Società Chimica Italiana

Sezione Piemonte e Valle d'Aosta

in collaborazione con

centro internazionale di studi PRIMO LEVI

100 1919 - 2019 comitato nazionale per le celebrazioni

Piano Nazionale Lauree Scientifiche Chimica e Scienze dei Materiali

PRIMO LEVI AWARD

assegnato da

Società Chimica Italiana (SCI) e Gesellschaft Deutscher Chemiker (GDCh)

a eminenti personalità del mondo della Chimica che si sono distinte per ricerche al servizio dell'umanità, per la difesa dei diritti umani e per l'avanzamento del dialogo tra chimica e società.

Il vincitore dell'edizione 2019
Prof. Vincenzo Balzani
nella città di Primo Levi

venerdì 13 dicembre

Aula Magna "Primo Levi"

del Dipartimento di Chimica dell'Università degli Studi di Torino

Via P. Giuria 7

14:30 Saluti, presentazione del Premio e del Prof. Balzani (Gianmario Martra, Presidente della Sezione SCI; Dario Disegni, Presidente del Comitato Nazionale per le celebrazioni del Centenario della nascita di Primo Levi; Angela Agostiano, Presidente della SCI)

15:00 Letture di brani di Primo Levi da parte di studenti

15:15 Conferenza del Prof. Vincenzo Balzani **"Dal mimete di Primo Levi alle macchine molecolari"**

16:15 Conferimento di borse di studio istituite dalla Sezione Piemonte Valle d'Aosta della SCI in occasione del centenario della nascita di Primo Levi e del premio ad una Tesi di Dottorato

16.45 Conclusione e buffet

La partecipazione è libera, fino ad esaurimento dei posti disponibili.

Si prega di segnalare la presenza a sci_piemontevalledaosta@chim.it

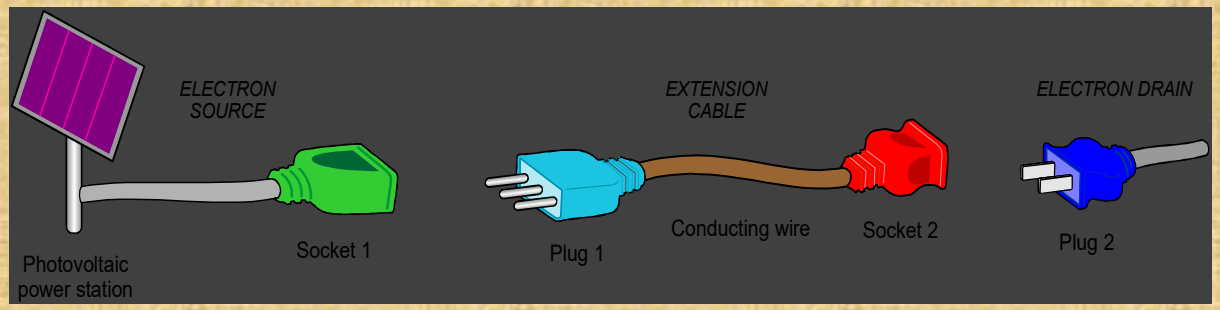
Dal Mimete di Primo Levi alle Macchine Molecolari

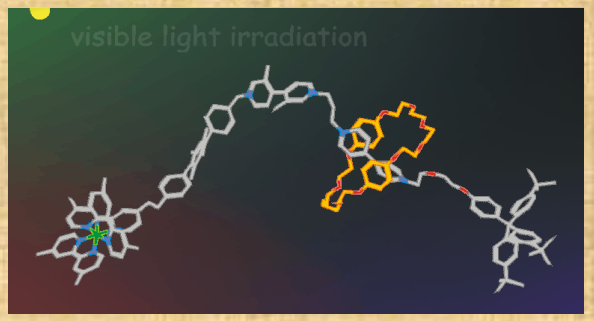
Vincenzo Balzani

Professore Emerito
Università di Bologna

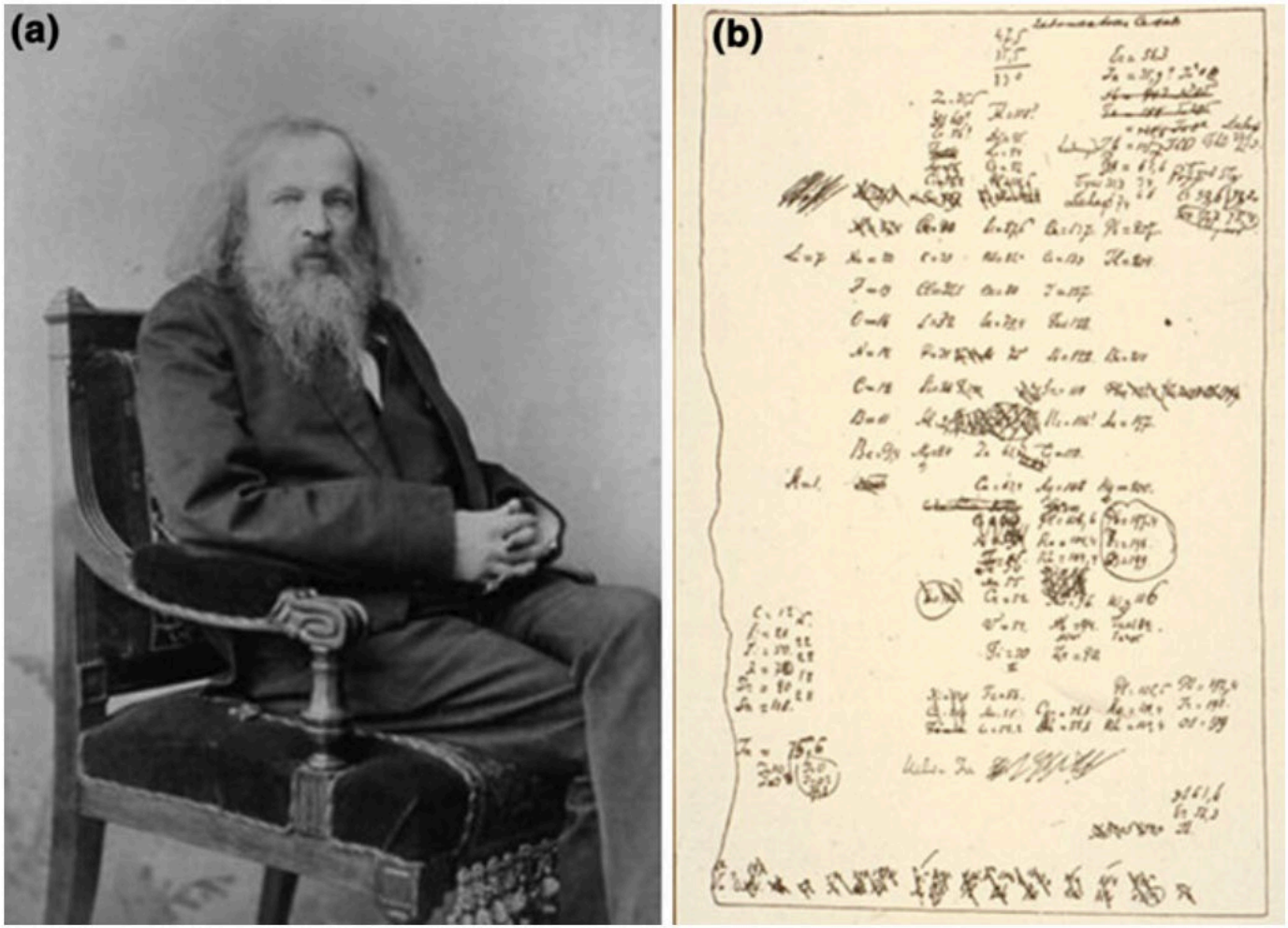
Conferenza Primo Levi Award

Aula Magna "Primo Levi"
Torino, 13 dicembre 2019



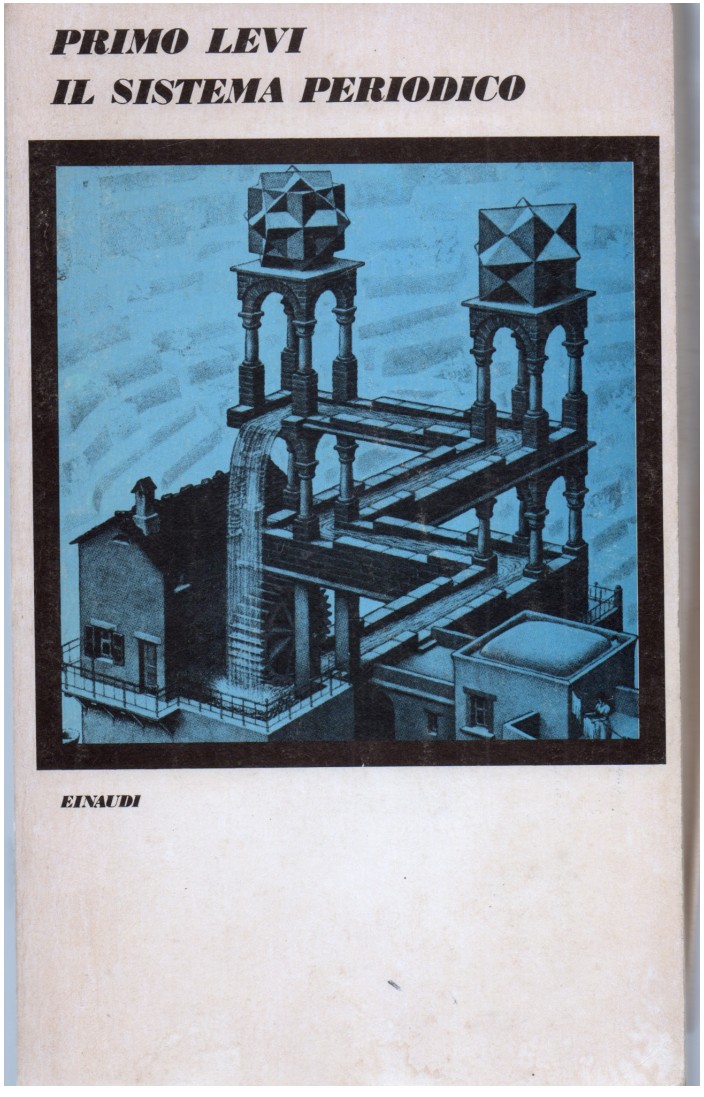


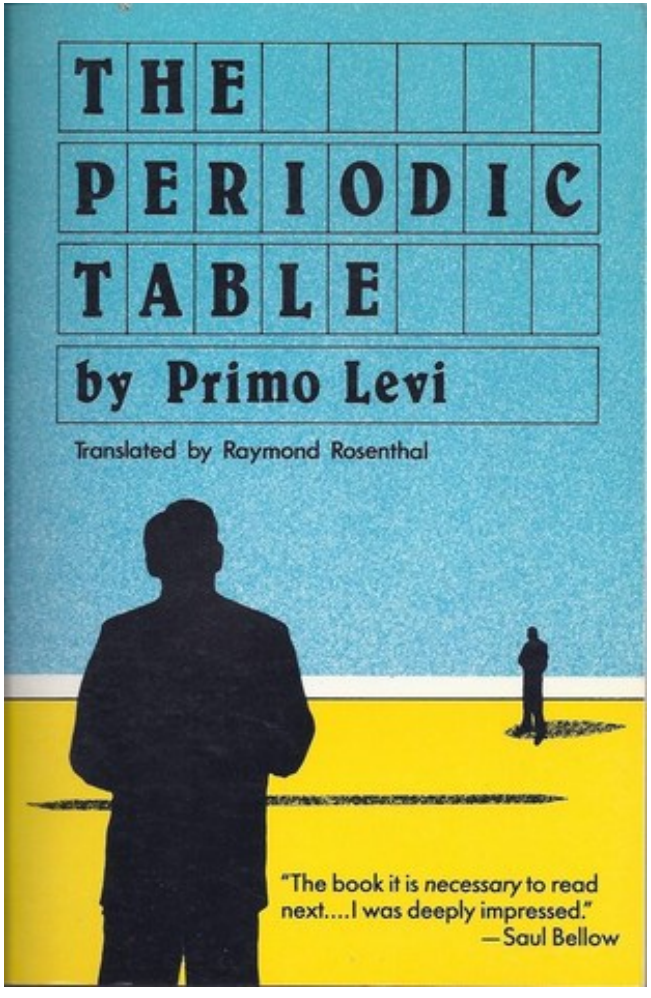
Primo Levi, 1919-1987



Dmitri Mendeleev and the earliest version of the Periodic Table, 1869

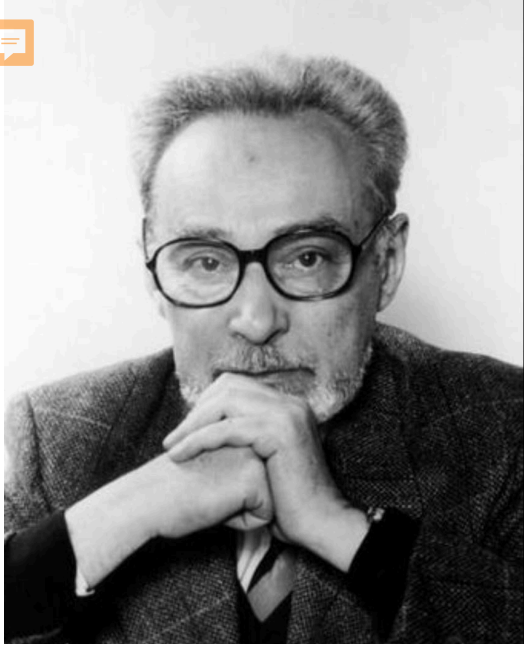
The most brilliant idea in the history of science



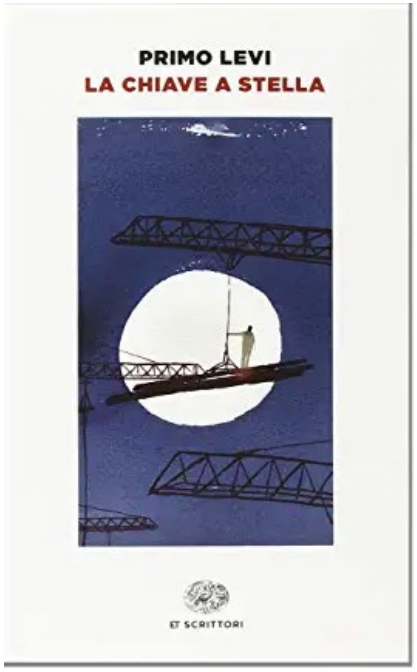


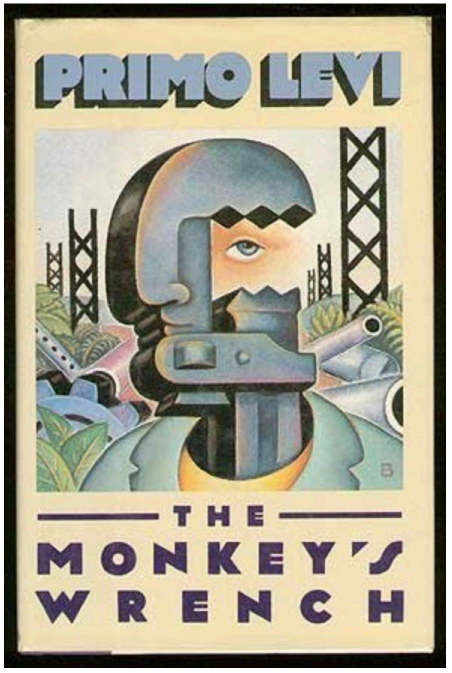
Royal Society of Chemistry, 2006:

