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**From:** Jeffrey Epstein <jeevacation@gmail.com>  
**Sent:** Sunday, September 4, 2011 6:33 PM  
**To:** [REDACTED]  
**Subject:** Re: FW: A Quantum-Thermodynamic Ratchet For Photonic Frequency Up-Pumping?

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On Sun, Sep 4, 2011 at 2:33 PM, [REDACTED] <mailto:[REDACTED]> wrote:

8-90% seems like a broad=range?

Maybe a typo.

=p class="MsoNormal">From:=span style="font-size:10.0pt"> Jeffrey Epstein [mailto:jeevacation@gmail.com]  
Sent: Sunday, September 04, 2011 11:32 AM  
To: [REDACTED]  
Subject: Re: FW: A Quantum-Thermodynamic Ratchet For Photonic =requency Up-Pumping?

yes,, photosynthes i= 8-90 % efficient. ,, it acts becasue of the wave nature of light, t=is isthe next frontier.

On Su=, Sep 4, 2011 at 2:18 PM, [REDACTED] <mailto:[REDACTED]> =g  
<mailto:[REDACTED]> > wrote:

That's true.

How many gaps do you think cou=d be activated by one photon?

Just =urious do you think that in our lifetimes we will have any energy breakthr=ughs?

From:=span style="font-size:10.0pt"> Jeffrey Epstein [mailto:jeevacation@gmail.com] Sunday, September 04, 2011 2:38 AM  
To: [REDACTED]  
Subject: Re: FW: A Quantum-Thermodynami= Ratchet For Photonic Frequency Up-Pumping?

photosynethes seems to work by not needing the particle at all , but the re=cting to its wave nature, . the light should be able to be tuned. an= not one gap but many being activated by the same photon

=div>

On Sun, Sep 4, 2011 at 2:48 AM, [REDACTED] <= href="mailto:[REDACTED]"> wrote:  
target="\_blank" > [REDACTED]

Oh Lord.

This is a very hard problem =93 do you have any interesting inputs to add here?

<= class="MsoNormal"> From: Lowell Wood [mailto:[REDACTED] <mailto:[REDACTED]> ]  
Sent: Saturday, Sept=ember 03, 2011 11:38 PM  
To: Rod Hyde; Jordin Kare  
Cc: 'Nathan Myhrvold'; C=uck Whitmer - External; 'Jeff Bowers'; Boris Nikolic (BGC3); [REDACTED]; David =.  
Tuckerman; 'Casey Tegreene'  
Subject: A Quantum-Thermodynamic Ratchet For Photonic Frequency Up-P=mping?

I continue to puzzle over Bill =99s "cheaper-&-cleaner-&-more abundant electricity for eve=yone" challenge-to-Inventors – currently 'aided =80 (entirely legally – physician's orders! J) by the modern version of the tradition=l opium-eater's favorite ingestible. J [Dr. Nikolic admon=shes me to comply completely with "the doctor's orders =80 along these lines – which call for remarkably heavy-&-fr=quent dosings -- so please do blame him entirely for this missive!  
<=pan style="font-family:Wingdings">J]

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In order to generate the maximum voltage-current product from a given area of (single-composition) semiconductor i=lluminated with a given flux, it's clearly desirable to have monoch=omatic radiation that's 'matched' to the bandgap, =-&-p Fermi levels, etc. of the chosen semiconductor. Howev=er, what God gives us – in generous total quantities, if not pleasa=tly high fluxes :) -- is a ~0.= eV Planckian spectrum with a batch of holes chewed in it, i.e., the solar=spectrum at AM1, for which the maximum-attainable energy conversion effici=ncency is widely believed to be ≤0.5.

Even =hese performance levels are attained only with a half-dozen p-n junction a=ftfully (i.e., very expensively) 'stacked' on each other, e=ch taking its bandgap-designated 'bite' from the incoming =adiation (and thus being semi-insanely expensive, even for USG purposes) =E2 cf. appended Figure. It clearly would be greatly pref=rable to have a large fraction of the energy of the solar spectrum =98presented' to a suitable photovoltaic converter-assembly after b=ing 'transfigured' to single-energy (e.g., ~2.5 eV) photon=.

