Slides available on links above

Background and Motivation

- End dependence on Fossil Fuels, reduce pollution, weariness to Nuclear or less satisfactory alternatives – the will is developing to "think the unthinkable".
- Advances in information theory, nanotechnology, The Maxwell Demon problem make this "an idea whose time has come".
- The developing glut of high quality institutions, researchers, papers, conferences, treatise and thesis. Recent developments in the top physics journal have prepared the way:
  - *Found Phys (2014) 44,235-247*
  - *Physics Letters A 374 (2010) 1801-1805*
  - *Cápek-Sheehan pub. Springer*
  - *Found Phys (2007) 37,1653-1658* and more.

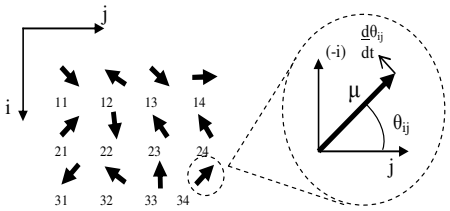
2

Background and Motivation 2

- My own journey started from looking at a water desalination scheme with deliquescent materials and reverse osmosis membranes (1st order phase transition) and computing a figure merit.
- To looking at the general principle of the requirement of phase transitions, to then concentrate on 2nd order magnetic system.
  - Cornwall R.O. "*How to build a Maxwell Demon from a 2nd order Phase Change System*" viXra:1311.0077
  - Cornwall R.O. Thesis: "*Novel Thermodynamic Cycles Involving Ferrofluids Displaying Temporary Magnetic Remanence*" viXra:1311.0078

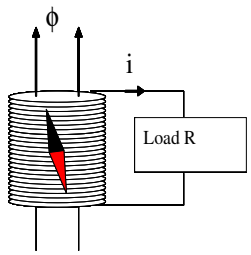
3

Kinetic Theory Model



$$\ddot{\theta}_{ij} = \frac{1}{I}\left(-k_{dip} \sum_{\substack{ii=i-1,\\ jj=j-1 \\ ii\neq i \wedge jj\neq j}}^{\substack{ii=i+1\\ jj=j+1}} \tau\left(\theta_{i,j}, \theta_{ii,jj}, \mathbf{m}, \mathbf{r}\right) - \mathbf{m}_{ij} \times \mathbf{B}_{ext} \right)$$

$$\overline{I\ddot{\theta}_{ij} = -k_v m_{ij} \sum_{ii,jj} \frac{\partial}{\partial t}\left(m_{ii,jj} \cos\theta_{ii,jj}\right) \sin\theta_{ij}} \rightarrow I\ddot{\theta}_{ij} = -k_v \left(m_{ij} \sin\theta_{ij}\right)^2 \dot{\theta}_{ij}$$



N.B. this is not just an inductor in a magnetise-demagnetise cycle but it is able to do excess work into the electrical load R.

- http://vixra.org/abs/1311.0077 short paper
- http://vixra.org/abs/1311.0078 thesis

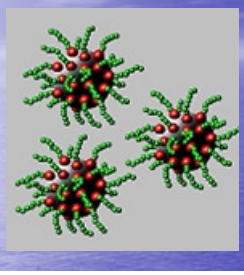
4

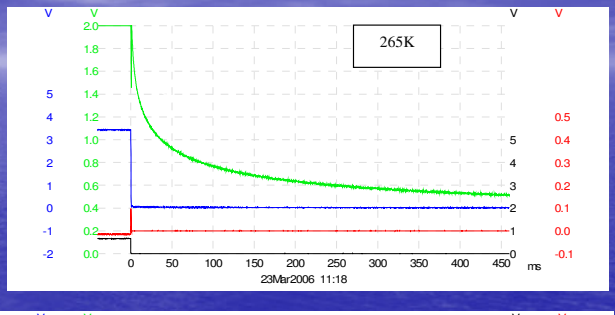
Cut straight to chase, simple engineering/experimental physics type description

I believe this the easiest way to explain. I've worked with engineering thermodynamicists and they tend to dwell on the thermodynamics, missing the simplicity

Kinetic theory intuitive basis of it: Brownian motion and Faraday's law

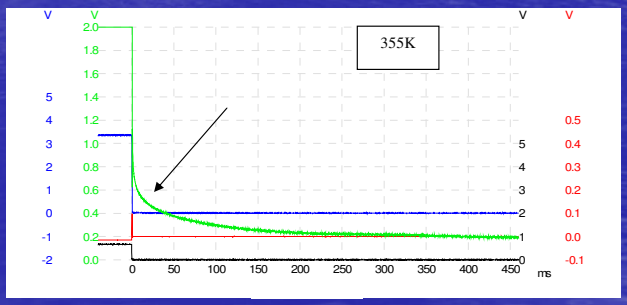
Superparamagnetic Materials





Brownian: $\tau_B = \frac{3V\eta_0}{kT}$

Néel: $\tau_N = \frac{1}{f_0} e^{\frac{KV}{kT}}$



5

Ferrofluids, nanoscale magnetic materials held in suspension by surfactants – one end secured to core, other is hydrophilic or solvent “loving”.