The best scientific book ever written

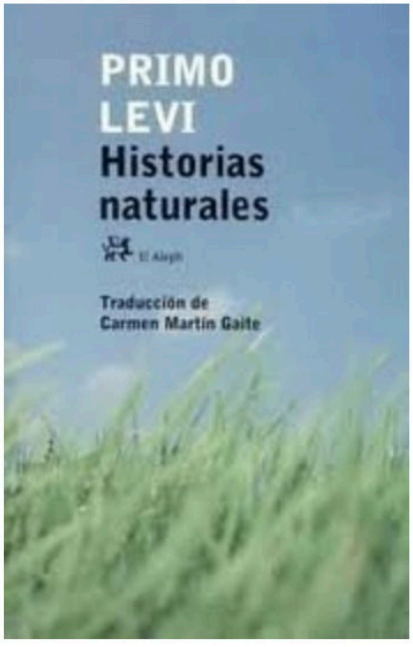


Primo Levi

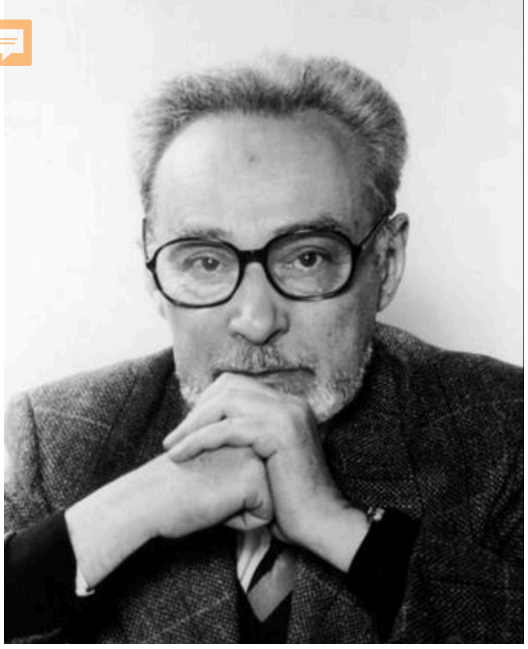

PRIMO LEVI
LA CHIAVE A STELLA
ET SCRITTORI


PRIMO LEVI
THE
MONKEY'S
WRENCH

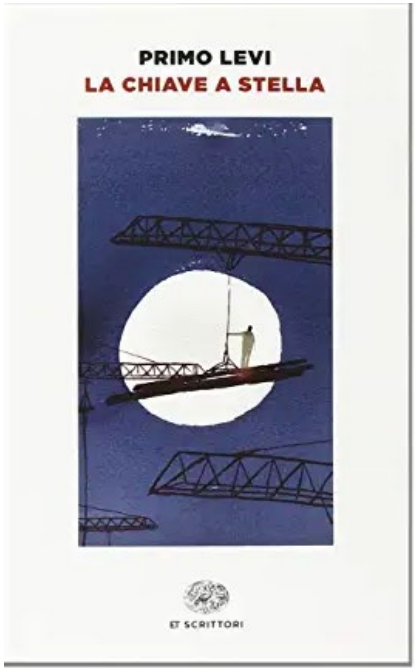

PRIMO LEVI
TUTTI I RACCONTI
A cura di Marco Belpoliti
ET BIBLIOTECA


PRIMO
LEVI
Historias
naturales
Traducción de
Carmen Martín Gaite


Primo Levi
Storie naturali



Primo Levi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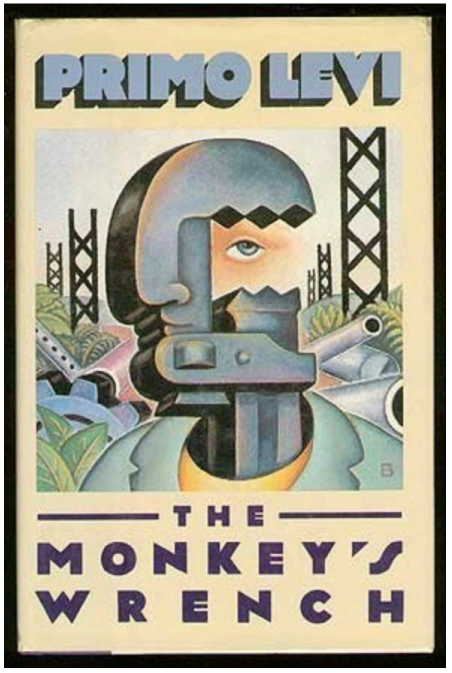
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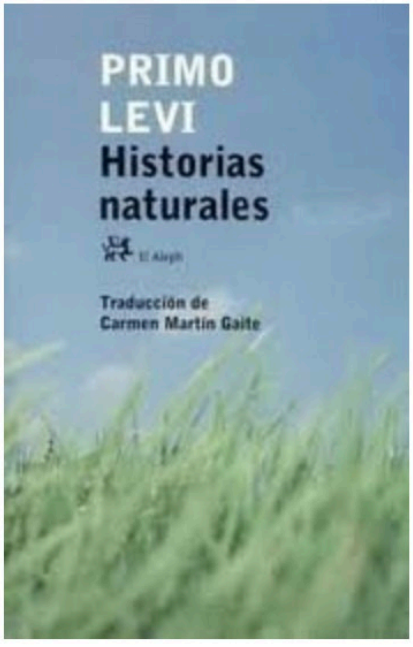
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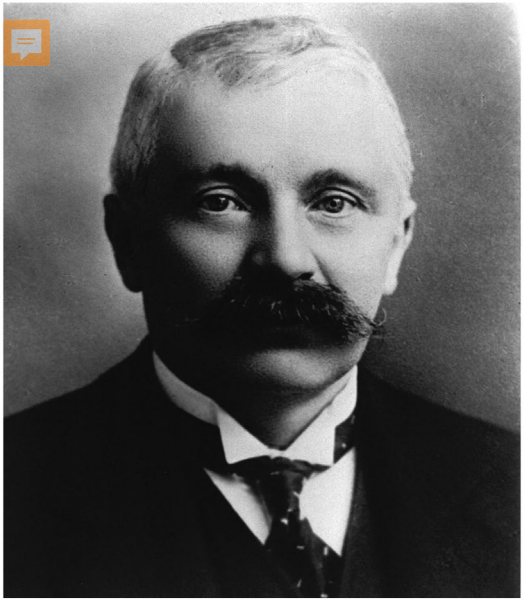
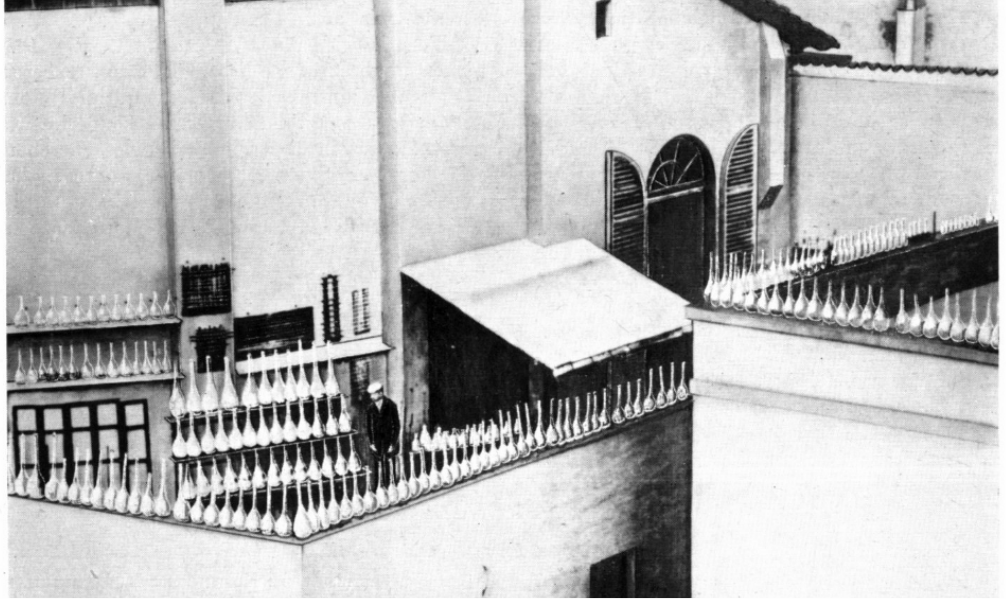
Primo Levi
Storie naturali



Giacomo Ciamician



Father of photochemistry and prophet of solar energy

Primo Levi

STORIE NATURALI

(*Natural Histories*)

L'ordine a buon mercato

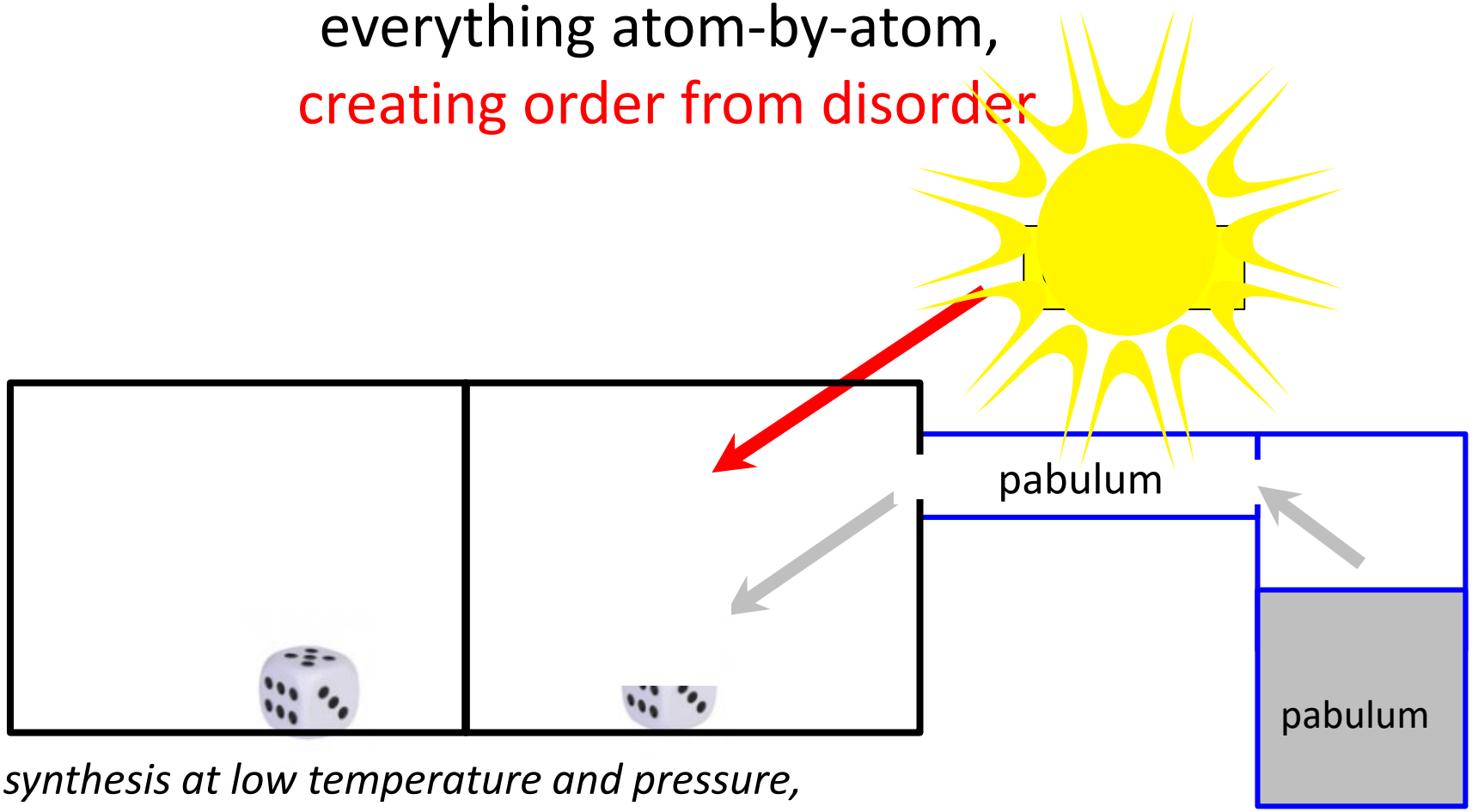
(Order on the cheap)

L'ordine a buon mercato *(Order on the cheap)*

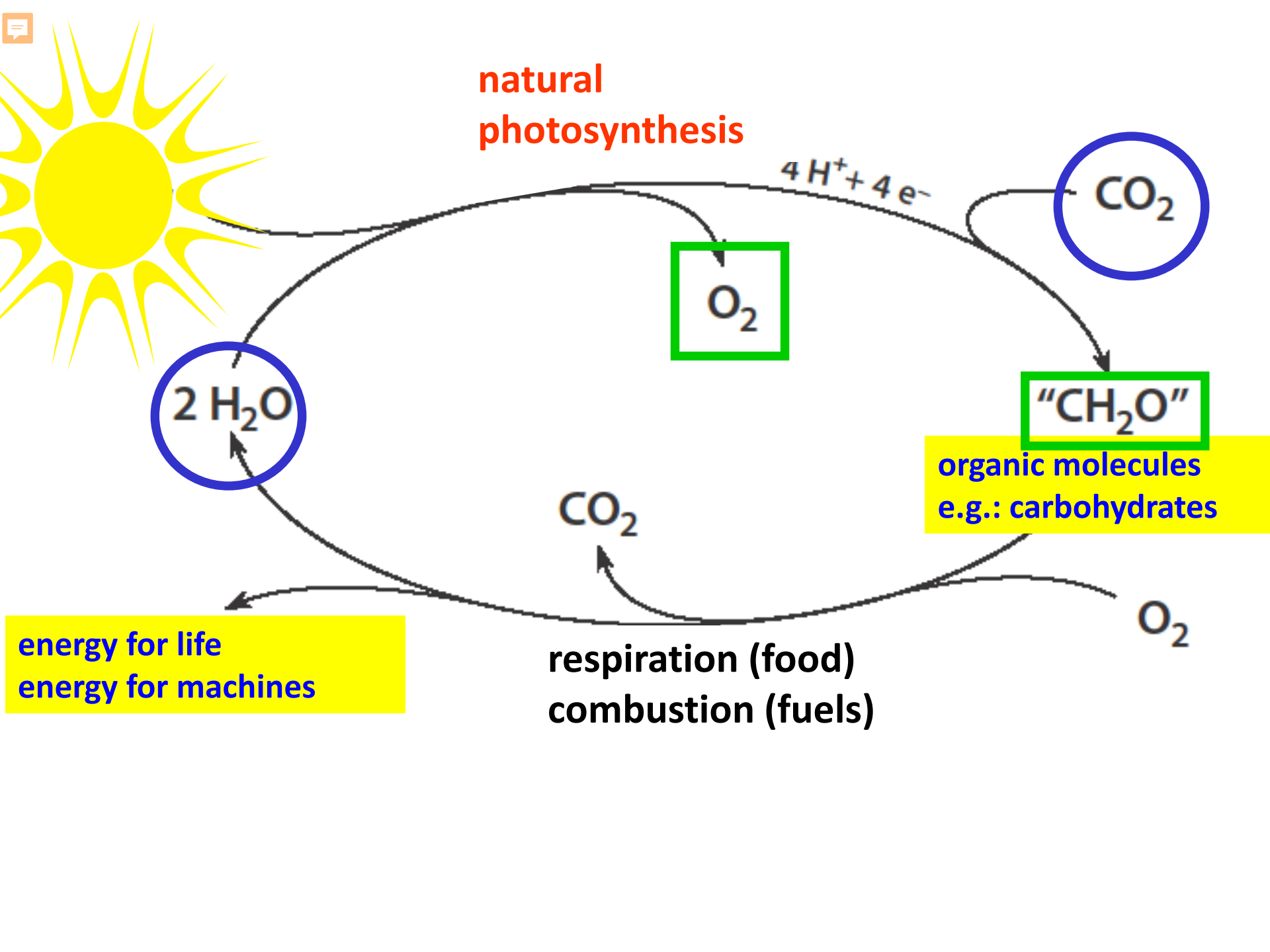
MIMETE

A machine capable of constructing everything atom-by-atom,

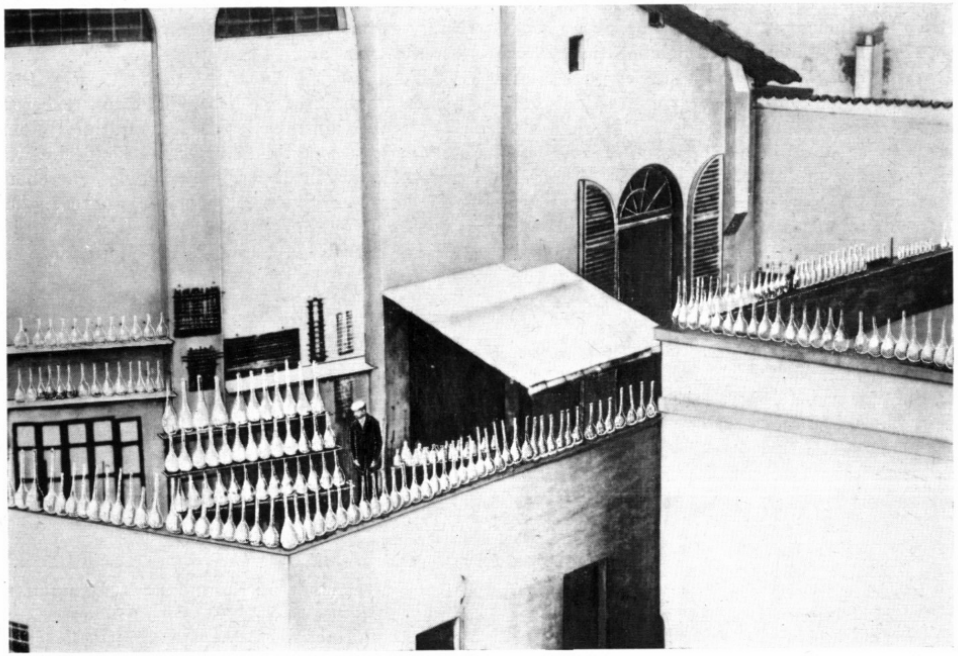
creating order from disorder



"… synthesis at low temperature and pressure, quickly and cheaply, the dream of four generations of chemists"


natural
photosynthesis
4 H+ + 4 e-
CO2
O2
2 H2O
"CH2O"
organic molecules
e.g.: carbohydrates
CO2
O2
energy for life
energy for machines
respiration (food)
combustion (fuels)

"Il ya un autre agent qui est de la plus grande importance, ... c'est la lumière".



CIAMICIAN *passant eu revue les centaines de flacons exposés au soleil sur le toit de son laboratoire.*

G. Ciamician

Bull. Chem. Soc. France,
IV Séries, Tome III, 1908, 1.

Anno Internazionale della Luce

L' Anno Internazionale della Luce e delle tecnologie basate sulla luce, 2015, è un'iniziativa delle Nazioni Unite che ha lo scopo di sensibilizzare sul progresso delle tecnologie basate sulla luce e sulle loro applicazioni. Wikipedia

2015: Anno Internazionale della Luce

La luce è una risorsa concreta fondamentale per lo sviluppo sociale ed economico

"… light excitation is especially
favorable to processes of oxidation
and reduction…

… it is conceivable that we might
make photoelectrochemical batteries
or batteries based on photochemical processes."

G. Ciamician: "The Photochemistry of the Future",
Science, *36*, 385 (1912)

“Where vegetation is rich, photochemistry may be left to the plants. In the desert regions, unsuitable to any kind of cultivation, photochemistry will artificially put their solar energy to practical uses”.

On the arid lands glass buildings will rise everywhere; inside of these will take place the photochemical processes that up until now have been the guarded secret of the plants, but that will have been mastered by human Industry, which will know how to make them bear even more abundant fruit than nature, for nature is not in a hurry and mankind is.

G. Ciamician, *The Photochemistry of the Future*, 1912

"… and if in a distant future the supply of coal becomes completely exhausted, civilization will not be checked by that, for life and civilization will continue as long as the sun shines!".

G. Ciamician: "The Photochemistry of the Future", *Science*, *36*, 385 (1912)

Reprinted from
12 September 1975, Volume 189, pp. 852-856

SCIENCE

1975, *189*, 856

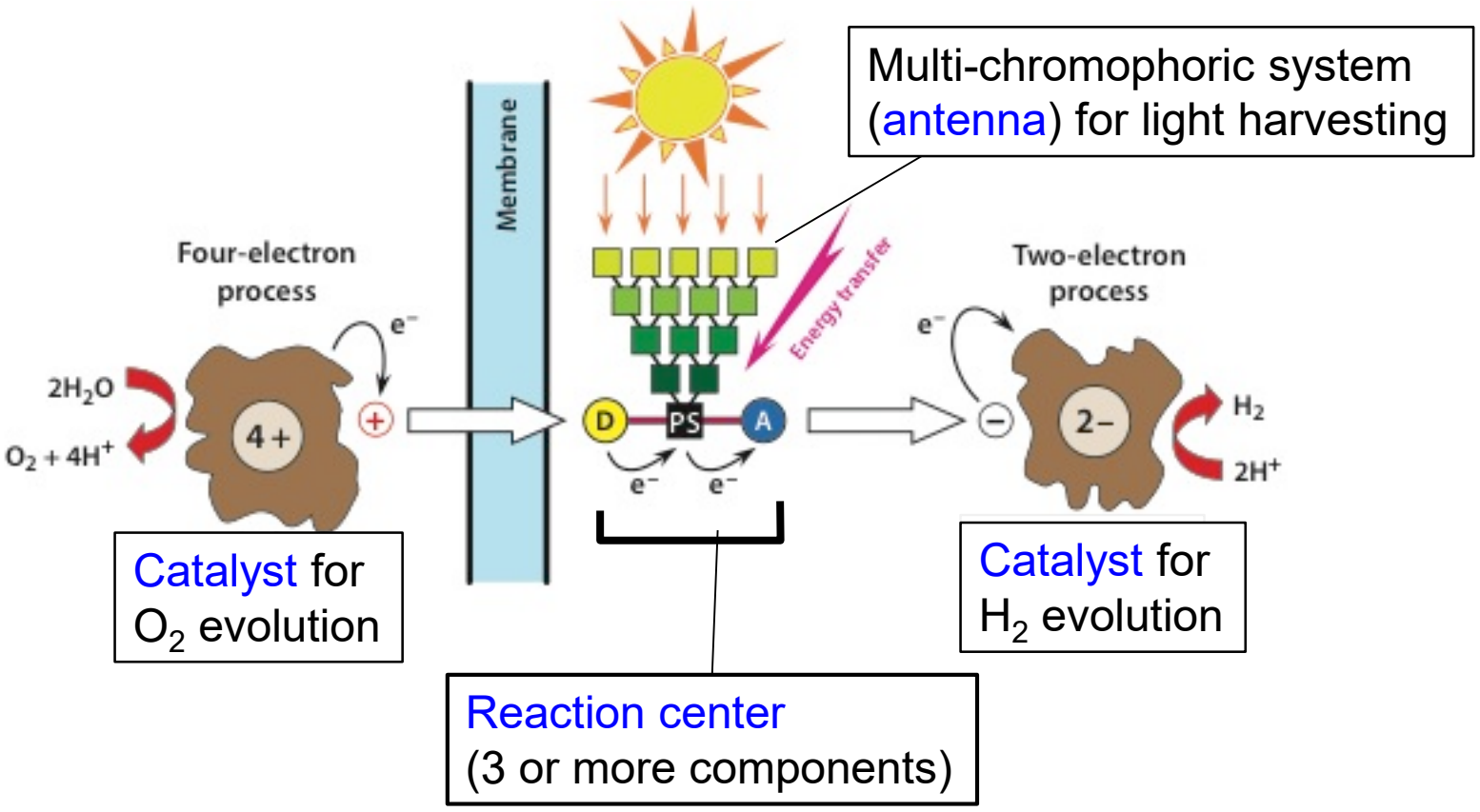
Solar Energy Conversion by Water Photodissociation

