From: Jeffrey Epstein <jeevacation@gmail.com>
Sent: Sunday, September 4, 2011 9:38 AM
To: [redacted]
Subject: Re: FW: A Quantum-Thermodynamic 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

On Sun, Sep 4, 2011 at 2:48 AM, [redacted] <[redacted]=on.org> wrote:

Oh Lord.

This is a very hard problem =E2 do you have any interesting inputs to add here?

<= class="MsoNormal"> From: Lowell Wood [mailto:[redacted]
<mailto:[redacted]>]
Sent: Saturday, Sept=mber 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?

=C2

I continue to puzzle over Bill =80 s "cheaper-&-cleaner-&-more abundant electricity for =veryone" challenge-to-Inventors – currently 'aided=E2 (entirely legally – physician's orders! J) by the modern version of the traditi=nal opium-eater's favorite ingestible. J [Dr. Nikolic adm=nishes me to comply completely with "the doctor's orders=E2 along these lines – which call for remarkably heavy-&=frequent dosings -- so please do blame him entirely for this missive= :)]

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In order to generate the maximum volta=e-current product from a given area of (single-composition) semiconductor =lluminated with a given flux, it's clearly desirable to have monoc=romatic radiation that's 'matched' to the bandgap,=n-&-p Fermi levels, etc. of the chosen semiconductor. Howe=er, what God gives us – in generous total quantities, if not pleas=ntly high fluxes :) -- is a ~0=5 eV Planckian spectrum with a batch of holes chewed in it, i.e., the sola= spectrum at AM1, for which the maximum-attainable energy conversion effic=ency is widely believed to be ≤0.5.

Even =hese performance levels are attained only with a half-dozen p-n junction a=tfully (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 w=at are the basic prospects for usefully – i.e., practically -- mon=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-excitations 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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Yes, of course I also have-in-mind the an=logous photochemical trick, in which we convert such 'spectrally-e=hanced sunlight' into high-energy chemical bond-rearrangements, e.=., energy efficiency-enhanced photosynthesis! J

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Of present interest are two distinct item=:

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

[2] C=mments of a 'practical' or implementation-focused characte=, 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=u>

=C2

Artificial light-harvesting=method achieves 100% energy transfer efficiency</=>

September 1, 2011 <http://www.physorg.com/ar=hive/01-09-2011/> by Lisa Zyga <http://www.physorg.com/editorials/>

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

(PhysOrg.com) -- In an attempt to=mimic the photosynthetic systems found in plants and some bacteria, scient=sts have taken a step toward developing an artificial light-harvesting sys=em (LHS) that meets one of the crucial requirements for such systems: an a=proximately 100% energy transfer efficiency. Although high energy transfer=efficiency is just one component of the development of a useful artificial=LHS, the achievement could lead to clean solar-fuel technology that turns =unlight into chemical fuel.

The researchers, led by Shinsuke Tak=gi from the Tokyo Metropolitan University and PRESTO of the Japan Science =nd Technology Agency, have published their study on their work toward an a=tificial LHS in a recent issue of the Journal =f the American Chemical Society <http://www.physorg.com=tags/journal+of+the+american+chemical+society/> .

"In order to realize an arti=icial light-harvesting system, almost 100% efficiency is necessary, =9D Takagi told PhysOrg.com. "Since light-harvesting systems=consist of many steps of energy transfer <http://www.physorg.com/tags/energy+tra=sfer/> , the total energy transfer ef=iciency becomes low if the energy transfer efficiency of each step is 90%.=For example, if there are five energy transfer steps, the total energy tra=sfer is 0.9 x 0.9 x 0.9 x 0.9 x 0.9 = 0.59. In this way, an efficient en=rgy transfer reaction plays an important role in realizing efficient sunli=ht collection for an artificial light-harvesting system."

As the researchers explain in their =tudy, a natural LHS (like those in purple bacteria <http://www.physorg.co=/tags/bacteria/> or plant leaves) is compos=d of regularly arranged molecules that efficiently collect sunlight and ca=ry the excitation energy to the system's reaction center. An artif=cial LHS (or "artificial leaf") attempts to do the same th=ng by using functional dye molecules.