Phenomenon not related to Curie Temperature

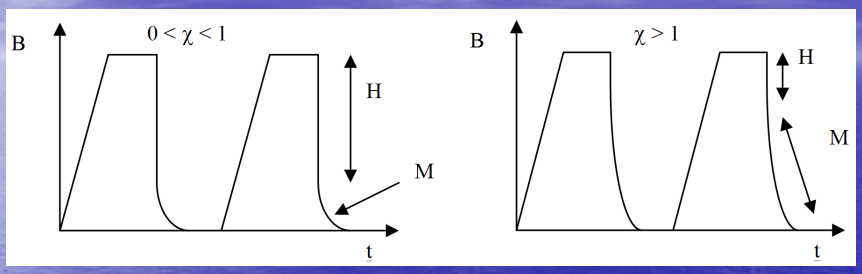
Superparamagnetic, two mechanisms: Neel and Brownian

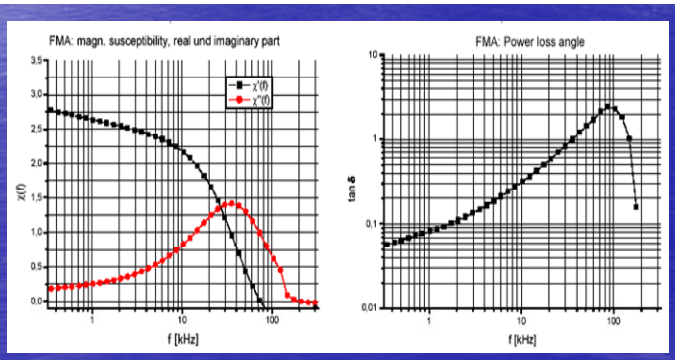
Magnetising field about 1800G, response field about 80G, so susceptibility 0.04

Low response is one of the experimental problems and will need new funds to improve ferrofluid

Has a property that is a strong function of temperature, therefore can be used to make an heat engine

General field cycling method





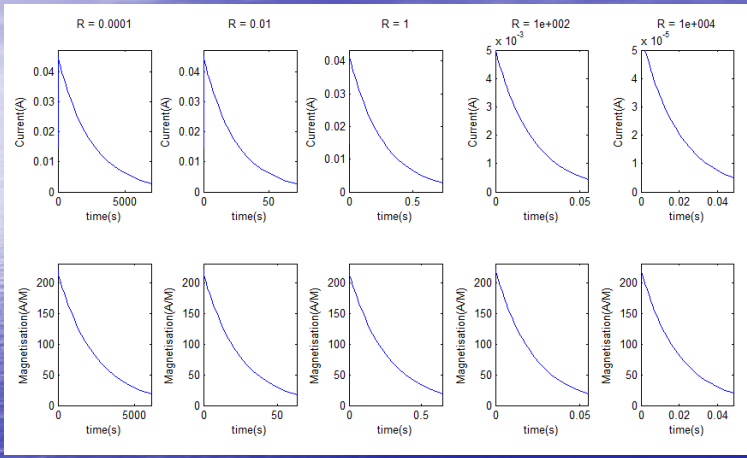
6

Repeated pulses, switch off to leave INDEPENDENT FLUX (no current, not just transformer action but generator action)

Micro-kinetic motion of heat turns little dipoles, just like a large magnet being turned and shaftwork (proof in thesis)

Above relaxation frequency heating occurs. SLOW ON, FAST OFF.

Electromagnetics 1



$$M = \chi \mu_r H$$

$$\frac{dM}{dt} = -\frac{1}{\tau}\left(M - \chi \mu_r H\right)$$

Re-magnetising "H" field

- Section 4 of thesis
- http://vixra.org/abs/1311.0078

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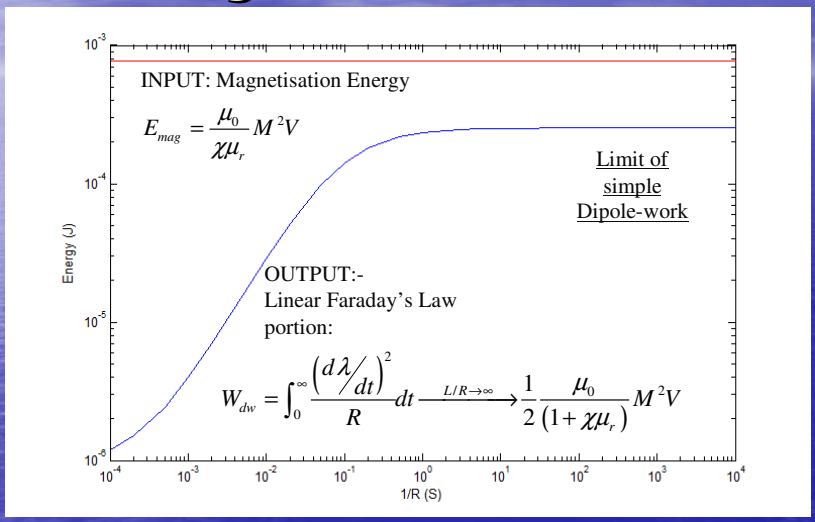
Simulation of experimental fact