V. Balzani, L. Moggi, M. F. Manfrin,
F. Bolletta, M. Gleria

H_2O + sunlight $\rightarrow$ H_2 + 1/2O_2

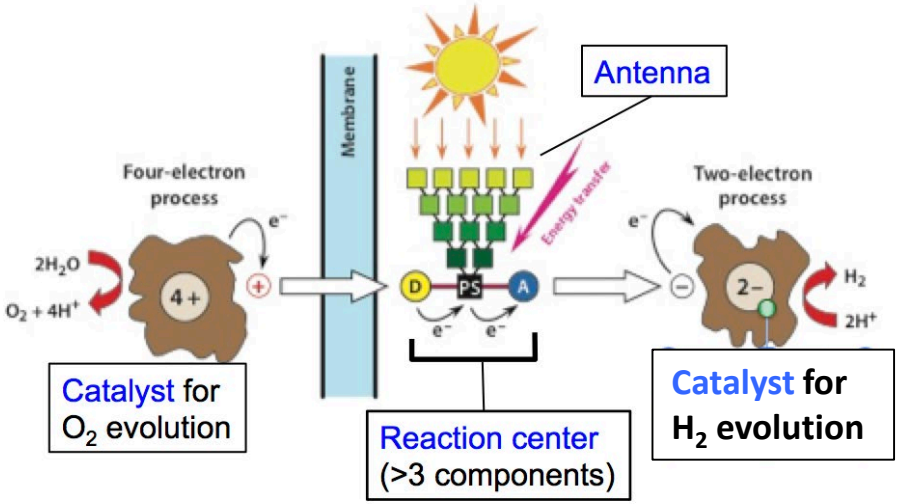
Artificial Photosynthesis

$$H_2O + \text{sunlight} \rightarrow H_2 + 1/2O_2$$



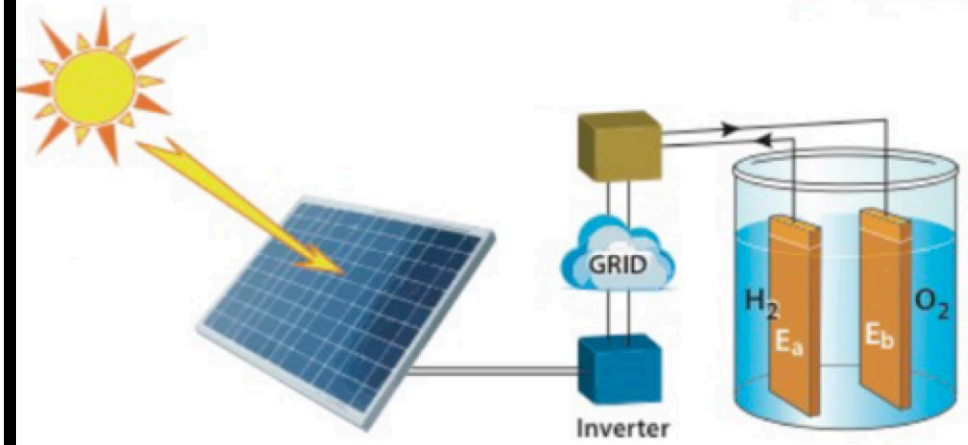
Artificial photosynthesis

H_2O + sunlight ⟶ H_2 + 1/2 O_2

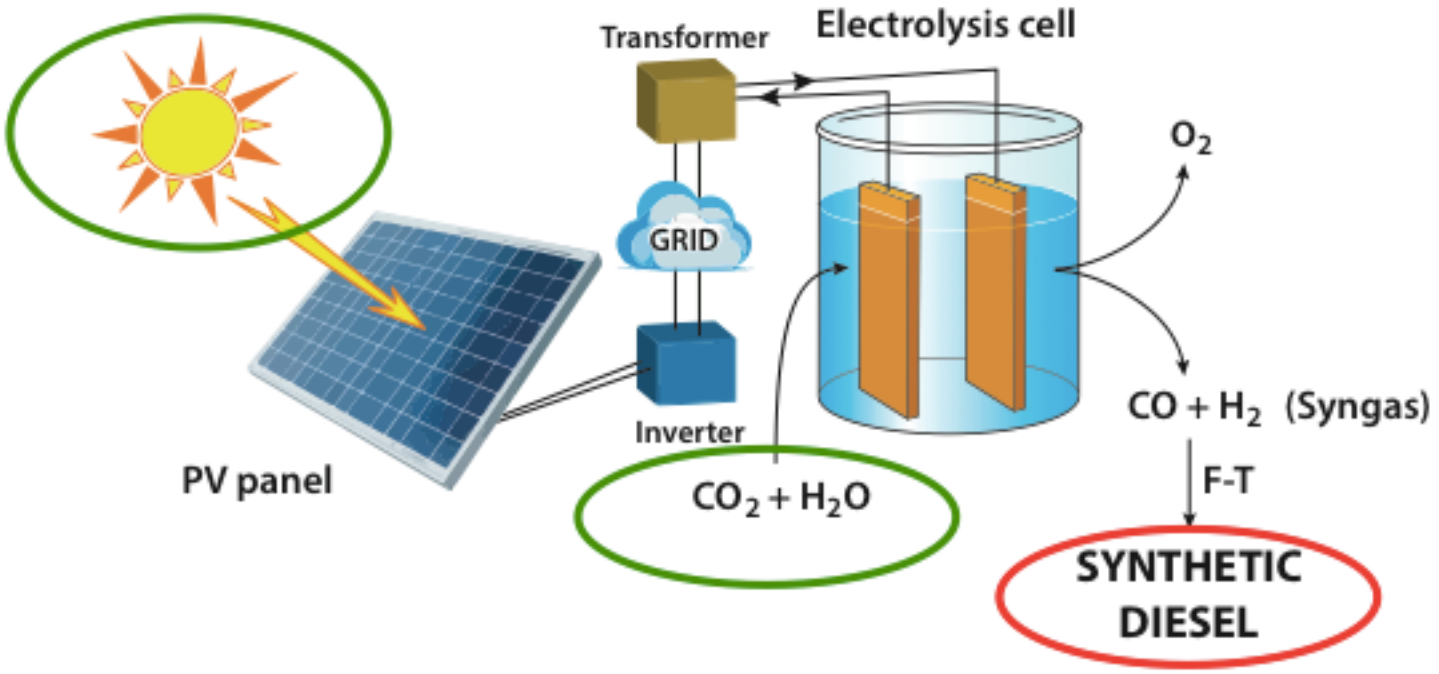


PV power followed by water electrolysis

H_2O + sunlight ⟶ H_2 + 1/2 O_2

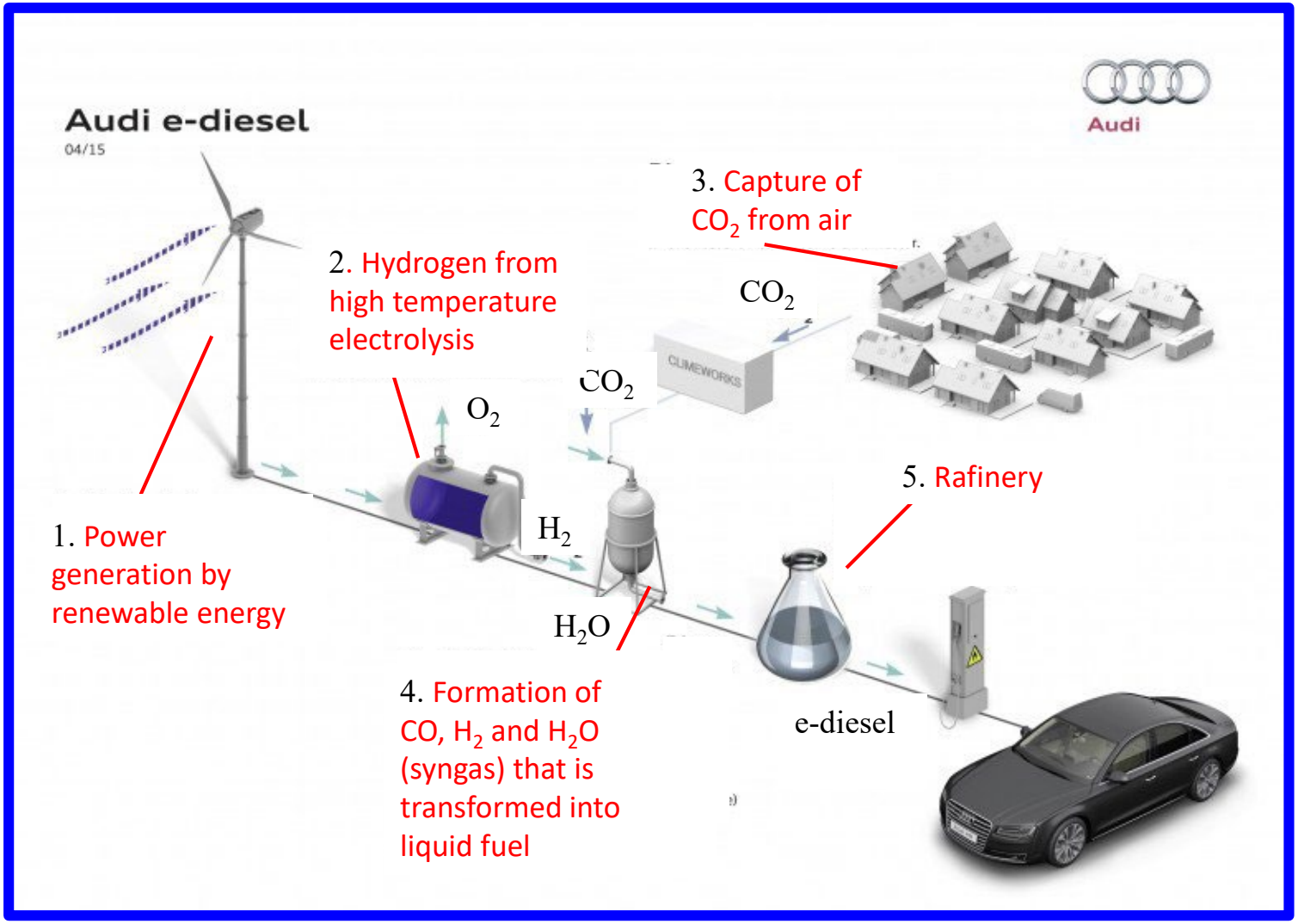


Co-electrolysis of water and carbon dioxide



Synthetic fuels from solar energy, H_2O, and CO_2

THE AUDI BLUE FUEL



- Schema impianto Fotovoltaico -

Energia solare ⟶ elettricità !

Consumo di energia nella storia dell'uomo

risorse

Nel 2018 il mondo ha consumato
ogni secondo:
250 ton di carbone
1000 barili di petrolio
105.000 metri cubi di gas

rifiuti

e ha prodotto
ton
di CO_2 al secondo

Combustibili fossili

C (carbone) + O_2 ⟶ CO_2

CH_4 (metano) + O_2 ⟶ CO_2 + H_2O

C_8H_{18} (benzina) + O_2 ⟶ CO_2 + H_2O

- insostenibilità ecologica e sociale

Consumo di energia

60
50
40
30
20
10
0

legno

carbone
rivoluzione industriale

Egitto Grecia Roma

-3000 -2000 -1000 0 1000 2000

anni

Inizio era cristiana

antropocene

Intergovernmental Panel on Climate Change (IPCC)

Comitato costituito sotto l'egida dell'ONU nel 1988

Il cambiamento climatico è
il problema più preoccupante
per l'umanità

Bisogna smettere di usare i combustibili fossili
entro il 2050

Bisogna trovare altre fonti di energia

Delegati di 195 nazioni

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE


SKOLSTREJK
FÖR
KLIMATET


SCIOPERO della SCUOLA
PER IL
CLIMA

Energie rinnovabili per custodire la casa comune

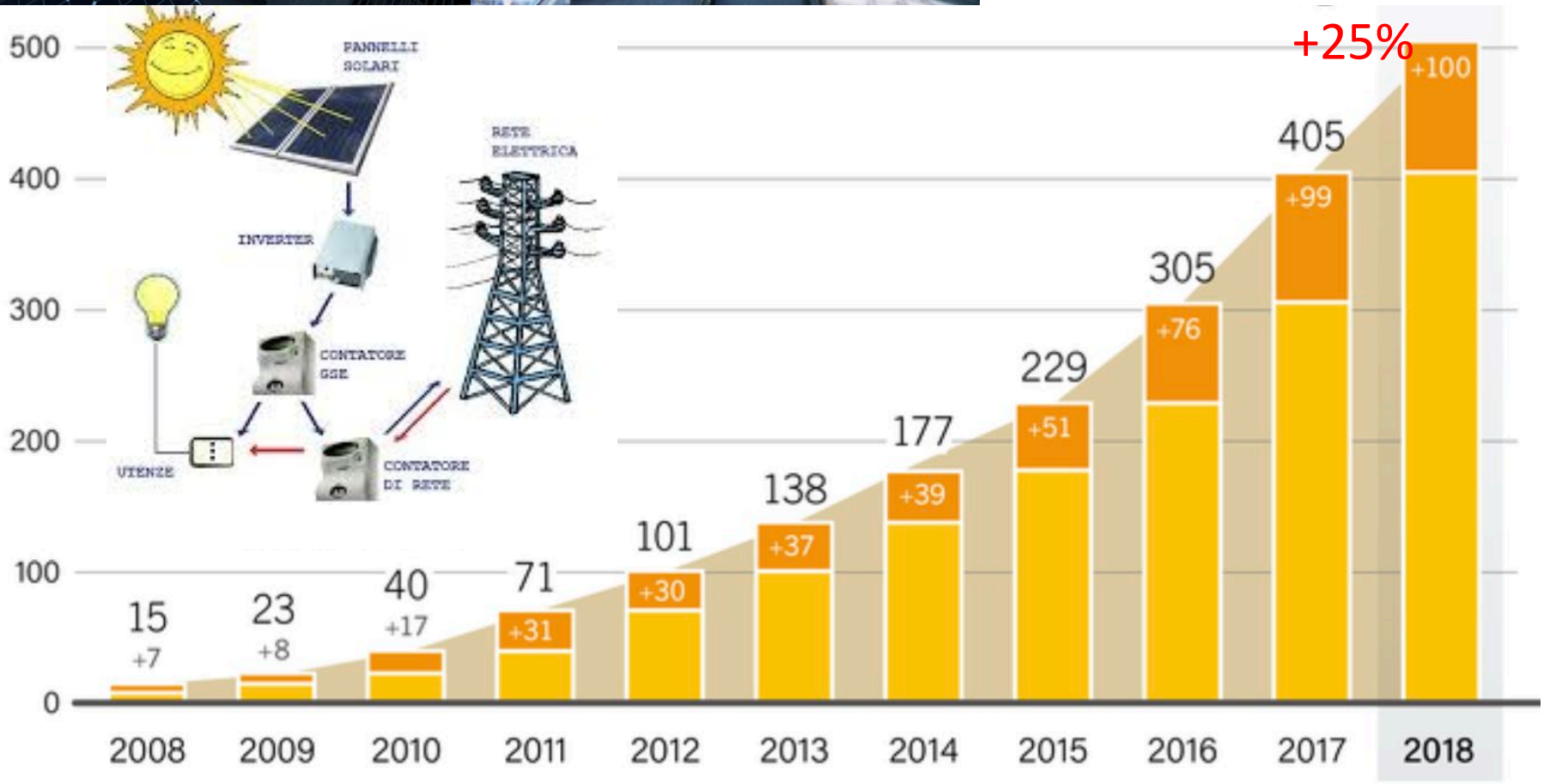
- abbondanti
- inesauribili
- ben distribuite

Sole
Vento
Pioggia

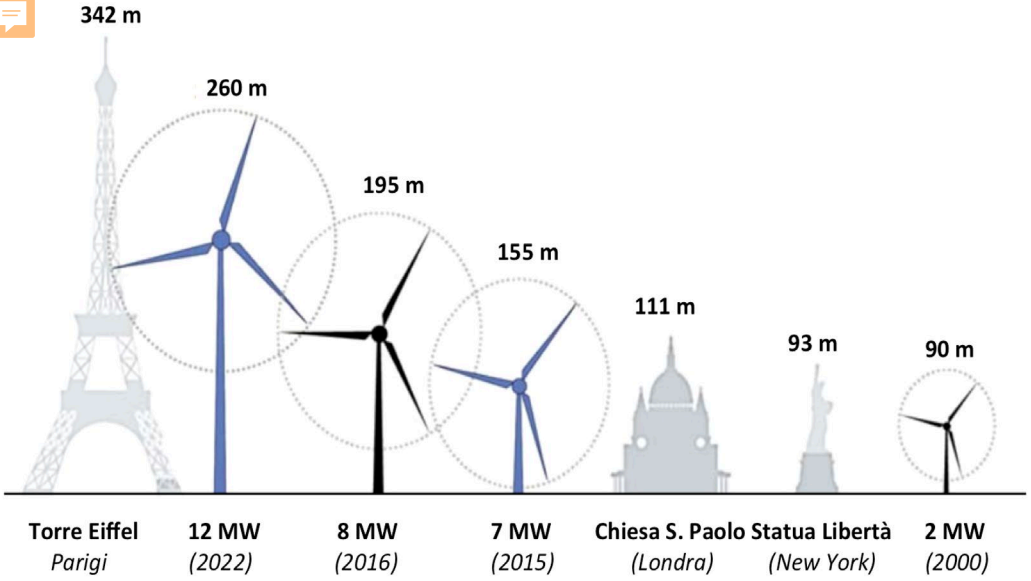
- non pericolose per l'uomo e per il pianeta (né oggi, né in futuro)

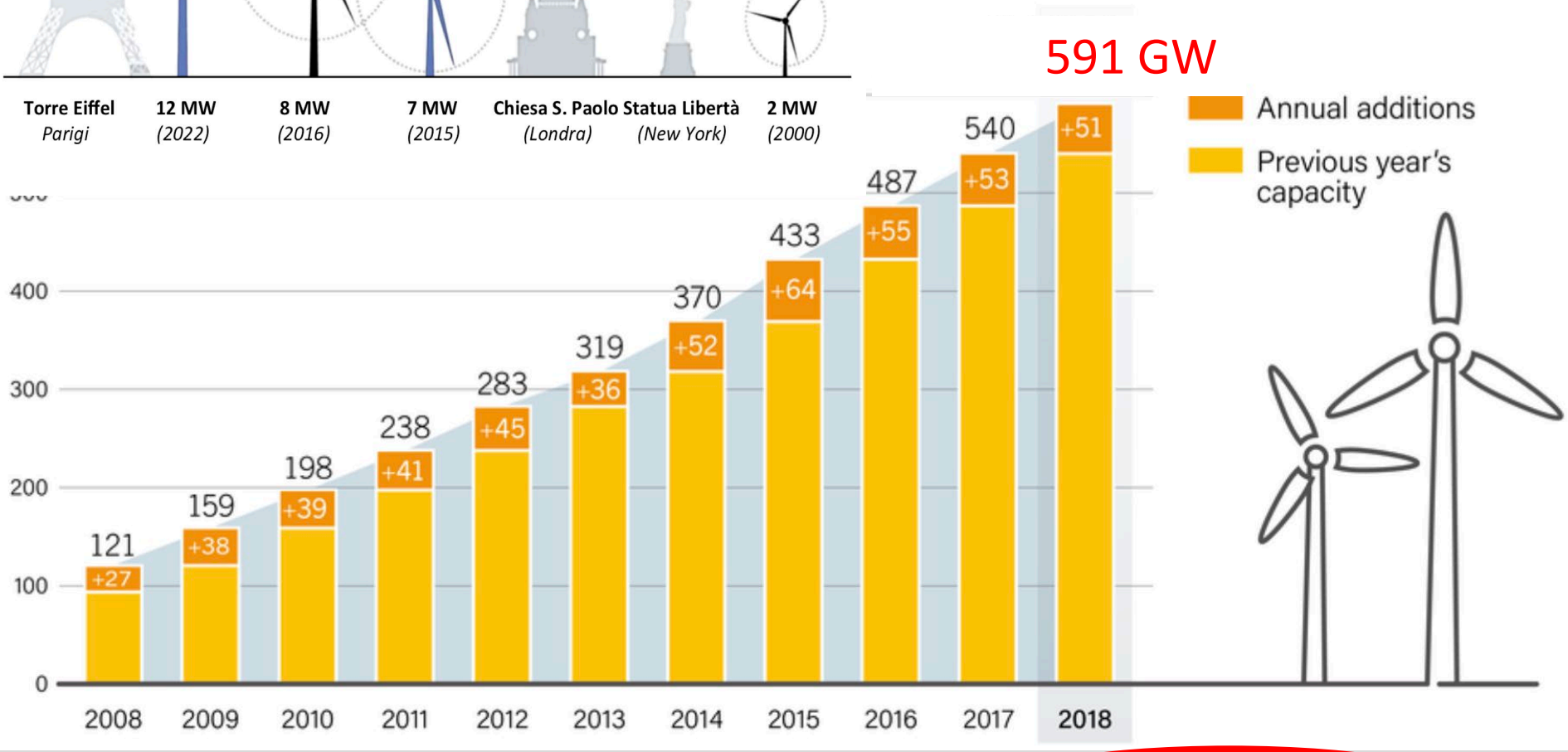
- capaci di:
  - favorire lo sviluppo economico
  - colmare le disuguaglianze
  - favorire la pace

505 GW



Nel 2018 ha generato energia pari a circa 120 reattori nucleari





Nel 2018 ha generato energia pari a circa 240 reattori nucleari

elettricità

elettrolisi

fuel cell

Calore

Idrogeno

combustibili

energie primarie
rinnovabili

molto | abbondanti

sole, vento, acqua

↑

dispositivi, congegni, apparati

(celle FV, pale eoliche, dighe, fuel cells ecc.)

