature of the ionosphere has been raised by hundreds of degrees in these experiments. A means and method is provided to cause interference with or even total disruption of communications over a very large portion of the earth. This invention could be employed to disrupt not only land based communications, both civilian and military, but also airborne communications and sea communications.

This would have significant military implications. It is possible to take advantage of one or more such beams to carry out a communications network even though the rest of the world's communications are disrupted.It can be used to an advantage for positive communication and eavesdropping purposes.

Exceedingly large amounts of power can be very efficiently produced and transmitted.This invention has a phenomenal variety of ... potential future developments. Large regions of the atmosphere could be lifted to an unexpectedly high altitude so that missiles

encounter unexpected and unplanned drag forces with resultant destruction or deflection. Weather modification is possible by, for example, altering upper atmosphere wind patterns or altering solar absorption patterns by constructing one or more plumes of atmospheric particles.

which will act as a lens or focusing device. Ozone, nitrogen, etc. concentrations in the atmosphere could be artificially increased.

Electromagnetic pulse defenses are also possible. The earth's magnetic field could be decreased or disrupted at appropriate altitudes to modify or eliminate the magnetic field.
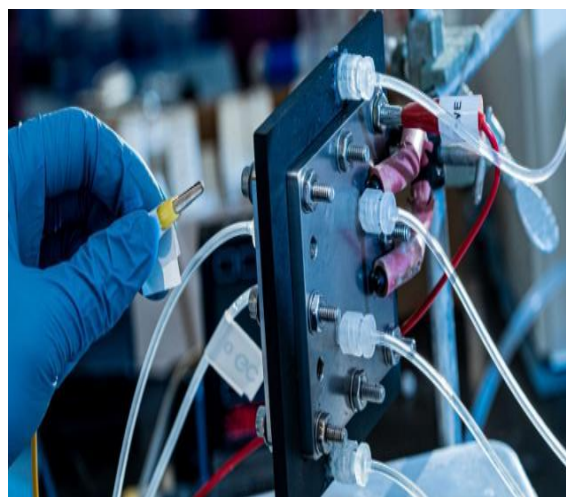

Figure1. *From Popular Mechanics*

- Scientists have created a way to convert carbon dioxide, an important greenhouse gas, into formic acid.

- Formic acid, also found in bee and ant venom, can be used to sustainably power fuel-cell systems.

- The new type of catalytic reactor was tested and ran continuously for 100 hours.

Scientists at Rice University have devised an environmentally friendly way to take carbon dioxide and turn it into liquid fuel. The device uses a catalytic reactor to transform the greenhouse gas into formic acid, an important chemical reagent that is also found in bee and ant venom. (21)"The big picture is that carbon dioxide reduction is very important for its effect on global warming as well as for green chemical synthesis," says lead researcher Hoatian WangWang, a chemical and biomolecular engineer at Rice, in a press statement. "If the electricity comes from renewable sources like the sun or wind, we can create a loop that turns carbon dioxide into something important

without emitting more of it." Tests revealed that the formic acid produced can store nearly half of the energy created during the reaction.

Formic acid can be used in a number of ways. The pungent, colorless liquid has antibacterial qualities and can be used as a preservative, according to the National Center for Biotechnology Information. Most importantly, it can be used as a fuel-cell fuel that, when burned, will emit carbon dioxide that can be recaptured and used to produce more fuel. It essentially creates a closed loop.

Two innovations allowed the scientists to better develop this technology. First, they used a catalyst made of bismuth atoms, which are far more stable than the atoms from transition metals such as cobalt, iron, or cadmium. Additionally, this type of catalyst can be reproduced at a much larger scale. (22, 23)

Next, the researchers developed a type of a new type of solid-state electrolyte that doesn't require salty water. Typically, in order to reduce carbon dioxide, water laced with salts like sodium chloride or potassium bromide is used as an electrolyte.

This method is less effective because the formic acid bonds with the salt, and it can be extremely expensive and time intensive to remove these salts later.

When tested, the reactor successfully ran for 100 hours without degrading, according to the release. How fast water is pumped through the reactor determines how concentrated the formic acid solution will be. Wang hopes that in the future, the technology could produce other useful products like ethanol and acetic acid.

Source: *Rice University*

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