Model very well by first order o.d.e. system

Electromagnetics 2



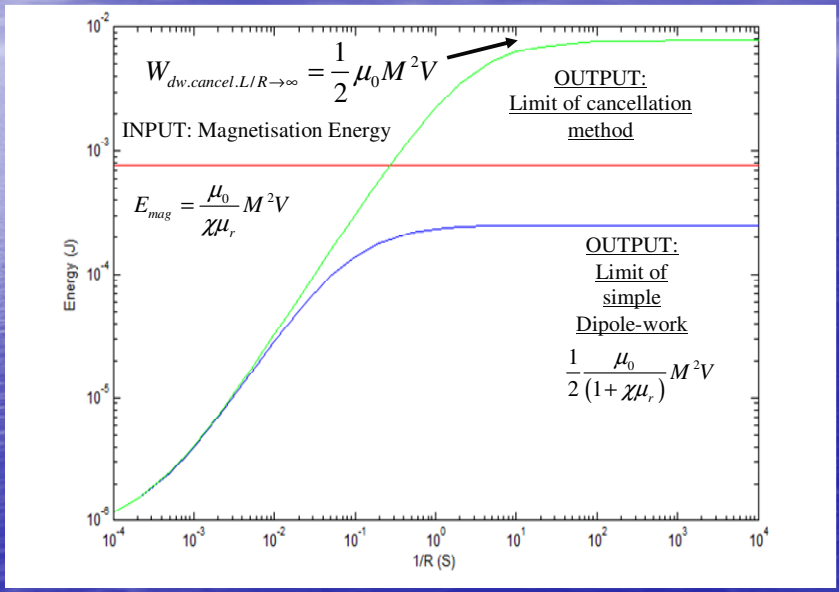
- Section 4 of thesis

8

What happens dumping into simple resistive load

Simulation and model

Electromagnetics 3



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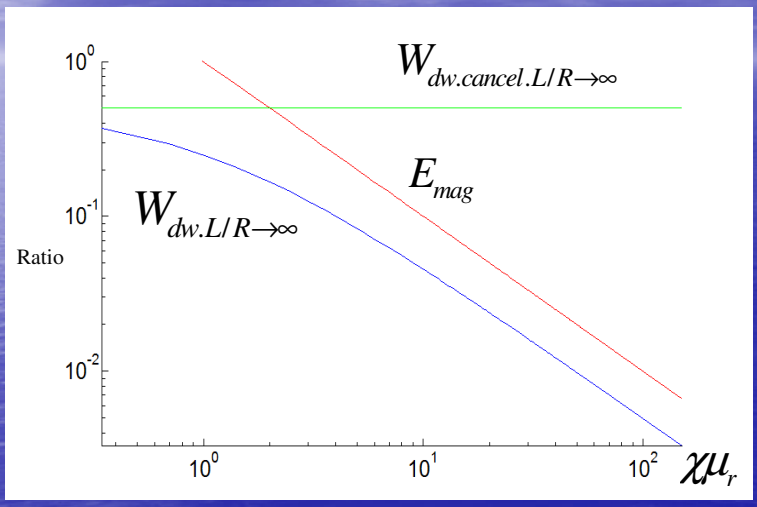
Limit by cancelling method is the magnetic field energy of the ferrofluid flux

Electromagnetics 4



- Graph of ratio of input E_{mag} to simple dipole work and work via cancellation method vs susceptibility

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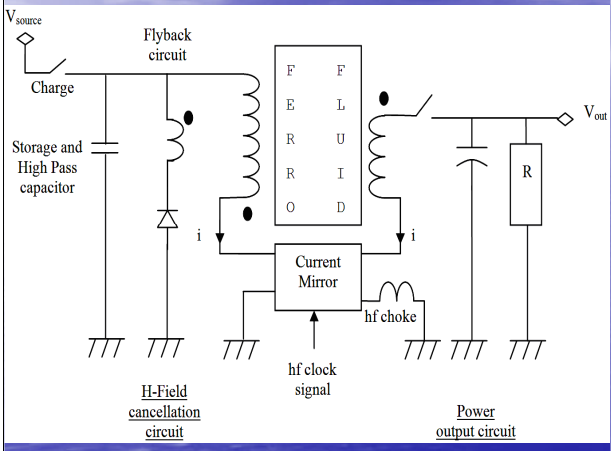
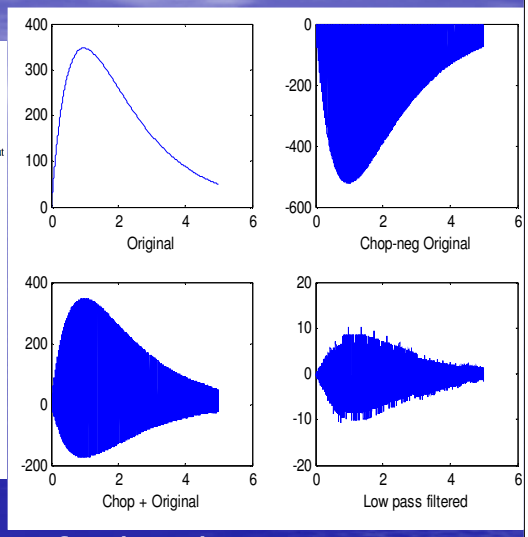
Susceptibility > 2 for over-unity