↑

metalli e altri materiali

che si trovano sulla Terra

Abbondanza relativa degli elementi di cui è fatta la Terra

Litio

Ruolo della scienza:

- Sostituire elementi critici con altri abbondanti
- Ridurre le quantità di materiali usati
- Rendere più efficiente il riciclo

La quantità di certi elementi sulla Terra è limitata, per cui bisognerà risparmiare e riciclare

LA LUCE CONTRO LA POVERTÀ

L'Anno Internazionale della luce rappresenta per l'Onu un contributo al raggiungimento sviluppo sostenibile e dello sradicamento della povertà.

Come l'acqua o il cibo, anche la luce è un bene di prima necessità. Un quinto della popolazione mondiale non ha accesso all'illuminazione elettrica e ricorre a lampade a petrolio o a candele. Ma queste primitive fonti di luce causano la morte di 1,5 milioni di persone ogni anno per malattie respiratorie e incendi».

E' di primaria importanza sviluppare tecnologie che portino a nuove forme di illuminazione ecologica e a basso costo.

durata 30 anni

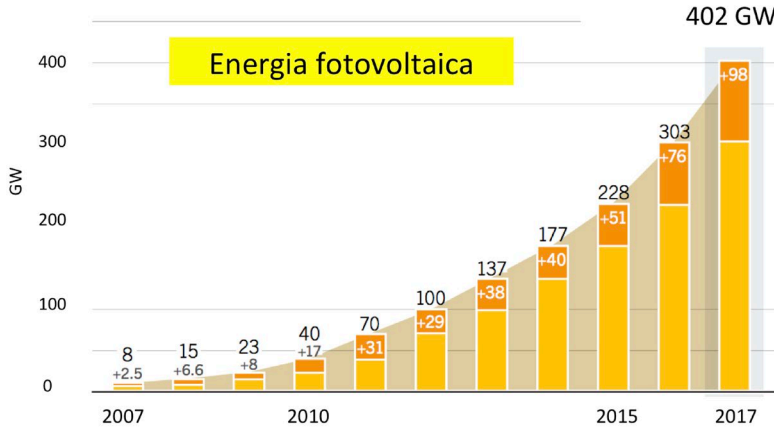
efficienza 20%

- Schema impianto Fotovoltaico -

scalabile

sviluppo: +25% all'anno

costi in diminuzione

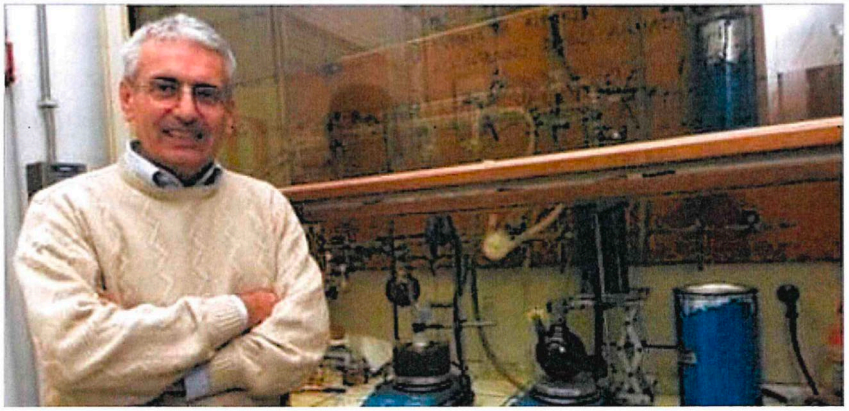


usabile ovunque

Nanomacchine che avrebbero divertito Primo Levi

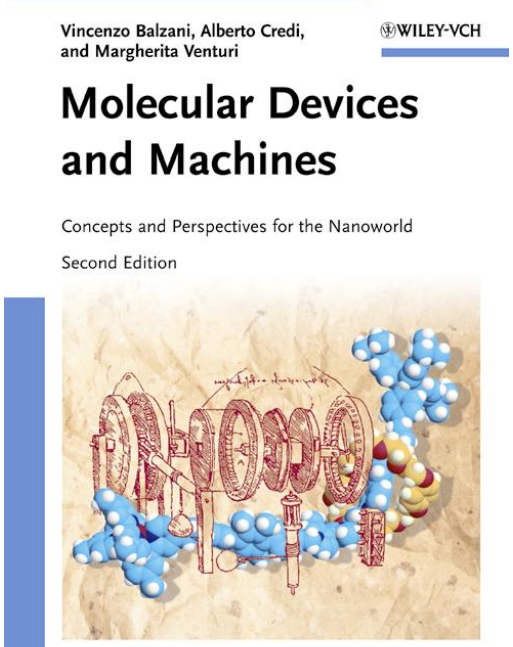
A Vincenzo Balzani il premio delle Società chimiche tedesca e italiana intitolato all'autore del “Sistema periodico”

Balzani, pioniere delle macchine molecolari premiate a Stoccolma

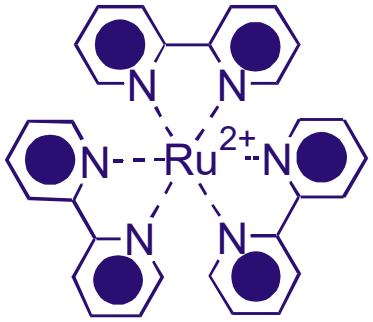


PIERO BIANUCCI

16 Settembre 2019

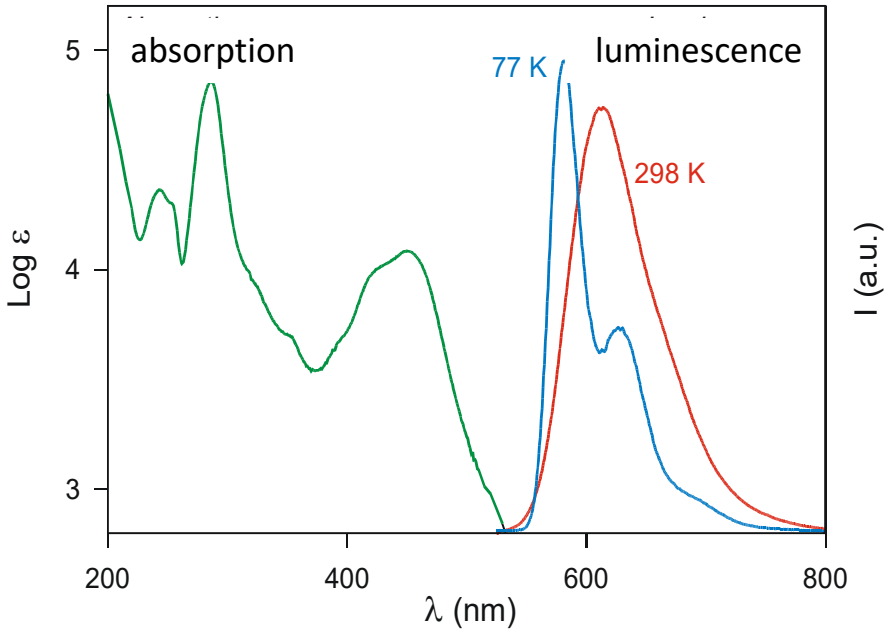


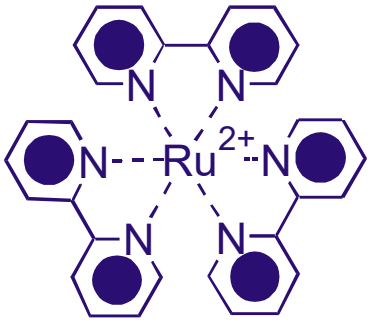
Vincenzo Balzani (foto) ha inventato sorprendenti “macchine molecolari” che funzionano su scala atomica come interruttori, leve, ingranaggi, pinze, minuscole centrali che producono energia. E’ lui il vincitore del “Primo Levi Award” assegnato dalla Società Chimica Tedesca e dalla Società Chimica Italiana, un riconoscimento creato nel 2017 da queste due società scientifiche per segnalare chimici che, oltre ad eccellere nel loro campo, si battono per una scienza al servizio dell’umanità e per quei diritti umani che furono calpestati ad Auschwitz. In linea con questo obiettivo, la motivazione del premio a Vincenzo Balzani richiama “la sua profonda attenzione agli aspetti sociali della scienza e al comportamento etico degli scienziati” e il suo “forte impegno nel promuovere la scienza per un mondo migliore, ridurre la povertà e fermare le guerre”. La consegna avverrà il 6 dicembre all’Accademia dei Lincei di Roma. E’ significativo che la Società di chimica tedesca stia a fianco di quella italiana in questa iniziativa. Primo Levi studiò sul classico manuale di chimica di Ludwig Gatterman, circostanza che gli salvò la vita perché gli rese familiare la lingua tedesca e gli fornì una capacità professionale ricercata nel campo di concentramento di Auschwitz.



$[Ru(bpy)_3]^{2+}$

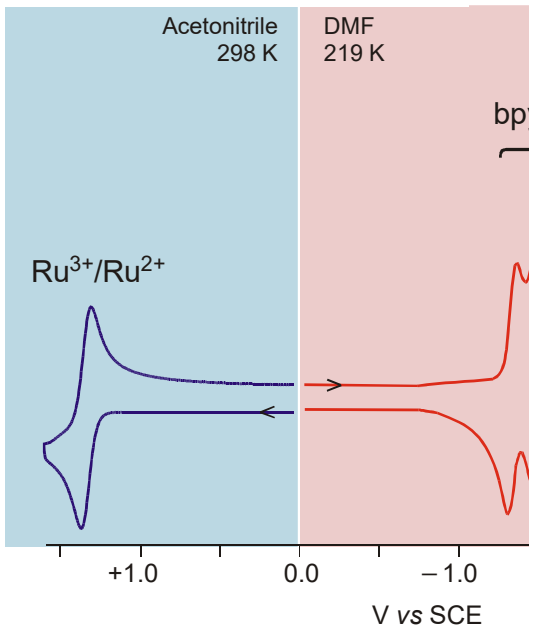
A clever molecule,
ideal for processing light signals

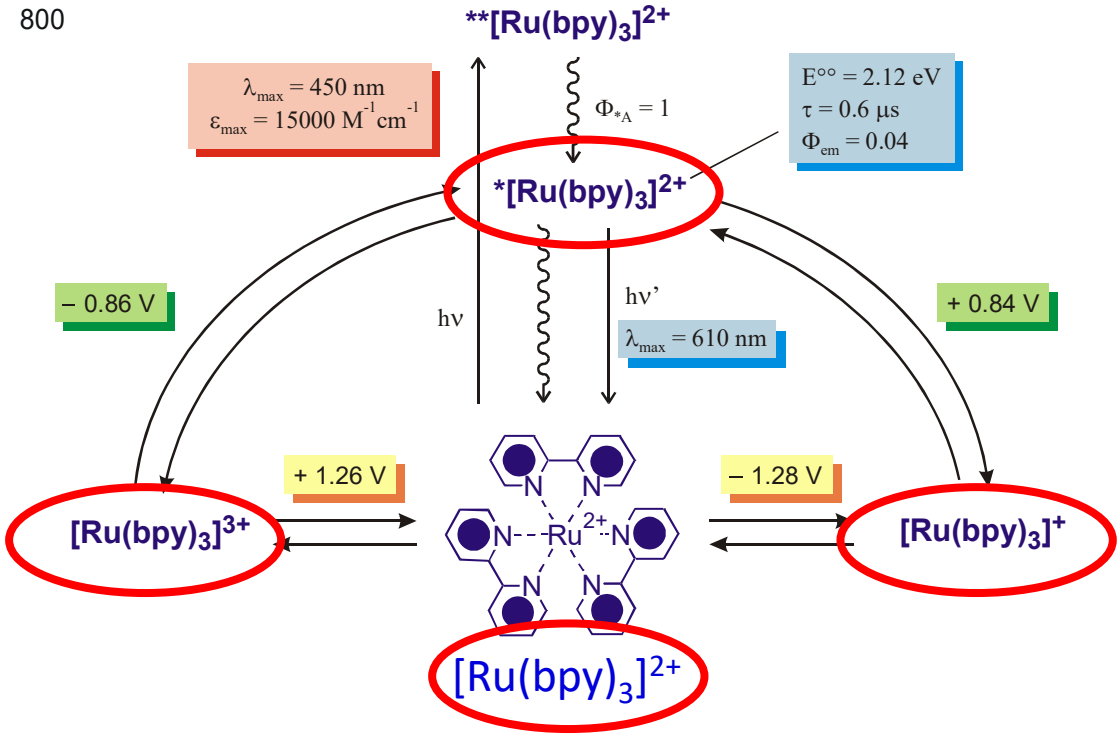




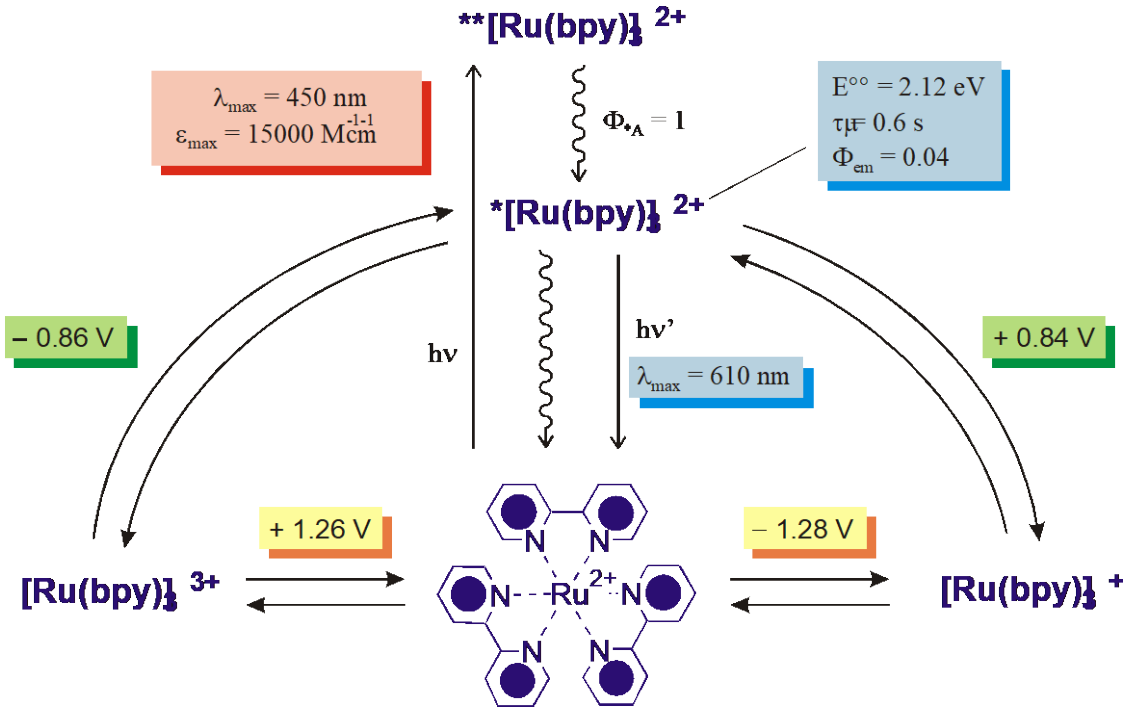
High stability toward ligand dissociation

cyclicvoltammetry





Juris, Barigelletti, Venturi, Campagna, et al.



Electrochemiluminescence

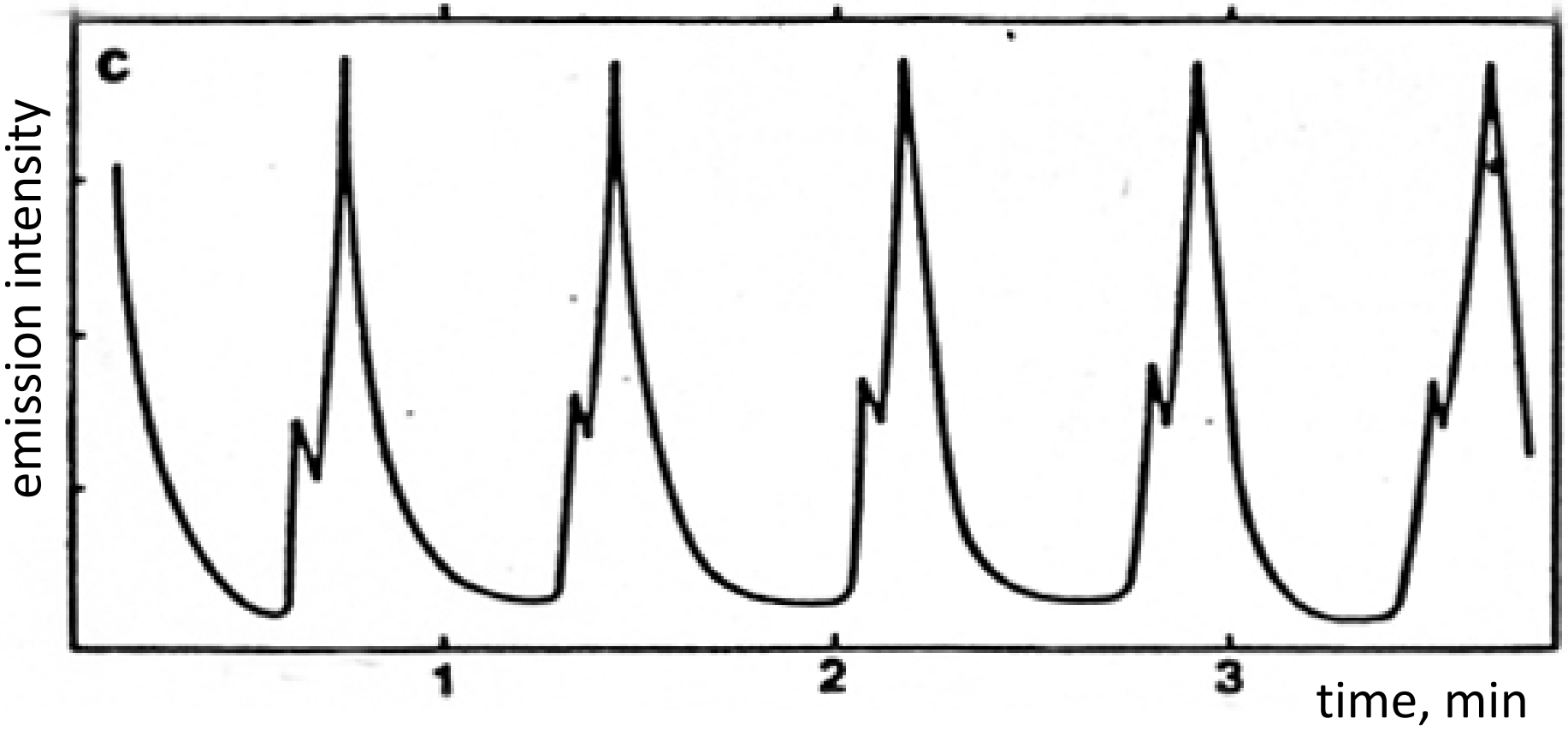
$[Ru(bpy)_3]^{2+} \xrightarrow{-e^-} [Ru(bpy)_3]^{3+}$

$[Ru(bpy)_3]^{3+} + (COOH)_2 \rightarrow {}^*[Ru(bpy)_3]^{2+} + \text{products}$

${}^*[Ru(bpy)_3]^{2+} + \rightarrow [Ru(bpy)_3]^{2+} + h\nu$

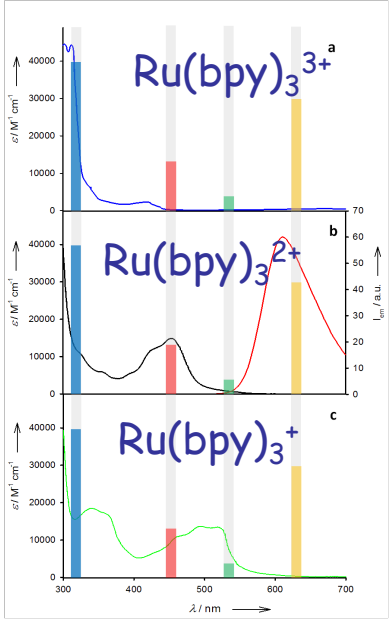
Maestri, Ciano, et al.