Building on the results of previous =esearch, the scientists chose to use two types of porphyrin dye molecules =or this purpose, which they arranged on a clay surface. The molecules =80 tendency to aggregate or segregate on the clay surface made it chall=nging for the researchers to arrange the molecules in a regular pattern li=e their natural counterparts.

"A molecular arrangement wit= an appropriate intermolecular distance is important to achieve nearly 100= energy transfer efficiency," Takagi said. "If the intermo=ecular distance is too near, other reactions such as electron transfer and=or photochemical reactions would occur. If the intermolecular distance is =oo far, deactivation of excited dye surpasses the energy transfer reaction="

In order to achieve the appropriate =ntermolecular distance, the scientists developed a novel preparation techn=que based on matching the distances between the charged sites in the porph=rin molecules and the distances

between negatively charged (anionic) sites=on the clay surface. This effect, which the researchers call the "=ize-Matching Rule," helped to suppress the major factors that cont=ibuted to the porphyrin molecules' tendency to aggregate or segreg=te, and fixed the molecules in an appropriate uniform intermolecular dista=ce. As Takagi explained, this strategy is significantly different than oth=r attempts at achieving molecular patterns.

"The methodology is unique,=E2 he said. "In the case of usual self-assembly systems, the=arrangement is realized by guest-guest interactions. In our system, host-g=est interactions play a crucial role for realizing the special arrangement=of dyes. Thus, by changing the host material, it is possible to control th= molecular arrangement of dyes on the clay surface."=/span>

As the researchers demonstrated, the=regular arrangement of the molecules leads to an excited energy transf=r efficiency of up to 100%. The results indicate that porphyrin dye molecule= <http://www.physorg.com/tags/molecules/> and clay host materials look like promising candidates for an artific=al LHS.

"At the present, our system =ncludes only two dyes," Takagi said. "As the next step, th= combination of several dyes to adsorb all sunlight is necessary. One of t=e characteristic points of our system is that it is easy to use several dy=s at once. Thus, our system is a promising candidate for a real light-harv=sting system that can use all sunlight <http://www.physorg.com/tags/sunli=ht/> . We believe that even photochemical re=ction parts can be combined on the same clay surface. If this system is re=lized and is combined with a photochemical reaction center, this system ca= be called an 'inorganic leaf.'"

More information: Yohei Ishida, et al. "Efficient Excited Energy Transfer=Reaction in Clay/Porphyrin Complex toward an Artificial Light-Harvesting S=stem." Journal of the American Chemical Society. DOI:10/102=/ja204425u

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Article

Efficient Excited Energy=Transfer Reaction in Clay/Porphyrin Complex toward an Artificial Light-Har=esting System

* Abstract <http:/=pubs.acs.org/doi/abs/10.1021/ja204425u>
* Full Text HTML <http://pubs.acs.org/doi/=ull/10.1021/ja204425u>
* <=pan style="text-decoration:none"><=span>Hi-Res PDF[1854 KB] <http://pubs.acs.org/doi/=df/10.1021/ja204425u>
* PDF w/ Links[993 KB] <http://pubs.acs.org/doi/=dfplus/10.1021/ja204425u>

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J. Am. Chem. Soc., Article ASAP

DOI: 1=.1021/ja204425u

Publication Date (Web): August 2, 20=1

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

Radiation Chemistry, Photochemistry, and P=otographic and Other Reprographic Processes <http://pubs.acs.org/topic=reprographic>

Abstract=/p>

The quantitative excited energy tran=fer reaction between cationic porphyrins on an anionic clay surface was su=cessfully achieved. The efficiency reached up to ca. 100% owing to the =80 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) suppr=ssion of the segregated adsorption structure of two kinds of dyes on the c=ay surface. By examining many different kinds of porphyrins, we found that=tetrakis(1-methylpyridinium-3-yl) porphyrin (m-TMPyP) and tetrakis(=-methylpyridinium-4-yl) porphyrin (p-TMPyP) are the suitable porphy=ins to accomplish a quantitative energy transfer reaction. These findings =ndicate that the clay/porphyrin complexes are promising and prospective ca=didates to be used for construction of an efficient artificial light-harve=ting system.

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