Electromagnetics 5



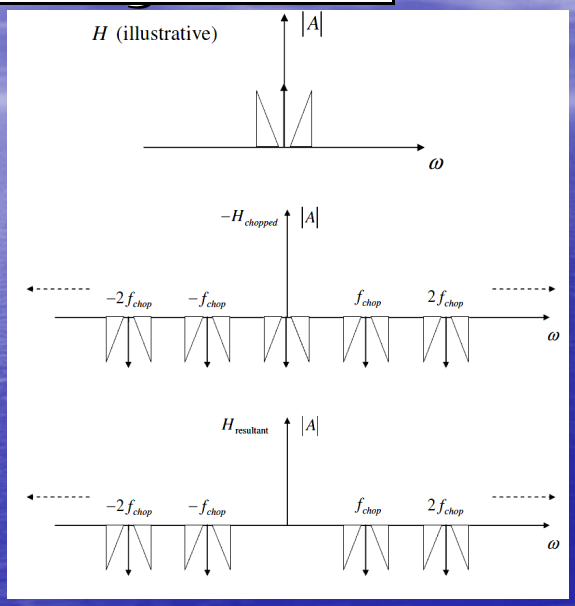


- Cancellation circuit chops copy of induced current. Consult section 4 of thesis for energy balance of the circuit that does this and equivalent circuit modelling

11

Simulated. Units are gauss. Real circuit does work.

Electromagnetics 6



- Fourier analysis depiction of how circuit works

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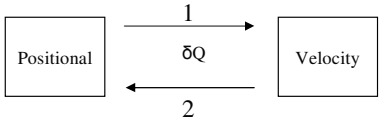
Fourier analysis depiction of how circuit works