$[Ru(bpy)_3]^{2+}$: an artificial molecular firefly



Oscillating chemiluminescence obtained from the Belusov-Zhabotinskii reaction catalyzed by $Ru(bpy)_3^{2+}$

Balzani, et al. JACS



**[Ru(bpy)3]2+

λmax = 450 nm
εmax = 15000 M-1cm-1

Φ*A = 1

E°° = 2.12 eV
τ = 0.6 µs
Φem = 0.04

*[Ru(bpy)3]2+

hν

hν'

λmax = 610 nm

− 0.86 V

+ 0.84 V

+ 1.26 V

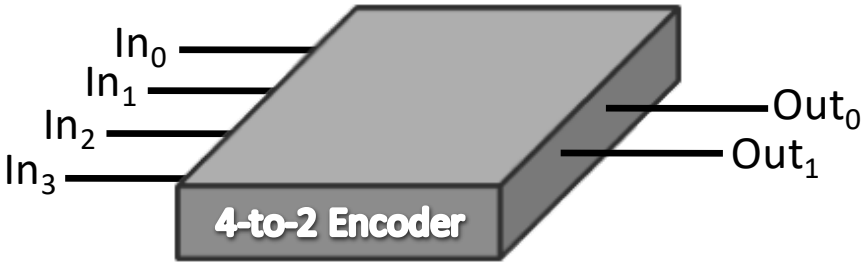
− 1.28 V

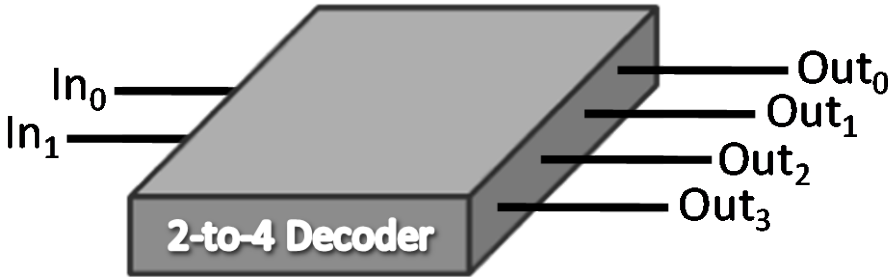
[Ru(bpy)3]3+

[Ru(bpy)3]+

[Ru(bpy)3]2+

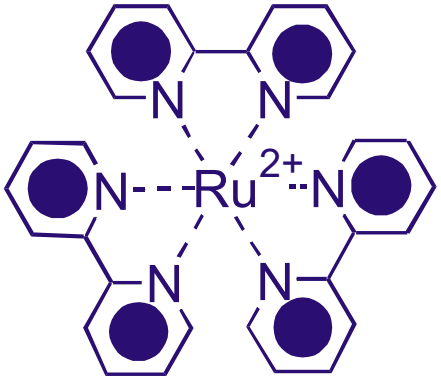
Juris, Barigelletti, Campagna, von Zelewsky, et al.,





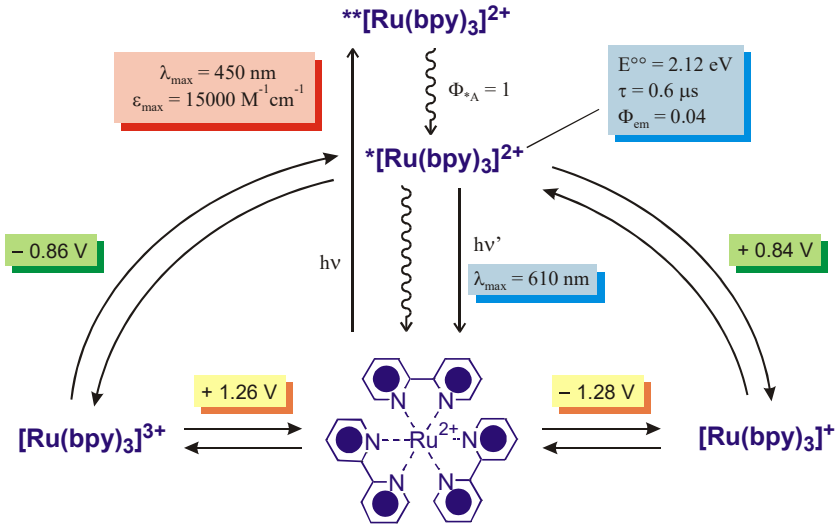
A 4-to-2 encoder
compresses 4 input bits
into two output bits

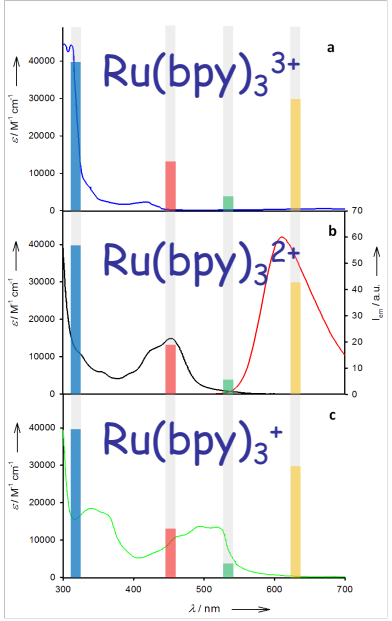
2-to-4 decoder
converts two coded inputs
into four readable outputs



$[Ru(bpy)_3]^{2+}$

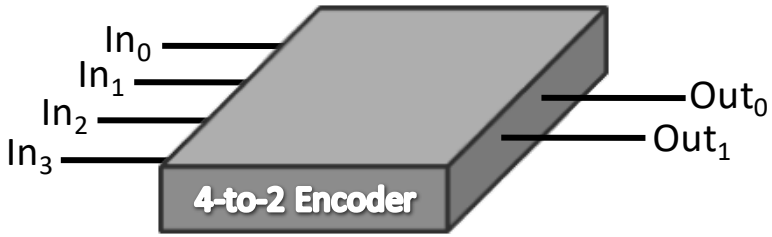
Ceroni, Bergamini, et al.





In_0	In_1	In_2	In_3	Out_0	Out_1
+1.4 eV	λ_{ex} = 450nm	-1.4 eV	+1.4/-1.4 eV	A 530nm	Em 620nm
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

encoder



Ceroni, Bergamini, et al.

Macroscopic Materials

↓ "top down" approach

MICROSTRUCTURES (μm)

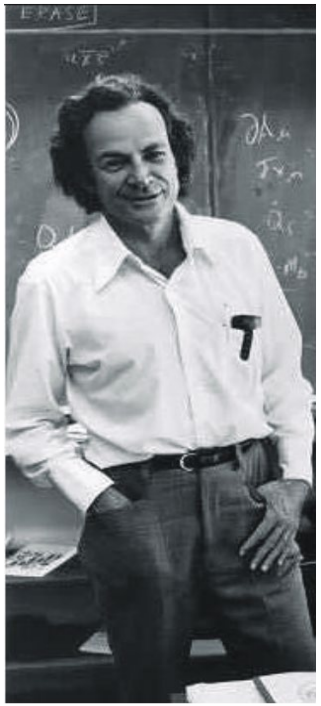
↓ much more difficult

NANOSTRUCTURES (1-100 nm)

new technologies for information, medicine, materials, etc.

↑ "bottom up" approach

Molecules



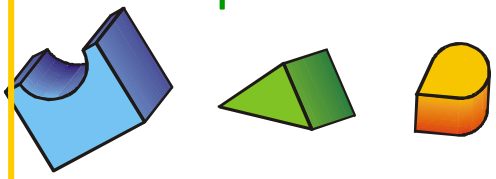
Richard Feynman

There is plenty of room at the bottom

Supramolecular chemistry

design + synthesis

molecular components

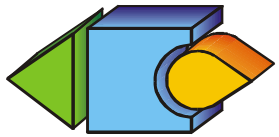


self-assembly,

or

design + synthesis

Supramolecular systems

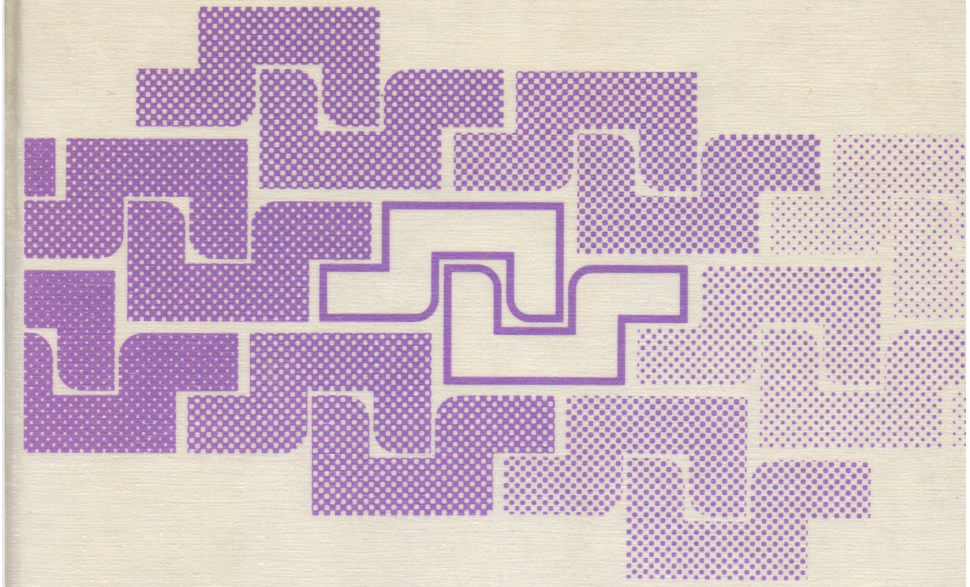


properties (chemical, photochemical, redox, …)

specific functions

"…..I've always been a rigger chemist, one of those who build structures …. They give me a model … and with a bit of experience, it is easy to tell right away the structures that can work from those that are possible only on paper.
It is reasonable to proceed a bit at a time, first attaching two pieces, then adding a third, and so on ….".

Primo Levi, The Monkey's Wrench



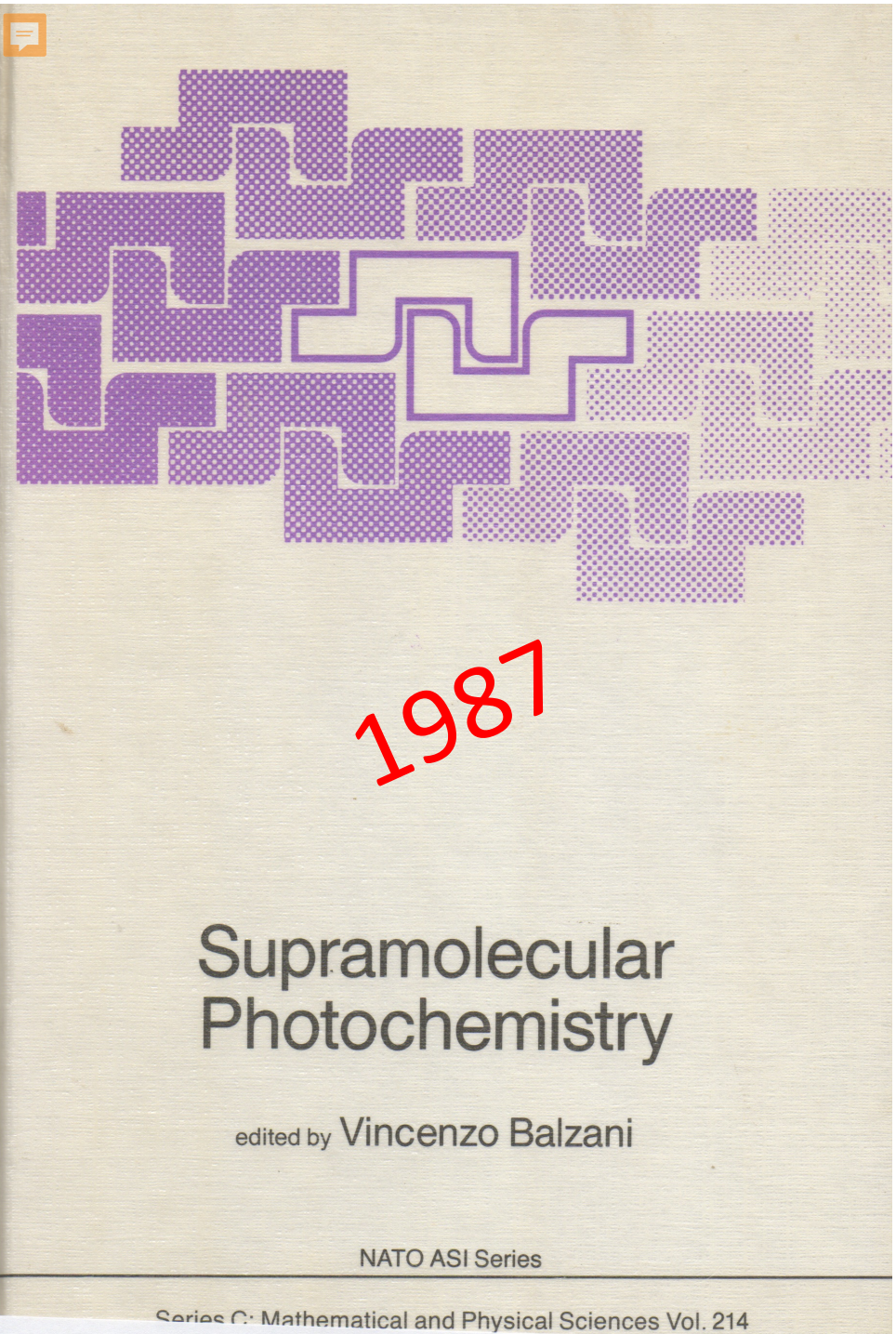
1987

Supramolecular Photochemistry

edited by Vincenzo Balzani

NATO ASI Series

Series C: Mathematical and Physical Sciences Vol. 214



From the

Preface of the book of Proceedings

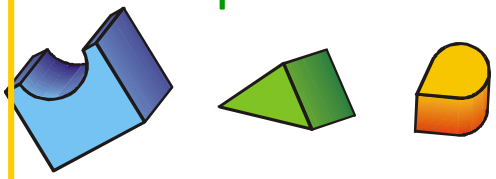
.....

The unpleasant condition of a world divided into two political blocks and the role of science and scientists in such a difficult situation were also discussed. Beyond the personal (often quite different) views, there was a strong, general desire for friendship and peace.

Nanotechnology

design + synthesis

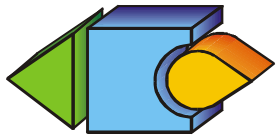
molecular components



self-assembly,

or

design + synthesis



Supramolecular systems

properties (chemical, photochemical, redox, …)

specific functions

molecular devices and machines

Nanotechnology

The marriage

of

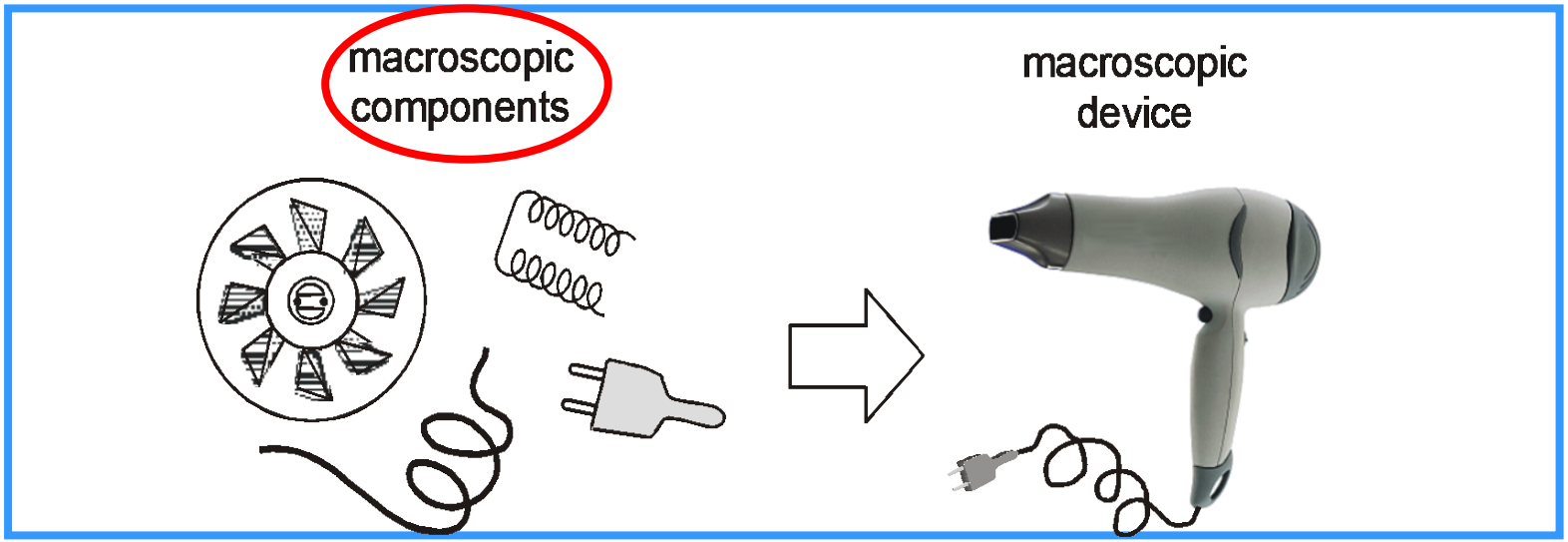
the synthetic talent of Chemists

with

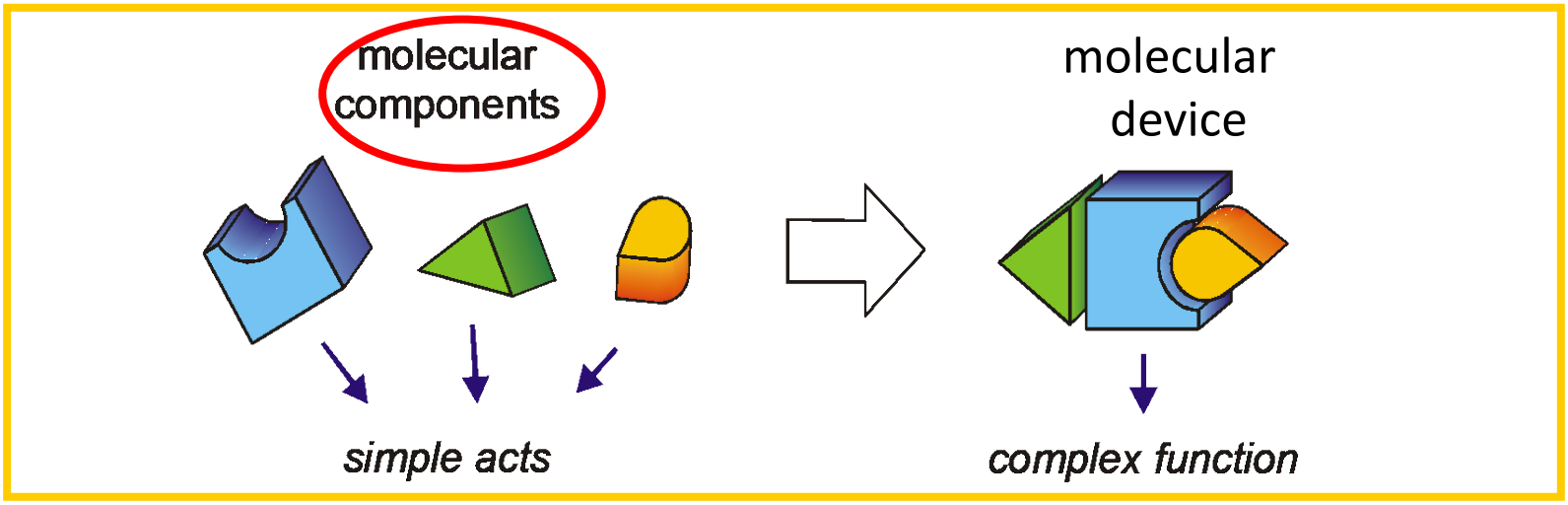
a “device driven” ingenuity

Roald Hoffman

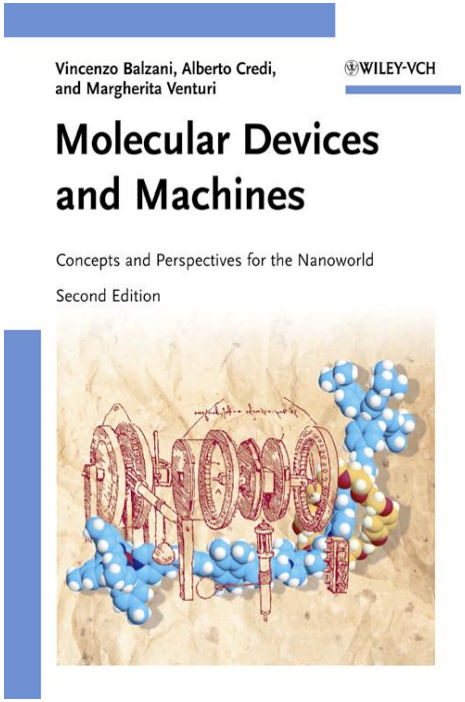
Macroscopic devices and machines (engineers)