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So wh=t are the basic prospects for usefully – i.e., practically -- mono=chromatizing the AM1 solar spectrum in the photovoltaic context?<=u>

These=prospects would seem to be of non-trivial magnitudes – at least to=me-in-present condition! – as suggested by the appended items (whi=h ‘connection’ is admittedly somewhat distant)?<=u>

Molec=lar quantum oscillators can have very high Qs in/about the visible optical=spectrum, e.g., 106, when they're in vacuum-type=circumstances, i.e., are ‘natural linewidth’-constrained.=C2 However, these Qs can be depressed by as much as ~4 orders-of-magnit=de, e.g., via collisional interactions in normal (zero-P, non-resonant) me=ia.

So, w=at can we do with sets-of-(preferably, high-Q molecular) oscillators =80 physically-&-spectrally associated’ with each other in a =uitably engineered environment (seemingly likely enabled by contemporary l=thographic capabilities, which already offers minimum features sizes most =f an order-of-magnitude smaller than visible spectral wavelengths of inter=st)?

We wo=ld presumably arrange these molecular assemblies in stacks of planar sheet= of ‘unit cells’ containing something of the order of a do=en high-oscillator strength transitions (perhaps carried on something like=a half-dozen well-chosen molecules – or quantum dots?) which would=together ‘cover’ the AM1 spectrum between, say, 0.5 and 1.= microns free-space wavelength.

These=would serve to ‘harvest’ most all of the inputted so=ar radiation over this ~1.6 octave-width spectral band and then make it av=ilable for re-radiation by a ‘master molecular’ oscillator=located proximate to the ‘unit cell’ to whose upper-level =hey would each be (chosen to) be chosen to couple by short-range non-radia=ive energy transfer while concurrently making an ‘energy contribut=on’ of the order of a few kT to the local medium – so as t= helpfully make up energy differences between the two donating quantum osc=llators and the donated-to one and (not quite incidentally) to conf=r a degree of thermodynamic irreversibility onto the energy transfer proce=s.

The d=nated-to molecule then fluoresces the up-pumped (in the frequency sense) q=antum energy with high quantum efficiency – helpfully conferred by=lack-of-competing de-exitations in its surroundings, e.g., the energy-goi=g-uphill inability to effectively back-transfer its excitation to adjacent=donating molecules.

These=up-pumped, quasi-monochromatic photons are then ‘inputted’=(via device-internal reflectors, etc. aimed at optical transfer efficiency=optimization) to a photovoltaic conversion section of the device.

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=u>

Yes, of course I also have-in-mind the analogous photochemical trick, in which we convert such 'spectrally-enhanced sunlight' into high-energy chemical bond-rearrangements, e.g., energy efficiency-enhanced photosynthesis! J

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Of present interest are two distinct items:

[1] <=>Constructive (i.e., repair-oriented!) criticism-as-may-be-indicated of the proposed physical mechanisms and stringing-togethers thereof; =u>

[2] Comments of a 'practical' or implementation-focused character, e.g., how can this proto-device be made to work significantly better =80 i.e., in-any-&-all-ways-more-practical -- than as-sketched above=

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Thanks!

Lowell</=>

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Artificial-light-harvesting method achieves 100% energy transfer efficiency

=a href="http://www.physorg.com/archive/01-09-2011/" target="\_blank">September 1, 2011 by Lisa Zyga  
<http://www.physorg.com/editorials/>

By arranging porphyrin dye molecules on a clay surface using the "Size-Matching Effect," researchers have demonstrated an energy transfer efficiency of approximately 100%, which is an important requirement for designing efficient artificial light-harvesting systems. Image credit: Ishida, et al. ©2011 American Chemical Society<=u>

(PhysOrg.com) -- In an attempt to mimic the photo=ynthetic systems found in plants and some bacteria, scientists have taken = step toward developing an artificial light-harvesting system (LHS) that m=ets one of the crucial requirements for such systems: an approximately 100= energy transfer efficiency. Although high energy transfer efficiency is j=st one component of the development of a useful artificial LHS, the achiev=ment could lead to clean solar-fuel technology that turns sunlight into ch=mical fuel.

The researchers, led by Shinsuke Takagi from the Tok=o Metropolitan University and PRESTO of the Japan Science and Technology A=ency, have published their study on their work toward an artificial LHS in=a recent issue of the Journal of the American =hemical Society <<http://www.physorg.com/tags/journal+of=the+american+chemical+socie>> .

"In order to realize an artificial light-har=esting system, almost 100% efficiency is necessary," Takagi told <=>PhysOrg.com. "Since light-harvesting systems consist of many =teps of bacteria <<http://www.physorg.com/tags/energy+transfer/>> or plant leaves) is composed of regularly =rranged molecules that efficiently collect sunlight and carry the excitati= energy to the system's reaction center. An artificial LHS (or =E2 artificial leaf") attempts to do the same thing by using f=ncitional dye molecules.