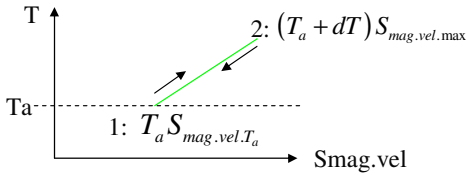
Nyquist sampling theorem

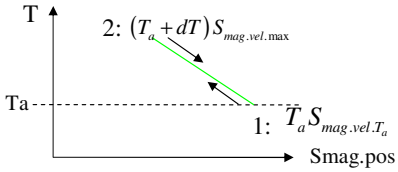
Thermodynamics 1

$$\Delta S_{total} = \Delta S_{mag.pos} + \Delta S_{mag.vel}$$

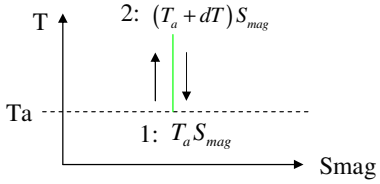


Velocity entropy



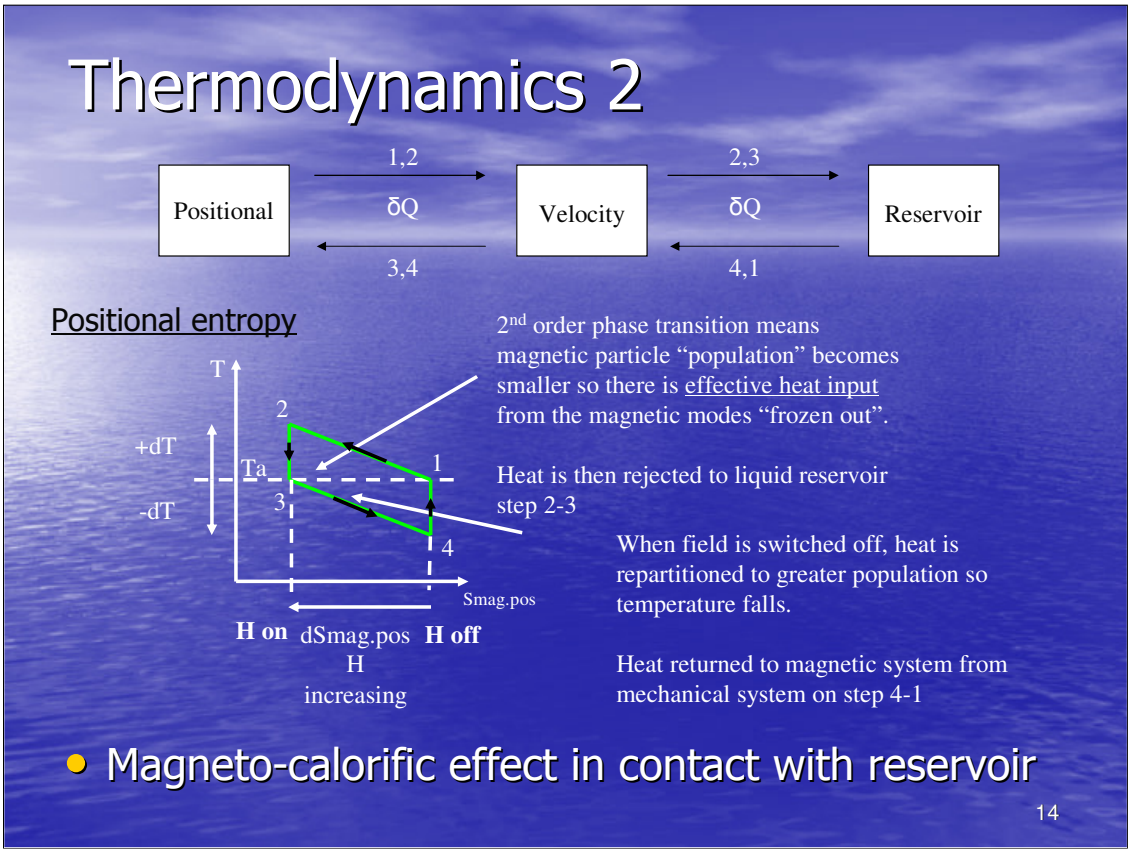


Positional entropy



Total entropy

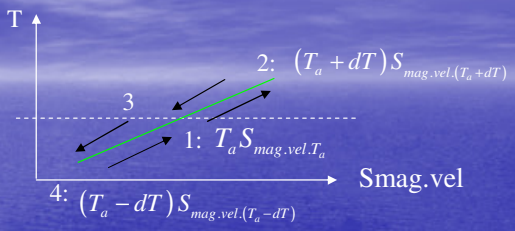
- Magneto-calorific effect in isolation. Section 2 of thesis.



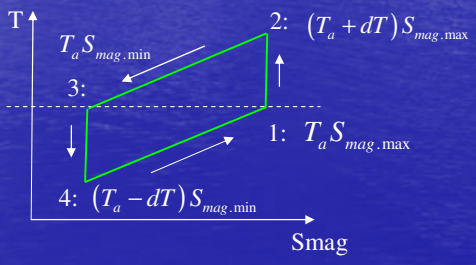
An experiment with a rubber band and an analogy to magnetic phase changing cycles and order-disorder transitions

Thermodynamics 3

Velocity entropy



Total entropy



- Magneto-calorific effect in contact with reservoir

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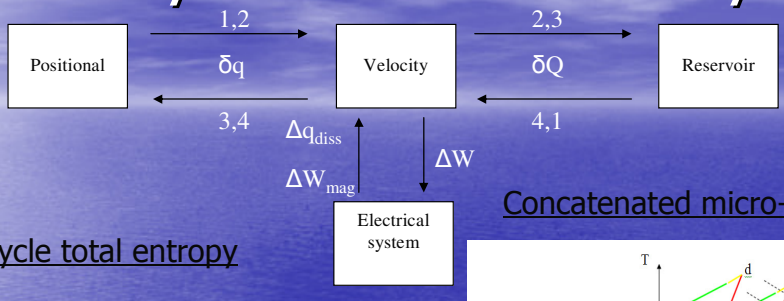
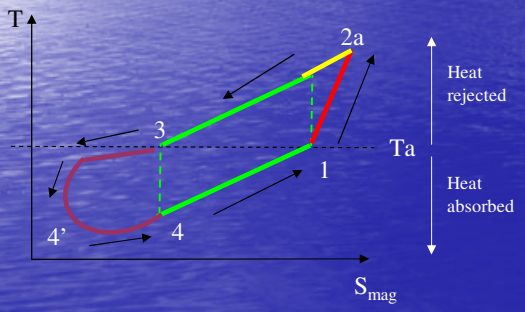
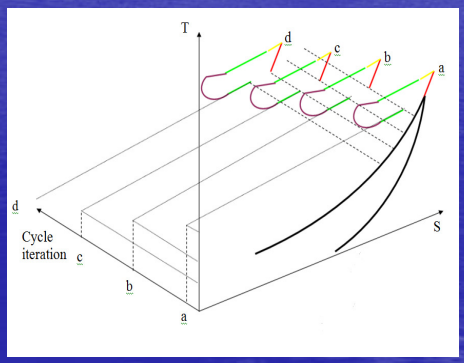
Thermodynamics 4 – The Cycle