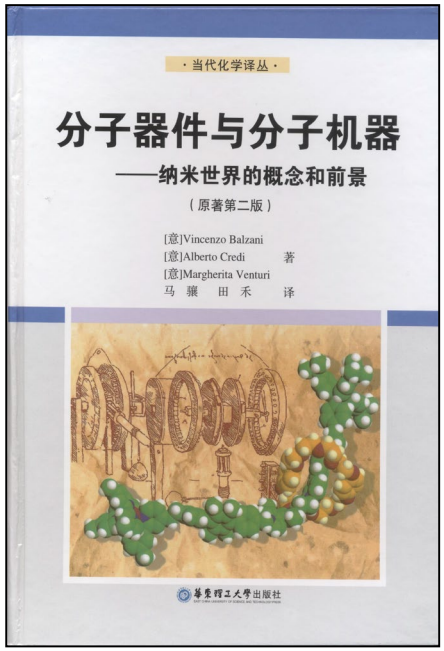


Molecular devices and machines (chemists)




The Nobel Prize in Chemistry 2016
KUNGL. VETENSKAPS AKADEMIEN
Photo: Caroline Schroder, © Institut de Science et d'Ingénierie Supramoléculaires
Photo: © 2016 Evanston Photographic Studios /Genie Lemieux
Photo: Stanjie De Olde, © University of Groningen
Jean-Pierre Sauvage
University of Strasbourg and the National Center for Scientific Research (CNRS), France
Sir Fraser Stoddart
Northwestern University, Evanston, IL, USA
Bernard L. Feringa
University of Groningen, the Netherlands
"for the design and synthesis of molecular machines"
8 December 2016
© Kungl. Vetenskapsakademien





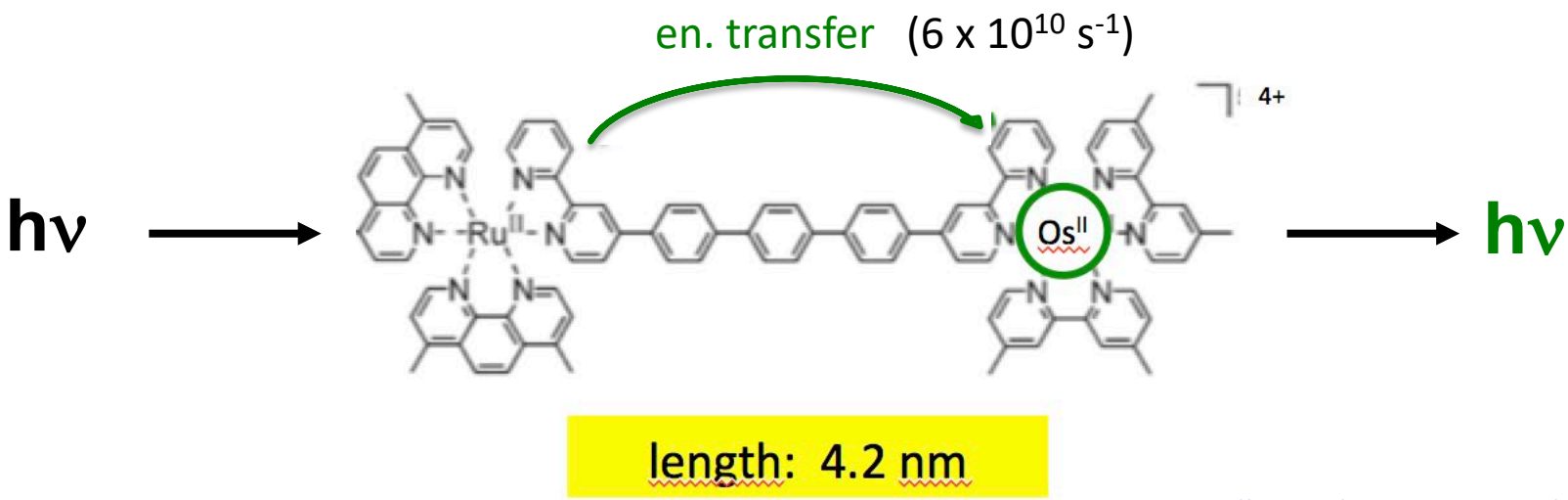
Devices for
signal processing

wires, switches, logic gates, decoder, encoder, memory elements, ……

System capable of
mechanical movements (machines)

Tweezers, doors, boxes, ion channels, lifts, linear motors, rotary motors, ...

Photonic molecular wire

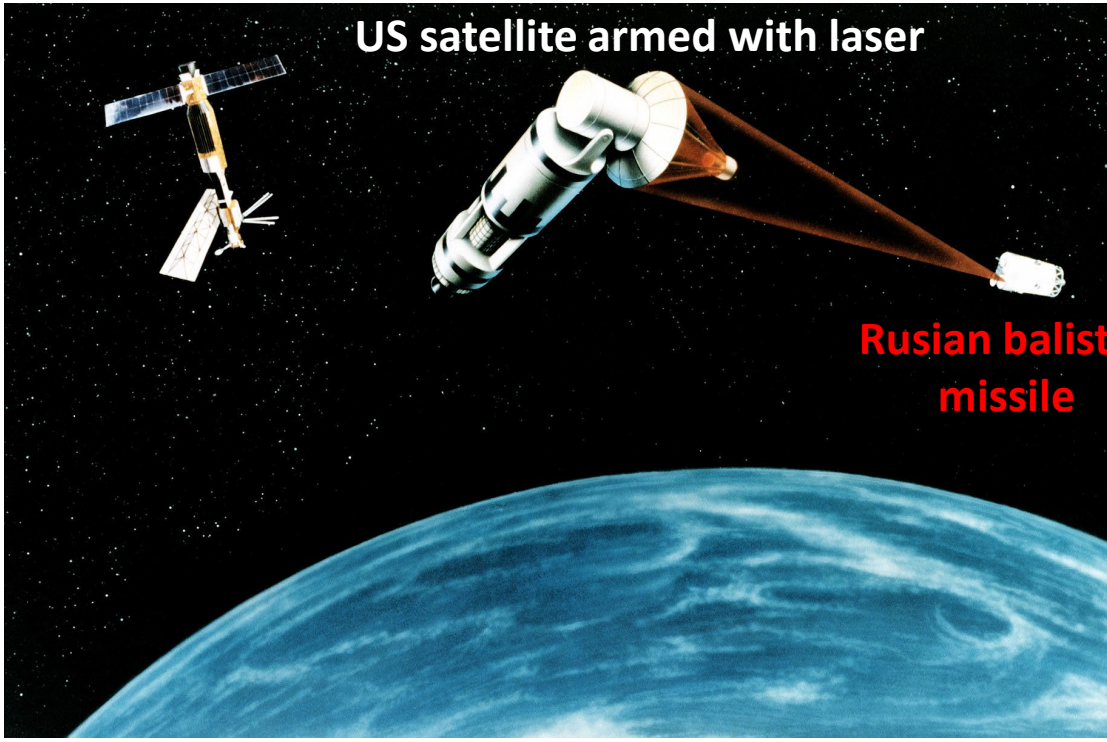


length: 4.2 nm

Barigelletti, Flamigni, De Cola, Sauvage, et al.

Ronald Reagan

Strategic Defense Initiative, 1988



Space shield

a missile defense system based on laser weapons

- 5 MAG. 1988

Roma, ...

0100 ROMA - P.le ALDO MORO, 7 (già p.le delle scienze)
TELEGRAFO: CORICERCHE - ROMA
TELEX: 610076 CNR RM I
TELEFONO: (06) 49931

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Allegati .....

OGGETTO Nota dell'Ambasciata degli Stati Uniti d'America in data 14.3.88

.....

C.N.R.
IST. FO... ...RADIAZIONI
16 MAG 1988
RICEVUTO

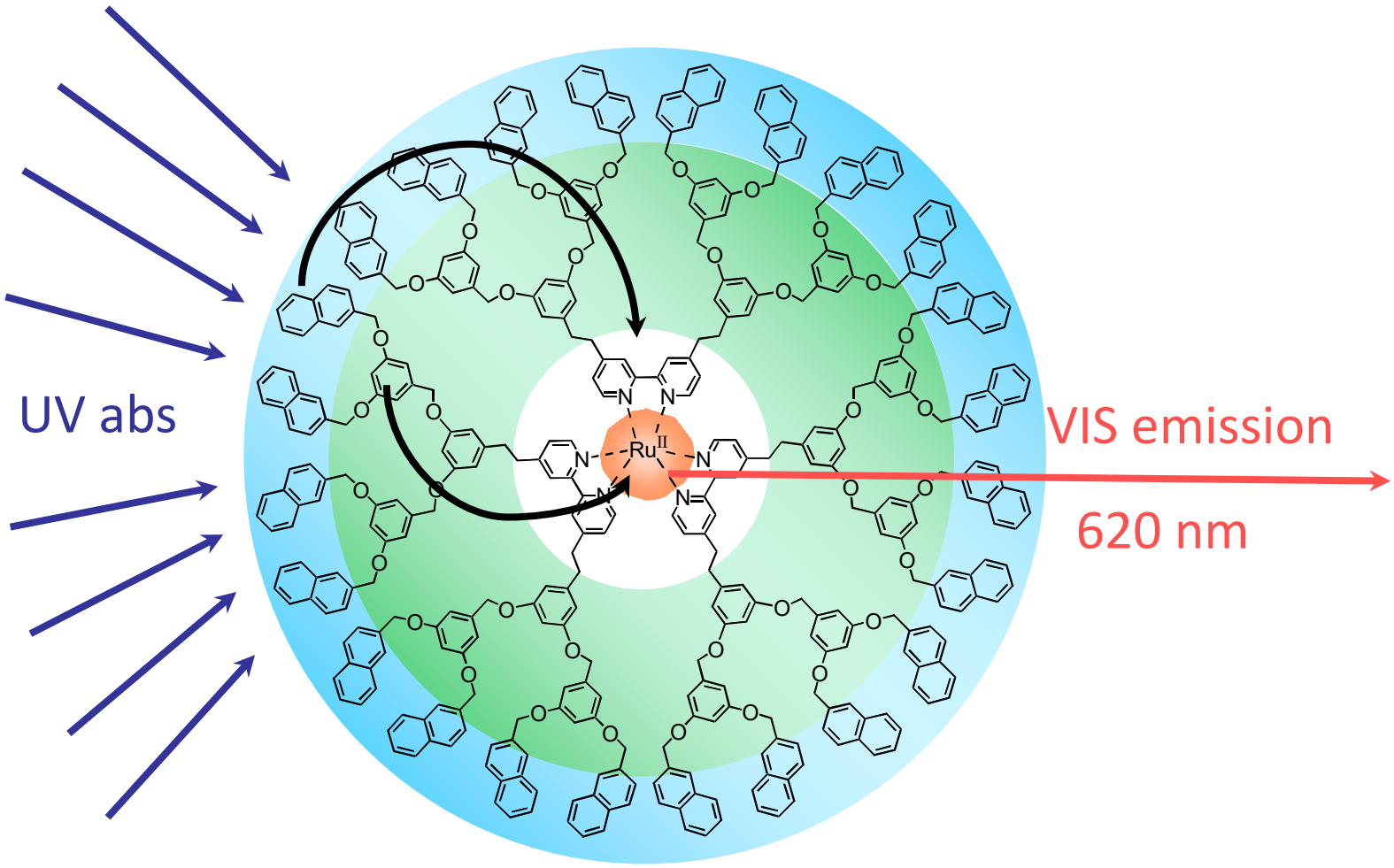
Al

Dott. Roberto DANIELI
Direttore dell'Istituto
di Spettroscopia Molecolare
del CNR
40126 - BOLOGNA

Prof. Vincenzo BALZANI
Direttore dell'Istituto
di Fotochimica e Radiazioni
di Alta Energia del CNR
40126 - BOLOGNA

Dott. Giuseppe BENTINI
Direttore dell'Istituto
di Chimica e Tecnologia dei
Materiali e dei Componenti
per l'Elettronica del CNR
40126 - BOLOGNA

Antennas for light harvesting



A dendrimer made of 43 molecular units; diameter 5 nm

Balzani, Vogtle, De Cola, et al.

UNIVERSITÁ DEGLI STUDI DI BOLOGNA
DIPARTIMENTO DI CHIMICA
"GIACOMO CIAMICIAN"
VIA SELMI, 2 - 40126 BOLOGNA (ITALY)

VINCENZO BALZANI
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Gruppo di
FOTOCHIMICA

November 29, 1994

Department of the Army
Chemical and Biological Division
P.O. Box 12211
Triangle Park, N.C. 27709-2211
USA

Dear Dr. Kieserof,

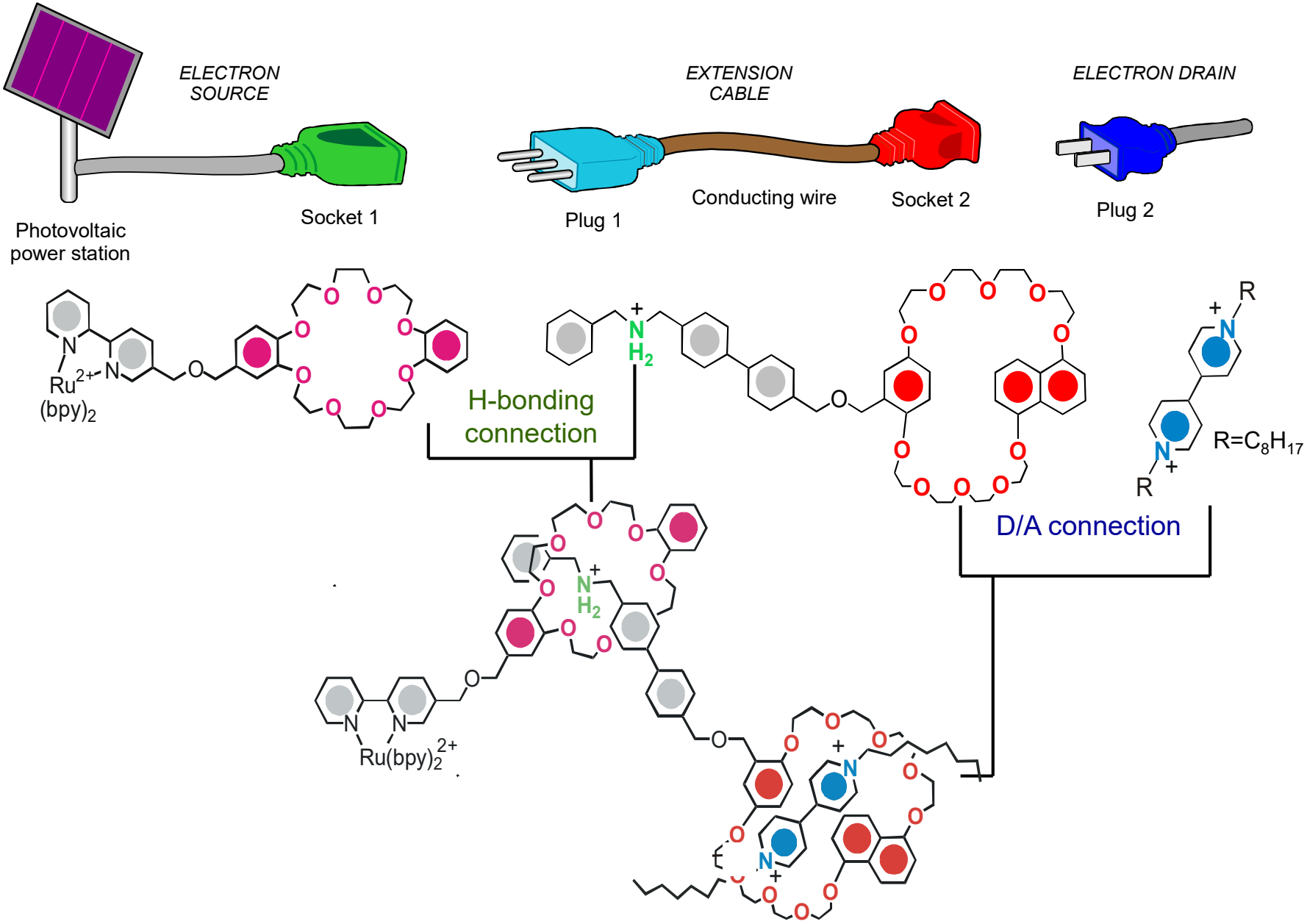
With reference to your fax of November 21, I would like to inform you that I am not interested to attend the workshop "**Dendrimer technology and its potential military applications to the US Army**"

I think, in fact, that dendrimer technology, as well as any other technology, should be developed for civil and peaceful applications and not for military purposes.