Building on the results of previous research, the sc=entists chose to use two types of porphyrin dye molecules for this purpose= which they arranged on a clay surface. The molecules' tendency to=aggregate or segregate on the clay surface made it challenging for the res=earchers to arrange the molecules in a regular pattern like their natural c=unterparts.

"A molecular arrangement with an appropriate=intermolecular distance is important to achieve nearly 100% energy transfe= efficiency," Takagi said. "If the intermolecular distance= is too near, other reactions such as electron transfer and/or photochemica= reactions would occur. If the intermolecular distance is too far, deactiv=ation of excited dye surpasses the energy transfer reaction." </=>

In order to achieve the appropriate intermolecular d=stance, the scientists developed a novel preparation technique based on ma=ching the distances between the charged sites in the porphyrin molecules a=d the distances between negatively charged (anionic) sites on the clay sur=ace. This effect, which the researchers call the "Size-Matching Ru=e," helped to suppress the major factors that contributed to the p=rphyrin molecules' tendency to aggregate or segregate, and fixed t=e molecules in an appropriate uniform intermolecular distance. As Takagi e=plained, this strategy is significantly different than other attempts at a=hieving molecular patterns.

"The methodology is unique," he said= "In the case of usual self-assembly systems, the arrangement is r=alized by guest-guest interactions. In our system, host-guest interactions=play a crucial role for realizing the special arrangement of dyes. Thus, b= changing the host material, it is possible to control the molecular arran=ement of dyes on the clay surface."

As the researchers demonstrated, the regular arrange=ent of the molecules leads to an excited energy transfer efficiency <<http://www.phys=rg.com/tags/transfer+efficiency/>> molecules <<http://=ww.physorg.com/tags/molecules/>> and clay h=st materials look like promising candidates for an artificial LHS.<=>

"At the present, our system includes only tw= dyes," Takagi said. "As the next step, the combination of=several dyes to adsorb all sunlight is necessary. One of the characteristi= points of our system is that it is easy to use several dyes at once. Thus= our system is a promising candidate for a real light-harvesting system th=t can use all sunlight <<http://www.physorg.com/tags/sunlight/>> . We believe that even photochemical reaction parts can=be combined on the same clay surface. If this system is realized and is co=bined with a photochemical reaction center, this system can be called an =E2 inorganic leaf."

More information: Yohei Ishida, et al. =9CEfficient Excited Energy Transfer Reaction in Clay/Porphyrin Complex tow=rd an Artificial Light-Harvesting System." Journal of the Ameri=an Chemical Society. DOI:10/1021/ja204425u

Article</=>

## Efficient Excited Energy Transfer Reaction in Clay/Porphyrin Complex toward an Artificial Light-Harvesting System

\* Abstract <<http://pubs.acs.org/doi/abs/10.1021/ja204425u>>  
\* Full Text HTML <<http://pubs.acs.org/doi/full/10.1021/ja204425u>>  
\* Hi-Res PDF [1854 KB] <<http://pubs.acs.org/doi/pdf/10.1021/ja204425u>>  
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PRESTO (Preliminary Research for Embryonic Science and Technology), Japan Science and Technology Agency, 4-1-8 Honcho Kawaguchi, Saitama, Japan

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[REDACTED] <mailto:takagi-shinsuke@tmu.ac.jp>

<<http://cas.org/>> Section:=/u>

Radiation Chemistry, Photochemistry, and Photographic and Other Reprographic Processes  
<<http://pubs.acs.org/topic/reproductive>>

### Abstract

=u>

The quantitative excited energy transfer reaction between cationic porphyrins on an anionic clay surface was successfully achieved. The efficiency reached up to ca. 100% owing to the "E2 Size-Matching Rule" as described in the text. It was revealed that the important factors for the efficient energy transfer reaction are (i) suppression of the self-quenching between adjacent dyes, and (ii) suppression of the segregated adsorption structure of two kinds of dyes on the clay surface. By examining many different kinds of porphyrins, we found that tetrakis(1-methylpyridinium-3-yl) porphyrin (m-TMPyP) and tetrakis(1-methylpyridinium-4-yl) porphyrin (p-TMPyP) are the suitable porphyrins to accomplish a quantitative energy transfer reaction. These findings indicate that the clay/porphyrin complexes are promising and prospective candidates to be used for construction of an efficient artificial light-harvesting system.

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