Micro-cycle total entropy



Concatenated micro-cycles



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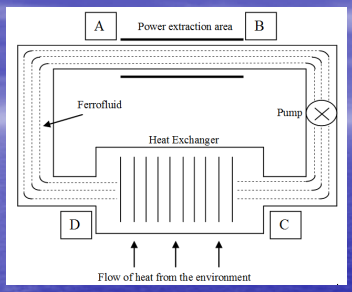
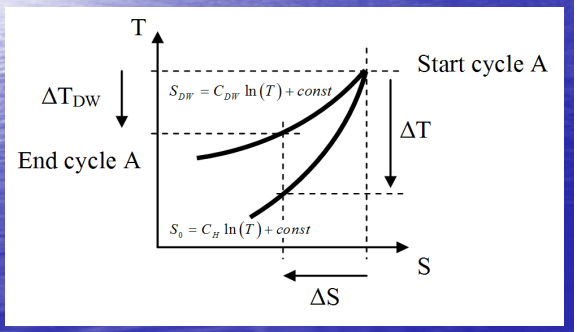
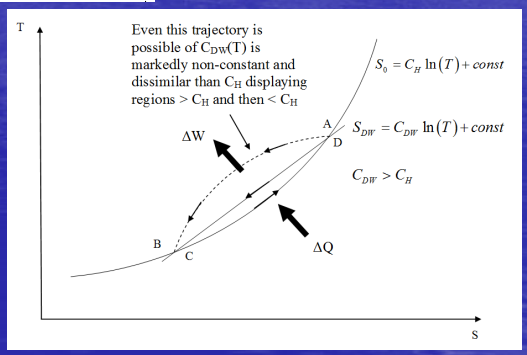
Thermodynamics 5 – The Cycle







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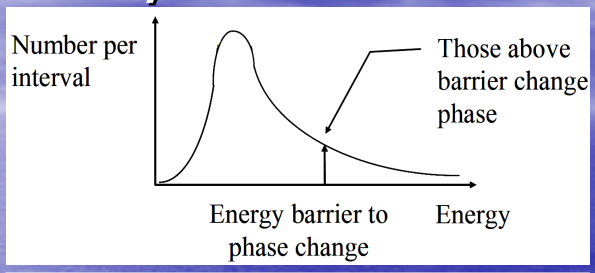
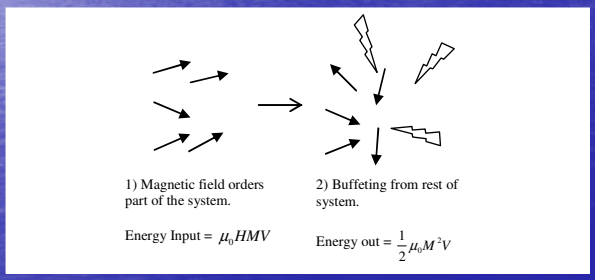
Power extraction of the order MegaWatts per meter cubed flow rate calculated. See thesis section 2.

Thermodynamics 6



1st order



2nd order

- 1st order demon with hygroscopic column ref: http://vixra.org/abs/1311.0077

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Phase equilibrium is at least a “half-way” demon.

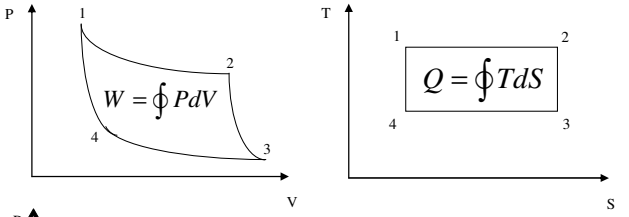
Did consider 1st order demon with hygroscopic column

“Reverse demon”

Thermodynamics 7

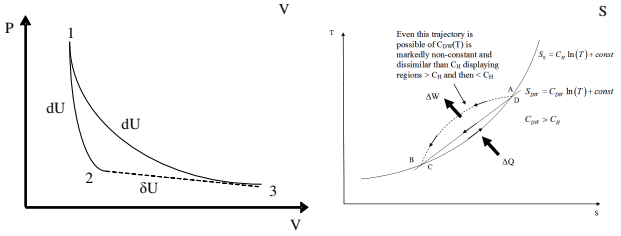
Carnot cycle

$$dU = \delta Q - \delta W$$



Phase change cycle

$$dU = TdS - PdV + \mu(P,T,\varphi)$$



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Descriptive diagram

The reason why phase change cycles can operate from one reservoir

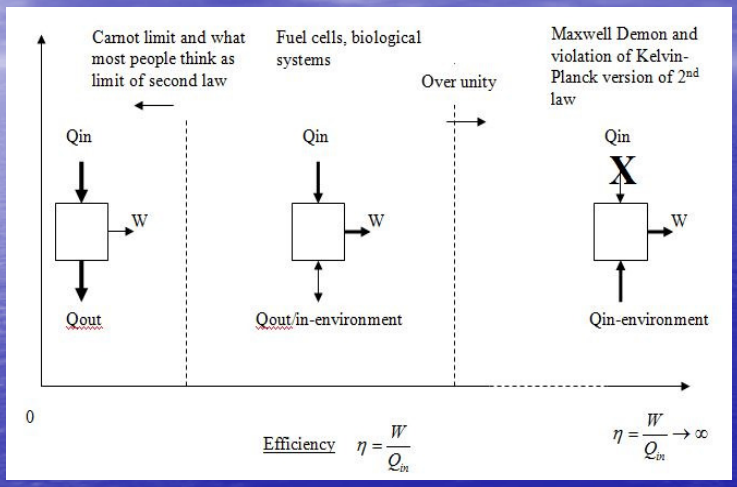
Chemists use convention with DU = dQ + dW physicists show internal energy increasing if environment does work on the system W = -Fdx