Best regards,

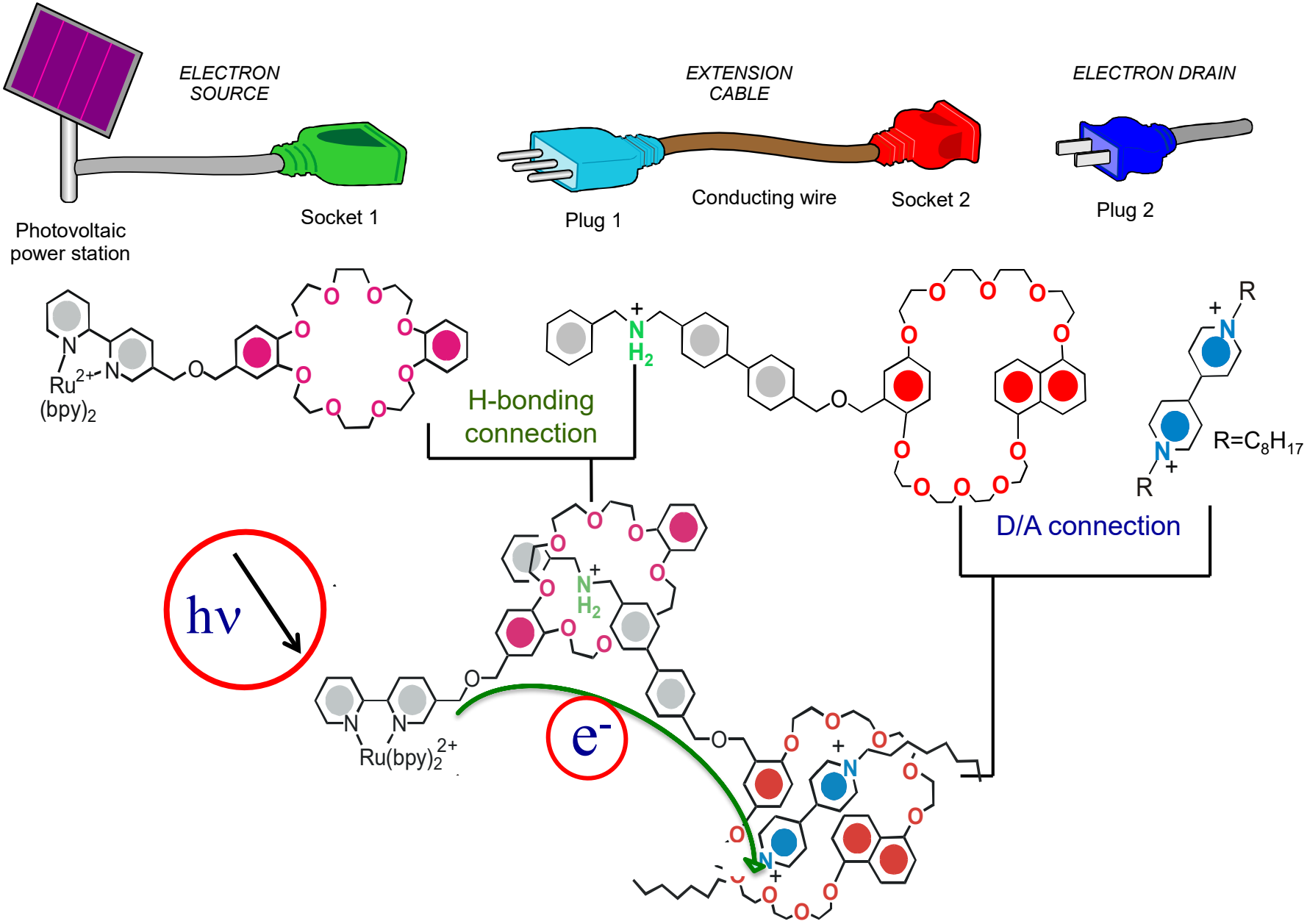
Vincenzo Balzani

Molecular extension cable



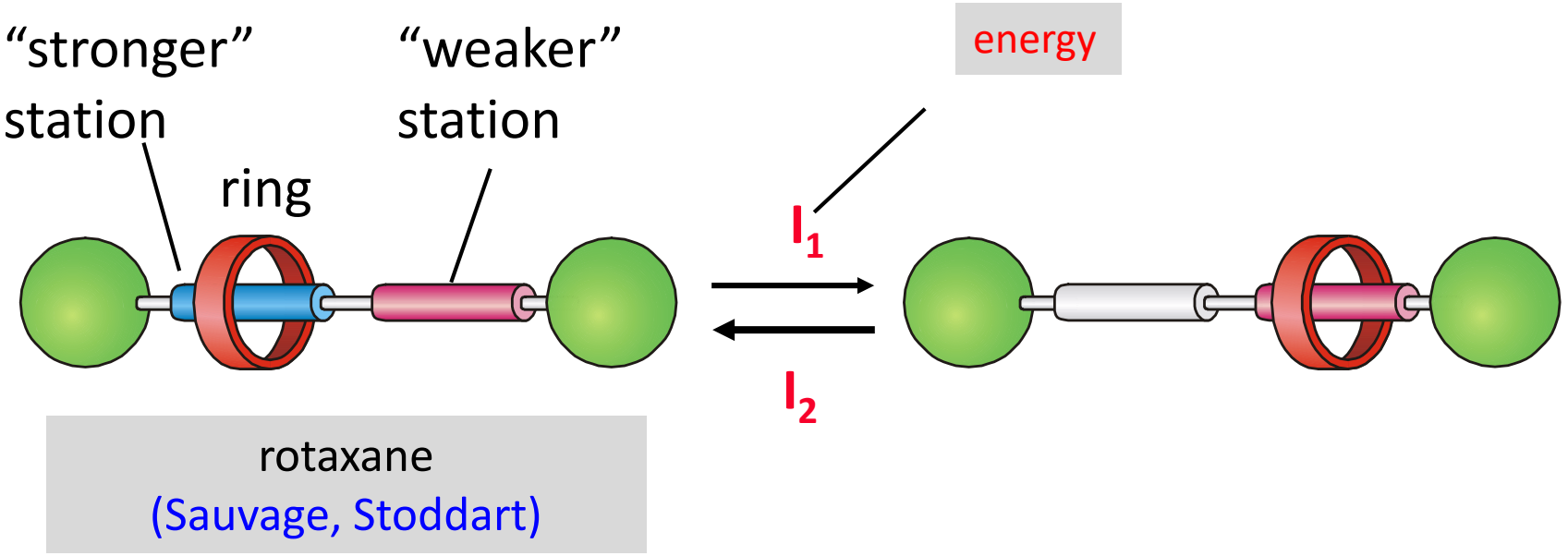
Ballardini, Credi, Gandolfi, Stoddart, et al.

Molecular extension cable

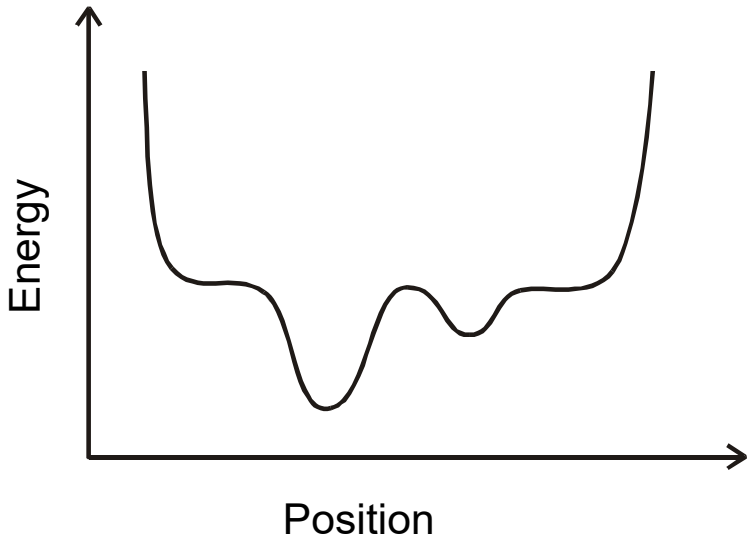


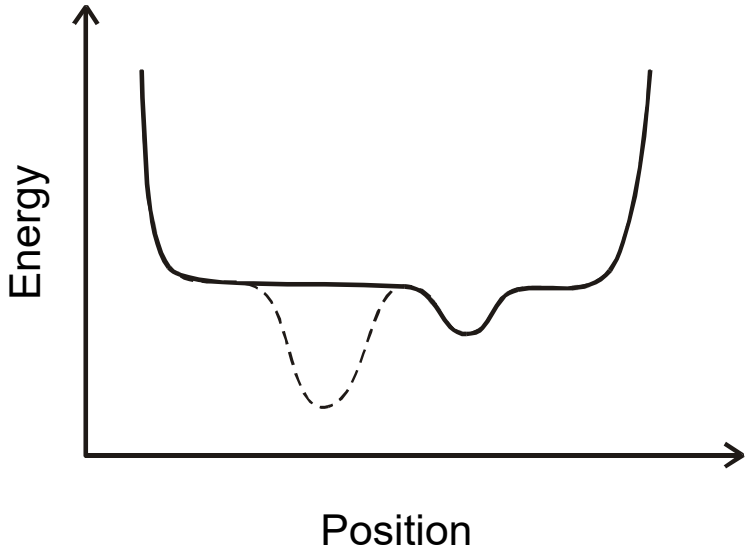
Ballardini, Credi, Gandolfi, Stoddart, et al.

Photoinduced motions in rotaxanes

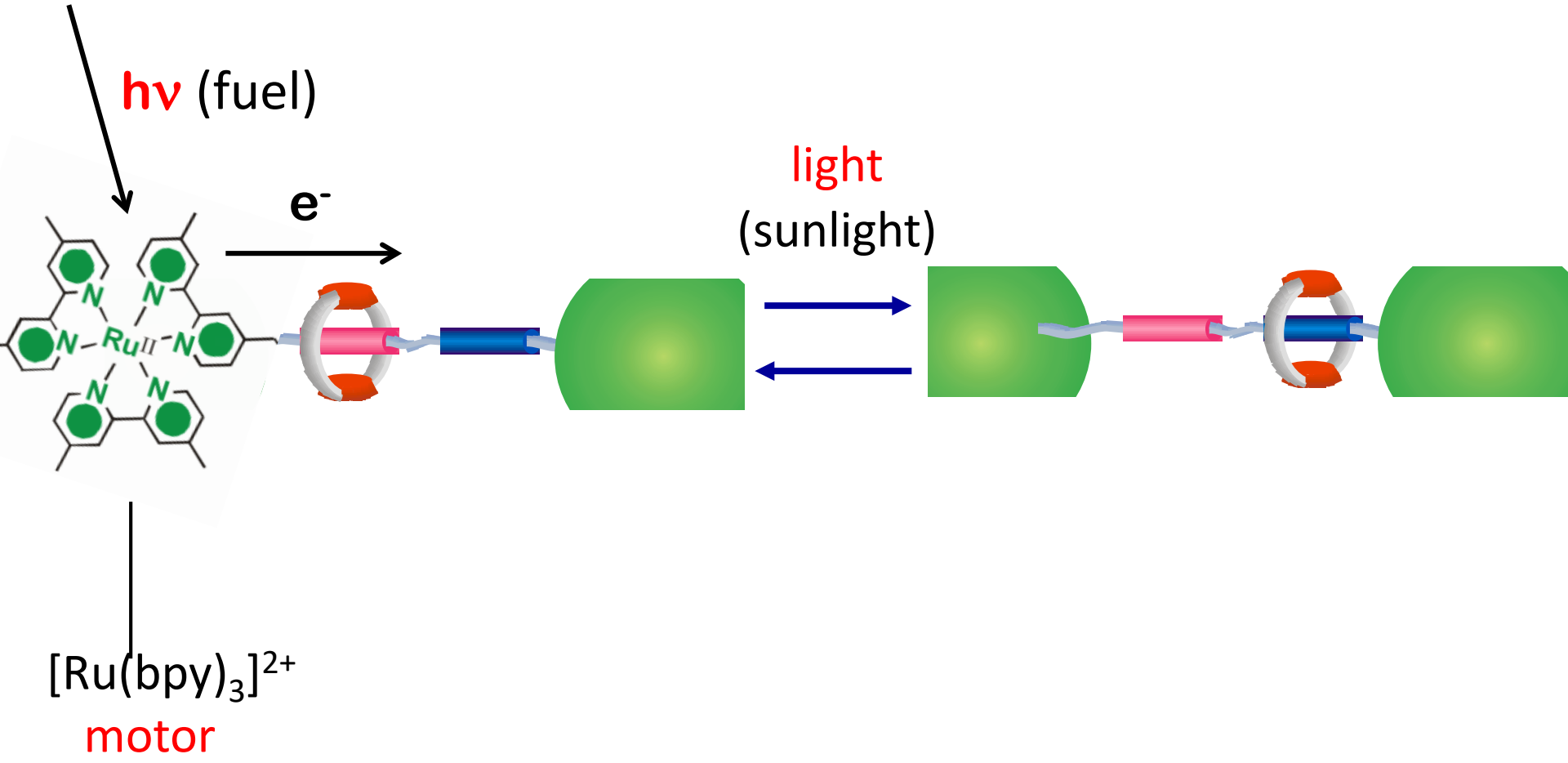


rotaxane
(Sauvage, Stoddart)



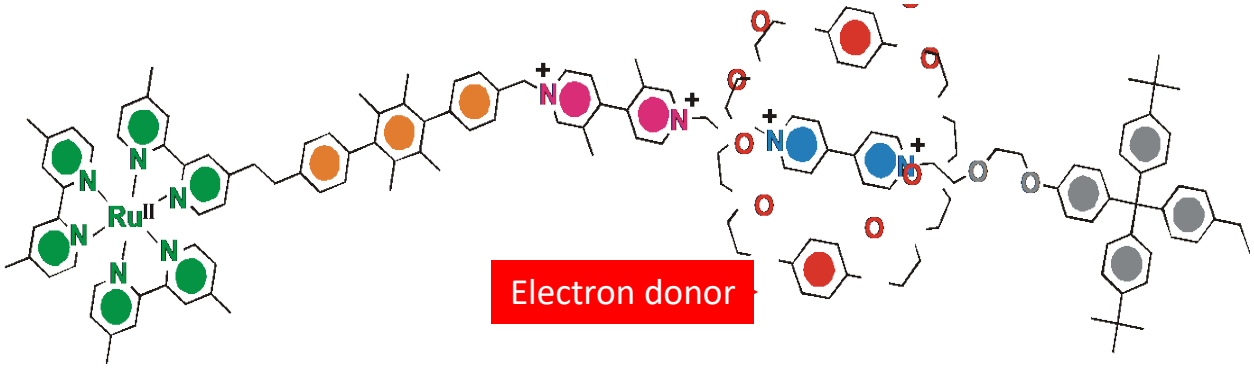


A light powered molecular motor

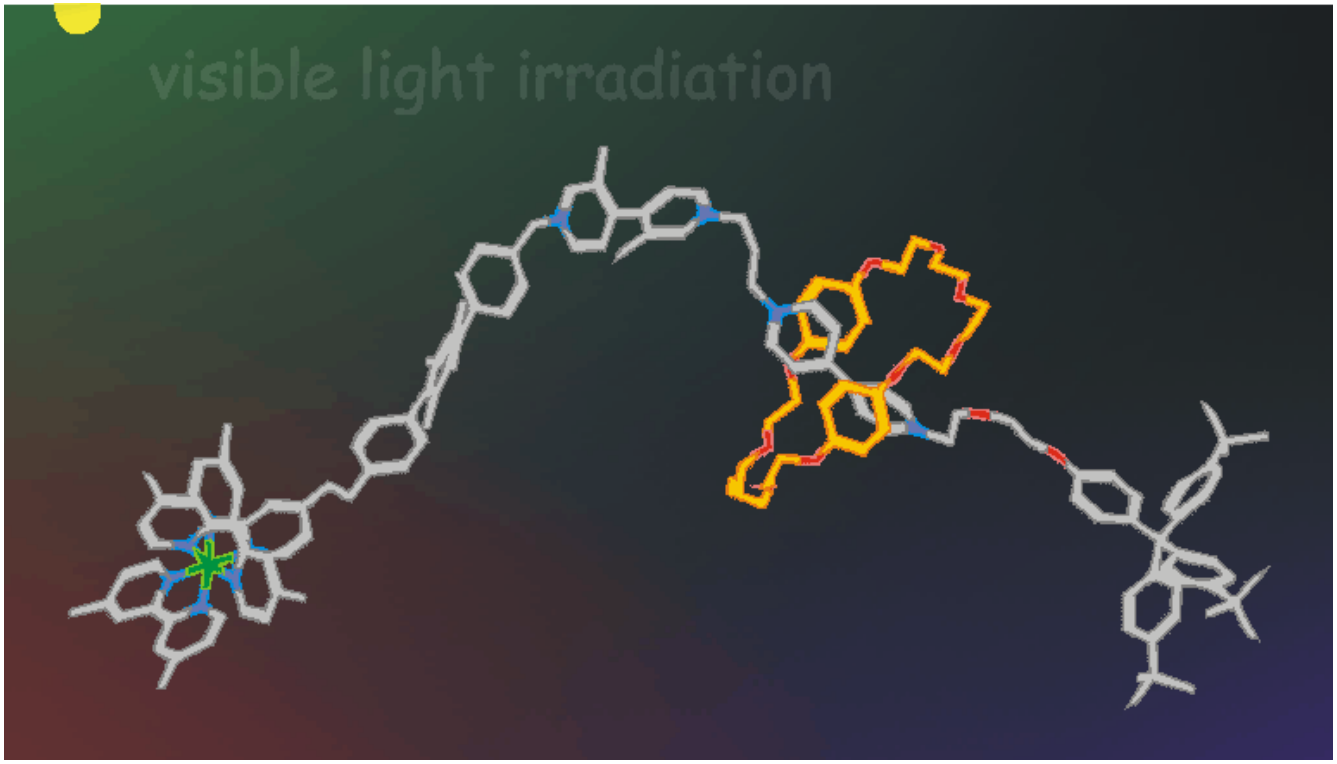


$[Ru(bpy)_3]^{2+}$
motor

photosensitizer and stopper | Rigid spacer | electron accettor A_2 | electron accettore A_1 | stopper

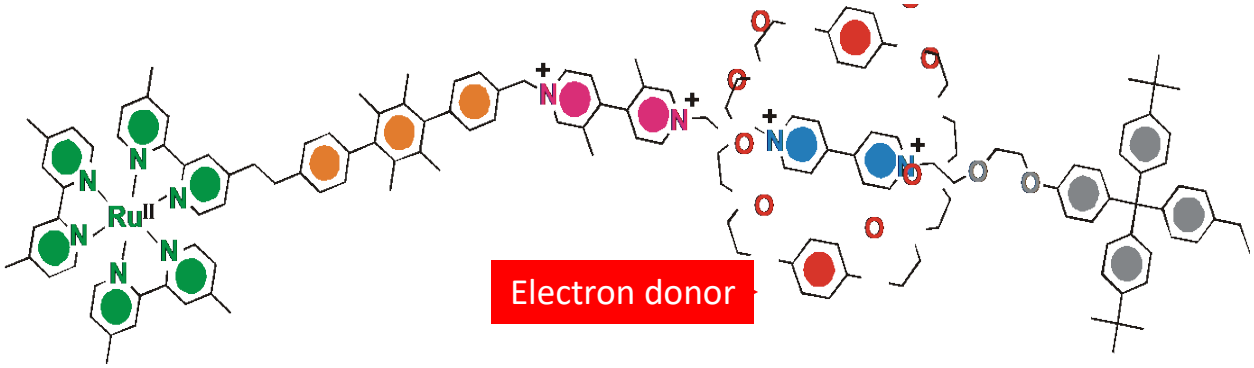


length: 6 nm

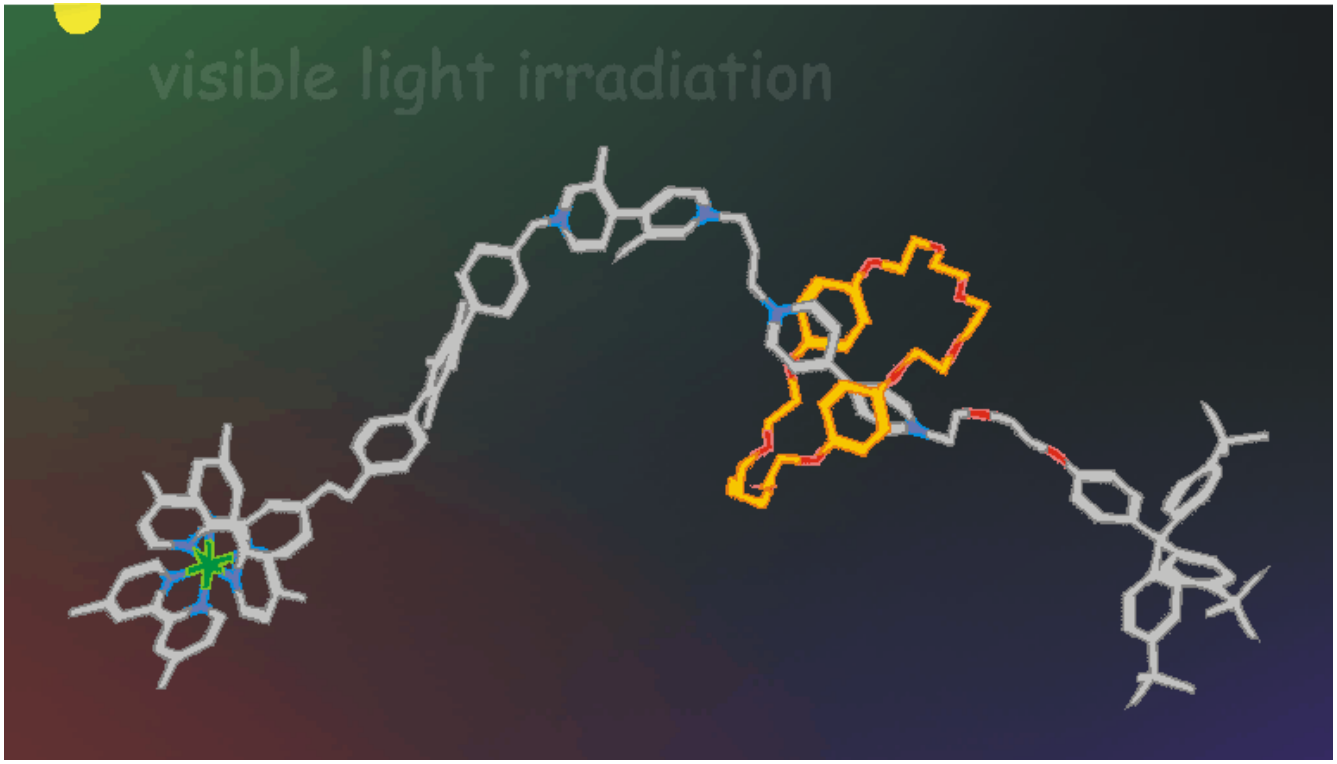


Credi, Ballardini, Venturi, Stoddart et al.

photosensitizer and stopper | Rigid spacer | electron accettor A_2 | electron accettore A_1 | stopper



length: 6 nm



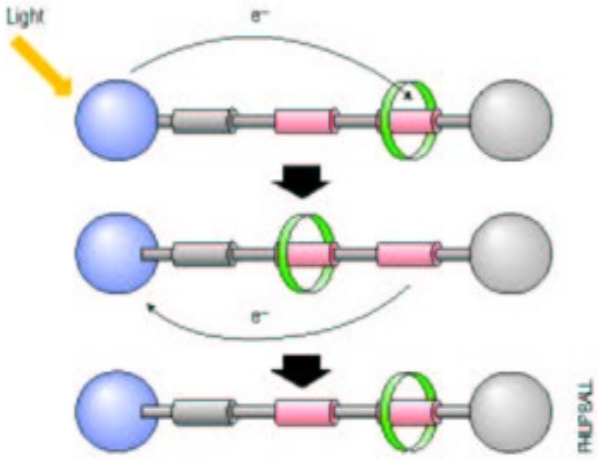
Conversion of sunlight into mechanical movement

An artificial molecular motor powered by sunlight

Credi, Ballardini, Venturi, Stoddart et al.

