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Dear Jonathan Hare,

Thank you so much for writing so interesting a letter. I am sorry to have been so slow in responding.

I am sure that you are on to a good thing in your curiosity about the Earth's electrical field. I don't know if Gaia has anything to do with its regulation but it would as you note be an economical way of affecting climate. Incidentally the most promising development in Gaia is the confirmation by the Australians this year that Cloud Condensation nuclei are indeed almost wholly the products of the atmospheric oxidation of dimethyl sulphide. A trace gas present at parts per trillion and coming from algae living in the oceans. I mention it to show how trace atmospheric constituents can have profound effects.

Some random thoughts. Have you considered ion molecule reactions in the atmosphere? Electron capture by CFCs might alter the natural recombination rate.

Your personal interests run parallel with my own, even to the extent of bomb making and electronics as a school boy.

With warm best wishes

Yours sincerely

Jim Lovelock

James E. Lovelock

21 ditchling Rise
Brighton.

Dear Prof. LoveLock, 31/7/91.

I'am writing to you because of my interest in your imaginitive work which has lead up to the 'Gaia' hypothesis.

I finished a degree in Physics two years ago at Surrey University, I then went on to sussex to do a Phd with Harry Kroto. I work in a chemistry dept. but the emphasis is on Astronomy. My work started on probing the various types of 'Soot's produced by arcing carbon rods in an inert gas atmosphere (this was to try and understand grain formation in molecular cloads and 'carbon' stars), out of this work came the fantastic discovery of a simple method of producing the C60 molecule. I managed with good timing and a generous helping of Luck, to get myself at the begging of a new branch of chemistry and all that I needed for a Phd! I include some papers and articals on the C60 affair which may be of interest. I'am now coming to the end of my second year at sussex and I suppose I'am begging to think about my next move.

I've always loved Nature and physics (especially electronics) has given me a very direct way of measuring it and trying to understand it in my own way.

I passed the Radio Amateurs exam at 16 and my 1st- Scientific love was electronics, which I'am good at, practically. I also spent a while as a kid making bombs, this may sound wreckless but it earned me an A at 'O' level, which I'am particully proud of because it was basically self taught. I remember those days ploughing through books way 'above my head', to find routes to make the chemicals I needed. It didn't matter how advanced the books were because it seems that when one is gripped with a passion ' to

to find out, then their is always a path round obstcals. I still feel this is true, its not something that can be taught in schools weather is it a measurer of intelligence, just curiosity I suppose.

Its with the same sort of naïve curiosity that I hope you will bare with me and consider some ideas I have had. I originally thought of writing to you to find out if any research possibilities exist, I would love to be involved. I wonder if you could send me any list of papers etc you have written on the subject.

My thoughts which may have a Gaian significance are with regard to the Earths Electrostatic Field;

As I understand it the Earths Electrostatic field (E) can be explained in the following way, about half way between the Earths surface and the ionosphere lies the Electrosphere. This is an ionised region that can be considered as a conducting ~~sphere~~ surface, which acts as a faraday cage. The consiquence of this is that any E field existing inside the cage (ie below the electrosphere) must be independant from Fields outside and have its origin from internal sources.

The E field has a magnitude of about 1 vcm^{-1} and rises vertically above the Earth, although this varies greatly with weather, altitude and location on the Earth.

Its origin is not fully understood but it is assumed to exist due to charge transfer by lightning discharge to Earth. This conveys a -ve net charge to the Earth, which is assumed to be a conductor and thus the charge arranges itself globally so there is no pot. diff over it. Thus there will exist a field anywhere on the Earth between ground and the electrosphere. However there is a positive ion current in the atmosphere continuously discharging the Earth. Calculations show that the Earth said discharge in about 40 min! So why does the E

not fall to zero ? well it is assumed that these storms are so frequent, globally, that they keep 'pumping' charge to the earth maintaining the $\underline{E}$ field all over the world.

Now it seems to me that the following should be true, however I must stress how naive these ideas are;

1) the $\underline{E}$ field is very high impedance and can thus be modified by nearby objects.

2) Ions and space charge will also modify field in fact a simple calculation shows that very few are needed;

to change the potential gradient by 1 volt in volts per meter;

$$\nabla_0 \underline{E} = \frac{\rho}{\varepsilon_0} \qquad \frac{d}{dh}(\underline{E}) \sim 1 \text{ V}$$

$$\therefore \quad \rho = \frac{\varepsilon_0 \frac{d}{dh}(\underline{E})}{e} \qquad \times 10^{-6} \text{ in ions per cm}^3$$

$$\rho \sim \frac{10^{-11} \cdot 10^{-6}}{2 \times 10^{-19}} \sim 50 \text{ singularly ionised ions cm}^{-3}$$

3) Evidence exists that there is a relation between Precipitation and $\underline{E}$ in cloads. [1]

4) $\underline{E}$ is modified dramatically by Local Weather conditions.

5) Small Earthed conducting points 'make' space charge by the Electrode effect. [1]

As a result of this I thought the following may have Gaia importance;

1) If the $\underline{E}$ field does effect 'when cloud's will rain' it has obvious environmental importance (Sir Oliver Lodge as long ago as 1883 used electrostatic precipitation techniques in chemistry)

2) Plant life emits ions and so will effect $\underline{E}$

3) If plant growth is effected by $\underline{E}$ (either directly or for example by effecting charged seed or pollen dispersion) and this is modified by this growth, then it is feasible to suggest that it could act as a feedback system to effect growth.

4) Although this is a philosophical point, I feel that Nature makes use of available phenomena - the $\underline{E}$ most (?) play a part somewhere.

In Summary then I feel that the Earths $\underline{E}$ field may have an effect on life, that it could be heavily modified by life, and that it may even have its origin by disequilibrium of charge due to life (ions emitted by plants and electrode effects in leaves etc) and electrical discharges on the surface of the planet.

Over the last year I have been trying to do some simple expts to explore these ideas but naturally the C_{60} affair has left me with little time for such things.

I have built a simple electrostatic voltmeter which consists of a small 10 cm^2 grid connected to the i/p of a CMOS op-amp wired for unity gain. The very high input impedance of the amp loads the $\underline{E}$ field little, although some modification of the $\underline{E}$ is inevitable due to the grid system.

I used an Americium 243 α emitter to supply ions to the grid, this acts as an 'equaliser' and speeds up the response of the Voltmeter.

$\vec{E}$ field changes due to weather phenomina and cloud cover are easily observed using a chart recorder. However I wanted to see if plant growth was effected by the $\vec{E}$ field. I proposed to have, say, two sets of seed trays, one with the 'Natural' field gradient the other with the same magnitude but ~~opposite~~ reversed field. I wanted to see if any alteration of the growth occured. However I just haven't had time to carry out these expts yet. It would be interesting to see how the $\vec{E}$ field is effected by the plant as it grows.

I wonder what you feel about all this? To be honest I feel that the $\vec{E}$ must have its place in the living world, but its effects may be more subtle than can be measured by the above simple experiments, but where can one start?

I guess the whole C_{60} story, tells me to go ahead and try, .. see what happens.. what can be lost. It seems from my limited experience that when one does an experiment properly we always learn something new, even if its just about the equipment one is using.

Thank you for your time, I would love to here from you,

yours sincerely

Jonathan Hare.

A good book on all this is;

[1]. J. Chalmers Atmospheric Electricity
Pergamon Press 1967.