Usual mantra: Isothermal-adiabatic-isothermal-adiabatic. Carves out area on T-S diagram.

Another way to carve out area if thermodynamic identity is not exact.

INTUITIVELY: It behaves as a different substance in part of the cycle so on a different curve

What is an heat engine?



- Intrinsic entropy change between start and end states

20

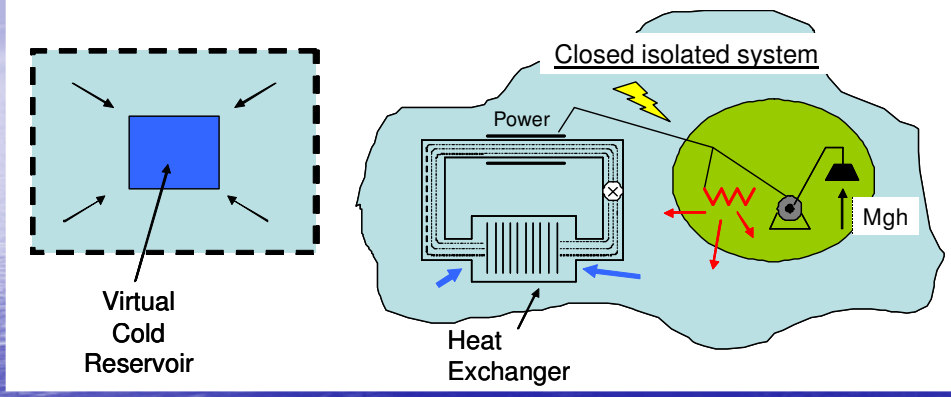
Supervisors initially sceptical about ferrofluid cycle in ferromagnetic regime (although super-paramagnetic) came up with definition that “must have a property that is a strong function of temperature”. This is only part of the picture, this prompted this slide.

The entropy change is part and parcel of operation. Can’t be engineered out.

Left sector: heat conduction -> Carnot limit. Thermal energy occupies all degrees of freedom available to it.

Middle sector: batteries, fuel cells, biological systems. Different mode of operation than just thermal release of chemical potential

De-facto reversible computing?



- Thermodynamic paradox, heat converted from one reservoir
  - $\Delta S=0$ in the isolated system (or even $\Delta S<0$) what of Kelvin-Planck, Clausius etc. statements of 2nd?
- Where is the "Arrow of Time"?
- Maxwell Demon link between Thermodynamics and Information. What now, since there is no "cost" for information?

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Not PM2, say the device lasted for a year it has worn out, its entropy has increased….

Can repair itself, needs energy and incorruptible code. Probabilistic

We age because cellular repair mechanisms themselves becoming damaged.

Rather than trying to make each logic gate, each logical step reversible, heat recovery is de-facto reversible computing.

Ultimate speed of information 1

- A posterior speed of Bell correlations over space-like distances
  - Zbinden, H.; Gisin, N., et al, *Testing the speed of 'spooky action at a distance'.* Nature, 2008. **454**.
- Measurement is random
- We claim measure no-measure protocol to send digital data over Bell channel despite randomness
  - http://vixra.org/abs/1311.0074 and http://vixra.org/abs/1506.0068

Measurement/Modulation at distant system and state of two photon system	State of distant system	State of local system	Local measurement by interferometer after modulation of distant system
No modulation: 'Binary 0' $\frac{1}{\sqrt{2}}\left(\lvert H\rangle_1\lvert V\rangle_2 + \lvert H\rangle_2\lvert V\rangle_1\right)$	Entangled => Pure state $\frac{1}{\sqrt{2}}\left(\lvert H\rangle_1 + \lvert V\rangle_1\right)$ (Or at least some superposition)	Entangled => Pure state $\frac{1}{\sqrt{2}}\left(\lvert V\rangle_2 + \lvert H\rangle_2\right)$	Pure state results in interference (Or at least some interference since source is not ideally pure)
Modulation: 'Binary 1' $\frac{\lvert H\rangle_1\lvert V\rangle_2}{\sqrt{2}}$ or $\frac{\lvert H\rangle_2\lvert V\rangle_1}{\sqrt{2}}$	Not entangled <=> Mixed state $\frac{\lvert H\rangle_1}{\sqrt{2}}$ or $\frac{\lvert V\rangle_1}{\sqrt{2}}$	Not entangled <=> Mixed state $\frac{\lvert H\rangle_2}{\sqrt{2}}$ or $\frac{\lvert V\rangle_2}{\sqrt{2}}$	Mixed state gives no interference