Nature Materials

In contrast to motors in nature, artificial ones generally require one input to cause motion, followed by another to reset the motor. Often these inputs are chemical fuels, and therefore generate waste products, as well as requiring intervention at each stage. Now Balzani *et al.* report an autonomous motor powered simply with light (*Proc. Natl Acad. Sci.* **103**, 1178–1183; 2006). The motor consists of a rotaxane — a ring threaded around a dumbbell-shaped component of two electron-acceptor sites, or 'stations', for the ring to move between, with a bulky stopper group on each end. Absorption of a photon at a stopper group initiates electron transfer to the station where the ring rests, causing displacement to the second station. An electron can then transfer back to the stopper group from the now-free first station, and the ring can return to its original position. The motor works analogously to a four-stroke engine, with fuel injection and combustion, piston displacement, exhaust removal and piston-replacement steps. The motors of Balzani *et al.* rely exclusively on intramolecular processes and light absorption, and therefore do not consume chemical fuel or produce waste.



SMALL

DOI: 10.1002/smll.200600072

Synthetic procedures

Nano Motor Powered by Solar Energy

Chemists at the University of Bologna (Italy), UCLA, and the California NanoSystems Institute (both USA) have designed and constructed a rotaxane-based molecular motor of nanometer size that is powered only by sunlight. The system is built up from a dumbbell-shaped component, which is more than 6 nm long, and a ring component of a diameter of approximately 1.3 nm. The ring component is trapped on the rod portion by two bulky stoppers, which are attached to the ends of the rod so that the ring cannot slip off. The rod portion of the dumbbell contains two "stations" that can be called "A" and "B". The absorption of sunlight by one of the two stoppers, a light-harvesting species, causes the transfer of one electron to station A, which is deactivated as far as wanting the ring to encircle it. As a consequence, the ring moves to its second port of call, station B. Station A is subsequently reactivated by the return of the transferred electron to the light-harvesting stopper, and the ring moves back to this station (see Figure 1). According to the scientists, possible areas for applications of these light-powered nanoscale motors are nanoelectronics, molecular computers, and valves that could perhaps be used for the delivery of anti-cancer drugs and other medications.

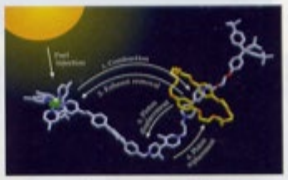


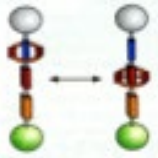
Figure 1. Molecular structure of the nano motor (image courtesy of the UCLA Newsroom).

V. Balzani et al., *Proc. Natl. Acad. Sci. (USA)* **2006**, *10*, 1178

Chem. & Eng. News

Light drives molecular motor

A molecular motor powered by sunlight alone has been prepared by chemists in Italy and in the U.S. (*Proc. Natl. Acad. Sci. USA* **2006**, *103*, 1178). Vincenzo Balzani and Alberto Credi of the University of Bologna, J. Fraser Stoddart of the University of California, Los Angeles, and their coworkers believe their device is unique for several reasons. Because it's powered solely by visible light, the motor's movement—the shuttling of a crown ether back and forth between two points on the handle of a dumbbell-shaped structure (shown)—requires no additional chemicals and produces no waste products. Also, the shuttle's movement relies on intramolecular processes, so it could, in principle, be operated at the single-molecule level. The motor moves when a ruthenium complex (green sphere) at one end of the dumbbell absorbs a photon and transfers an electron to a 4,4'-bipyridinium moiety (blue bar) within the dumbbell's handle. This reduction prompts the crown ether (pink circle) to move 1.3 nm to a 3,3'-dimethyl-4,4'-bipyridinium unit (red bar) in the compound. The crown ether moves back to its original position via a back electron-transfer process.



Nature

RE | Vol 440 | 16 March 2006

PHOTOCHEMISTRY

Lighting up nanomachines

Euan R. Kay and David A. Leigh

A cleverly engineered molecule uses light to generate a charge-separated state and so cause one of its components to move. It's the latest study of a molecular machine that exploits nature's most plentiful energy source.

Nature runs the nanomachinery that makes life possible using the last word in clean, free and readily available power sources — sunlight. In photosynthetic bacteria and green plants, photon absorption by chlorophyll generates a charge-separated state, from which the electron is quickly passed down a cascade of electron carriers, ultimately generating energy in a convenient chemical form. Can similar capabilities be engineered? An exemplary effort to do just this is given by Balzani *et al.* who, writing in *Proceedings of the National Academy of Sciences*[1], describe photochemical experiments on an artificial machine that uses light to displace a fragment of its unimolecular structure.

Those who seek to harness the Sun's energy for synthetic molecular machines find that chemistry is always throwing up obstacles. In particular, charge recombination typically occurs thousands or millions of times faster than the nuclear movements on which such machines rely, making charge-separated states difficult to exploit. This problem can be overcome using bimolecular systems: here, the charged partners quickly diffuse apart so their energy can be used, for example, to achieve switching in a rotaxane[2]. This class of molecule, consisting of a ring that shuttles randomly and incessantly along a string, stopped only by bulky groups at the string's termini, is also that used by Balzani and colleagues[1].

Their rotaxane[1] (Fig. 1) incorporates two structurally different bipyridinium sites — 'stations' 1 and 2 — that slow the shuttling ring's motion through strong short-range electrostatic interactions. The ring thus divides its time between station 1, station 2 and the rest of the string in the ratio of around 95:5:≈1. At room temperature, the ring shuttles between the stations tens of thousands of times per second, but the net flux is zero. So no work can be done, or useful task performed, by the shuttling action (the 'principle of detailed balance'[3]).

One of the bulky end-groups of the rotaxane's string is a ruthenium tris(bipyridine) complex. This can absorb a photon of visible light and so form a reactive, excited state that donates an electron to the more easily reduced of the two bipyridinium sites — station 1, the ring's preferred binding site. One would normally expect the resulting charge imbalance to be corrected by back-transfer of an electron on

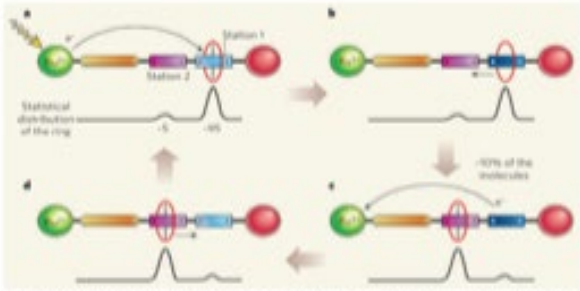
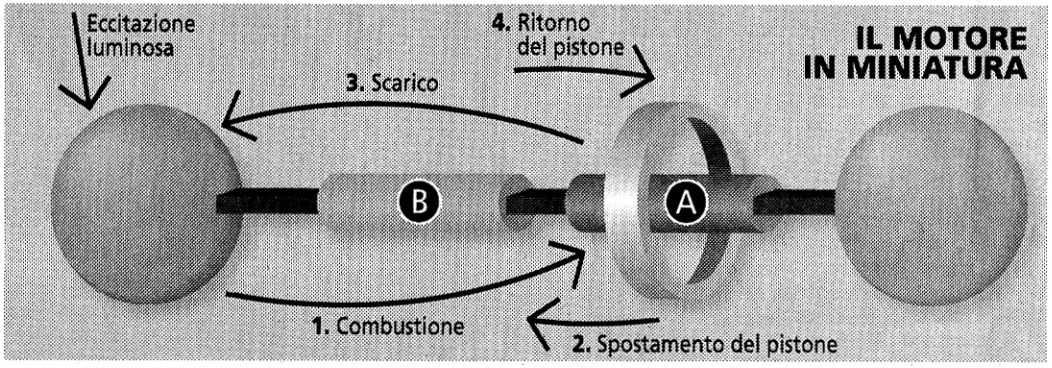


Figure 1 | Light-driven molecular shuttle. Balzani and colleagues' rotaxane[1,2] consists of a molecular ring free to move along a molecular string. **a**, At equilibrium in the ground state, the ring spends most of the time over station 1, as a result of attractive, non-covalent interactions. But irradiation of the ruthenium complex (green) at one end of the string generates a highly reducing excited state, resulting in electron transfer to station 1, and the weakening of this station's electrostatic interactions with the ring. **b**, Normally, charge recombination is fast in comparison with nuclear motions, but here a delay allows approximately 10% of the molecules to undergo significant Brownian motion, shifting the distribution of these rings to favour station 2. **c**, When charge recombination eventually does take place, the higher binding affinity of station 1 is restored, and **d**, the system relaxes to restore the original statistical distribution of rings.

Il nanomotore è meglio di una Formula 1

DUE MOLECOLE CON IL SOLE COME CARBURANTE. TANTE APPLICAZIONI, DALLA MEDICINA ALL'INFORMATICA

UN motore di Formula 1 arriva a 20 mila giri al minuto. Questo supera i 60 mila. Piacerebbe di sicuro a Schumacher, se non fosse piccolissimo: è un nanomotore formato da due molecole. Invisibile a occhio nudo. Ha però un vantaggio straordinario: non richiede benzina, lo fa girare la luce del sole. Per questo i ricercatori dell'Università di Bologna, che l'hanno realizzato con l'Università della California, lo chiamano «Sunny». La notizia è su «Pnas», la rivista



RIVOLUZIONARIO Ideato da un chimico italiano al quale il ministero della Moratti nega fondi per la ricerca

Ecco il motore perfettamente ecologico

Per ora è una molecola, ma crescerà

di Pietro Greco

Come molti nobili, ha un doppio nome: «rotaxano» nel linguaggio specialistico dei chimici. Sunny per gli amici. È un nuovo motore con due caratteristiche: è del tutto ecologico, perché non produce scorie; agisce a scale piuttosto piccole, quelle dei nanometri (un miliardesimo di metro) in un processo interamente controllato dall'uomo. Ha la forma di una ciambella con un diametro di 1,3 nanometri che scende e sale ciclicamente lungo un asse lungo 6 nanometri. [illegible]

L'uomo che ha diretto l'équipe che lo ha messo a punto, Vincenzo Balzani - uno dei 50 chimici più citati al mondo, l'unico italiano nella classifica dei primi 100 - ne è molto orgoglioso. Non solo perché è una macchina molecolare frutto di oltre sei anni di intenso lavoro. Non solo perché è piuttosto veloce: compie 60.000 cicli in un minuto. Ma soprattutto perché è un motore integralmente ecologico: consuma solo energia solare e non produce scorie di sorta.

Funziona con la luce solare non produce nessuna scoria ed è molto veloce

un'ora. Sunny è tre milioni e seicentomila volte più veloce. È anche per questo che l'articolo con cui Vincenzo Balzani e i suoi col-

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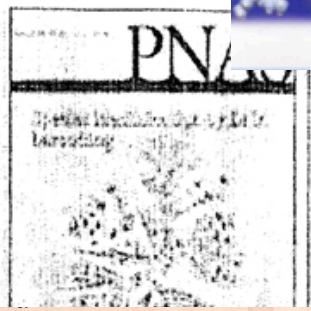
Fraser Stod



ecologico perfetto. Naturalmente non sappiamo se e quando questo nanomotore diventerà un motore e se e quando questo motore potrà essere commercializzato. Tuttavia il lavoro di Vincenzo Balzani e del suo gruppo italo-americano conferma che le nanotecnologie, le tecnologie sviluppate alla dimensione in cui iniziano a diven-

MADE IN ITALY IL PIÙ ECOLOGICO E VELOCE DEL MONDO

Un nanomotore a «benzina» solare

Chimici bolognesi hanno costruito una macchina microscopica azionata dalla luce, che non genera alcun prodotto di scarto

DI LARA RICCI

Come funziona

Metti il sole nel motore. Per motore molecolare si intende un sistema di molecole in grado di compiere lavoro meccanico, in modo controllato dall'uomo. Il nostro motore molecolare super-veloce è composto da due molecole: una filiforme lunga circa 6 nanometri che funziona da asse di scorrimento; l'altra ad anello con un diametro di circa 1,3 nanometri infilata nella prima. Quando il motore è in funzione l'anello scorre avanti e indietro lungo l'asse con estrema rapidità. Andata e ritorno in meno di un millesimo di secondo. Vale a dire una frequenza di 100 hertz o, per analogia con il motore a scoppio, 60mila giri al minuto.

Ad oggi esiste un solo altro motore molecolare ecologico costruito dall'uomo. È stato realizzato da alcuni scienziati dell'Università di Groningen nei Paesi Bassi ma è notevolmente più lento. Per completare un ciclo impiega infatti un'ora.

Vincenzo Balzani, Alberto Credi,
and Margherita Venturi

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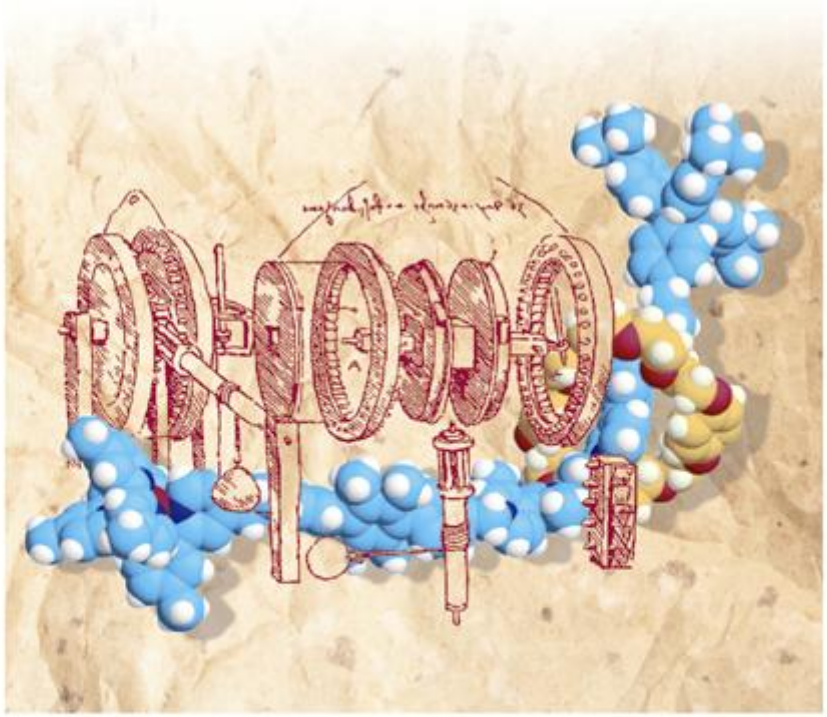


English Edition

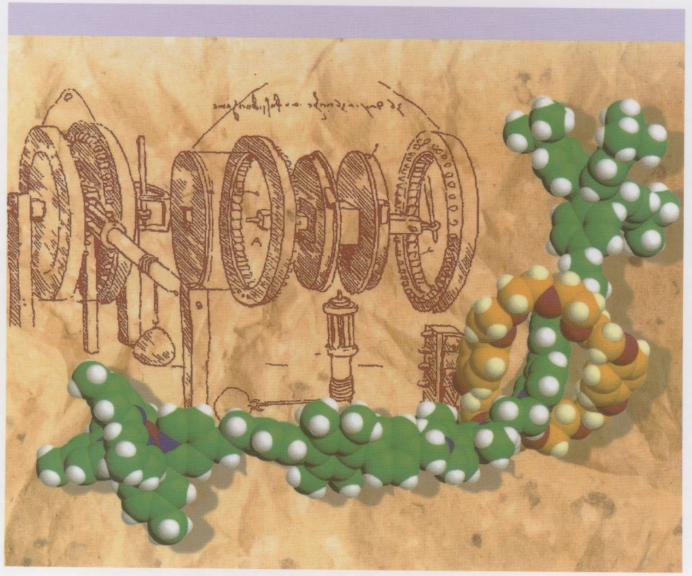
·当代化学译丛·

分子器件与分子机器

——纳米世界的概念和前景

（原著第二版）

[意]Vincenzo Balzani
[意]Alberto Credi 著
[意]Margherita Venturi
马骥 田禾 译



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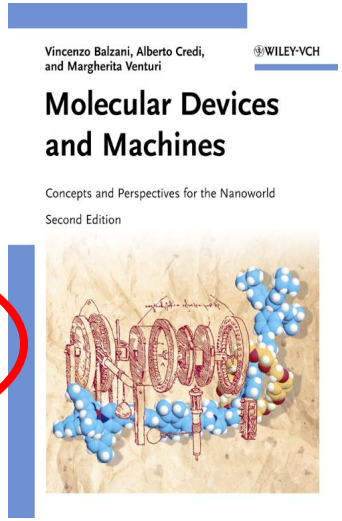
Chinese Edition

17
The Role of Science in Our Time



17.1
Introduction

This book deals with science, mostly with basic science; therefore, it could (some readers will say it should) have ended with the previous chapter. But, nowadays, can science be treated as a separate, neutral, and aseptic item? Can a scientist ignore the problems of the human society and isolate himself in an ivory tower? We believe not. We believe that there is a great need to debate the role of science and scientists in our society, and that a scientific book offers an opportunity that should not be missed concerning this problem [1].

“ Whether you are a believer or not, if you are given a choice, don't let yourself be seduced by material and intellectual interest, but choose within the range that can make the journey of your companions and your posterity less painful and less dangerous.
Don't hide behind the hypocrisy of neutral science: you are learned enough to know how to evaluate whether a cobra or a chimera or maybe nothing will come out of the egg you're hatching. ”

Primo Levi, Covare il cobra

Social responsibility of scientists

Scientists must carefully control that science and technology are used:

For peace, not for war

For preserving the planet on which we live,
not for destroying it

For reducing, not for increasing the gap between developed and underdeveloped countries

For alleviating poverty,
not for maintaining privileges

Snowflakes are one of nature's most
fragile things, but just look at
what they can do when
they stick together.

F. Barigelletti, B. Branchi, M. Ciano, L. De Cola, L. Flamigni, M. Gleria, M. Guardigli, M. T. Indelli, I. Manet, S. Monti, G. Mulazzani , P. Passaniti, F. Puntoriero, N. Sabbatini, D. Sandrini, M. Semeraro, L. Serroni, . A Torreggiani, G. Varani, V. Vicinelli