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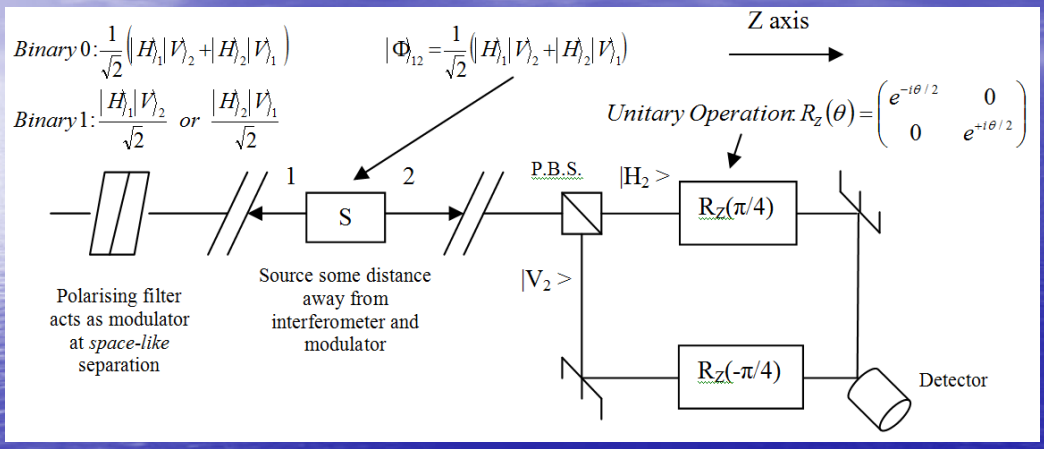
Don't do by half measures. Extraordinary claims, extraordinary evidence… Do it wrong or inconclusive, get crucified.

Funding-experiments-publication catch-22

Ultimate speed of information 2



- http://vixra.org/abs/1311.0074
- Disproof of No-communication theorem
  - http://vixra.org/abs/1506.0068

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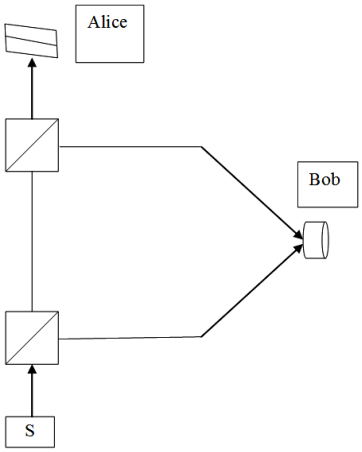
Entangled particles. Spontaneous Parametric Down-conversion (SPDC). Sources very expensive, no joy from labs or journals. Door closed.

Ultimate speed of information 3



$$P(\text{Measurement, bit 1}) = \left|\frac{i}{\sqrt{2}}\right|^2 + \left|\frac{i}{\sqrt{4}}\right|^2$$
$$= 0.5 + 0.25$$
$$= 0.75$$

$$P(\text{No-measurement, bit 0}) = \left|\frac{i}{\sqrt{2}}\right|^2 + \left|\frac{e^{i\theta}}{\sqrt{4}}\right|^2 + 2\left|\frac{i}{\sqrt{2}}\right|\left|\frac{e^{i\theta}}{\sqrt{4}}\right|\cos(\arg\theta)$$
$$= 0.5 + 0.25 + \frac{1}{\sqrt{2}}\cos(\arg\theta)$$
$$= 0.75 \pm 0.707\cos(\arg\theta)$$
$$= 0.043 \text{ minimum}$$

- Single photon path entanglement method
  - http://vixra.org/abs/1410.0113

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Necessity mother of invention, so came up with this which can be done cheaply.

Diagram is more of a schematic

Seems easy enough but musn't do half-hearted.

"Extraordinary claims, extraordinary evidence" so need good lab to do properly otherwise get crucified.

Conclusion: Severing the link between Information and Physics?

- Landauer: "Information is physical". Yes… but not entirely.
- Maxwell-Szilard's Demon, Turing-Shannon: link to thermodynamics conclusive?
  - Reversible computing by the methods in this conference?
  - Time's Arrow is loss of information.
- Other area of my research – What is the Ultimate Speed of Information?
  - A digression but relevant.
  - Bell's Theorem vs. Relativity.
  - Disproof of "No communication theorem"?
  - A method to send classical data over a Bell channel.
  - If information breaks the laws of physics, then it is not entirely physical.
  - Rough analogy: If an operating system is a "universe" (a set of rules), Java runs on any OS, not implementation dependent.
  - Conclusion: Information *is* metaphysical. Explanation of reality may not be wholly materialistic. Truly in realm of mathematics. Furthermore in mathematics we have Godellian notions of things which are true which can't be proven.

http://vixra.org/author/remi_cornwall

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