Odpoledne s chemií

Úžasná chemie boranů

přednáší: Michael Londesborough, Ph.D.

Tato síťovací akce (KA6) vč. vytvoření prezentace byla podpořena v rámci realizace projektu
ZIP MUNI, reg. č. CZ.02.3.68/0.0/0.0/19_068/0016170

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

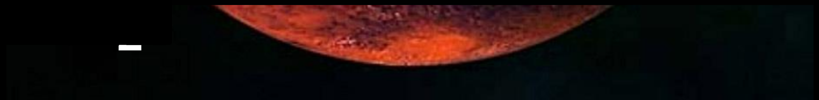
MUNI
PŘÍRODOVĚDECKÁ
FAKULTA


ONE WAY

VENUS

Země – 0.04% CO_2

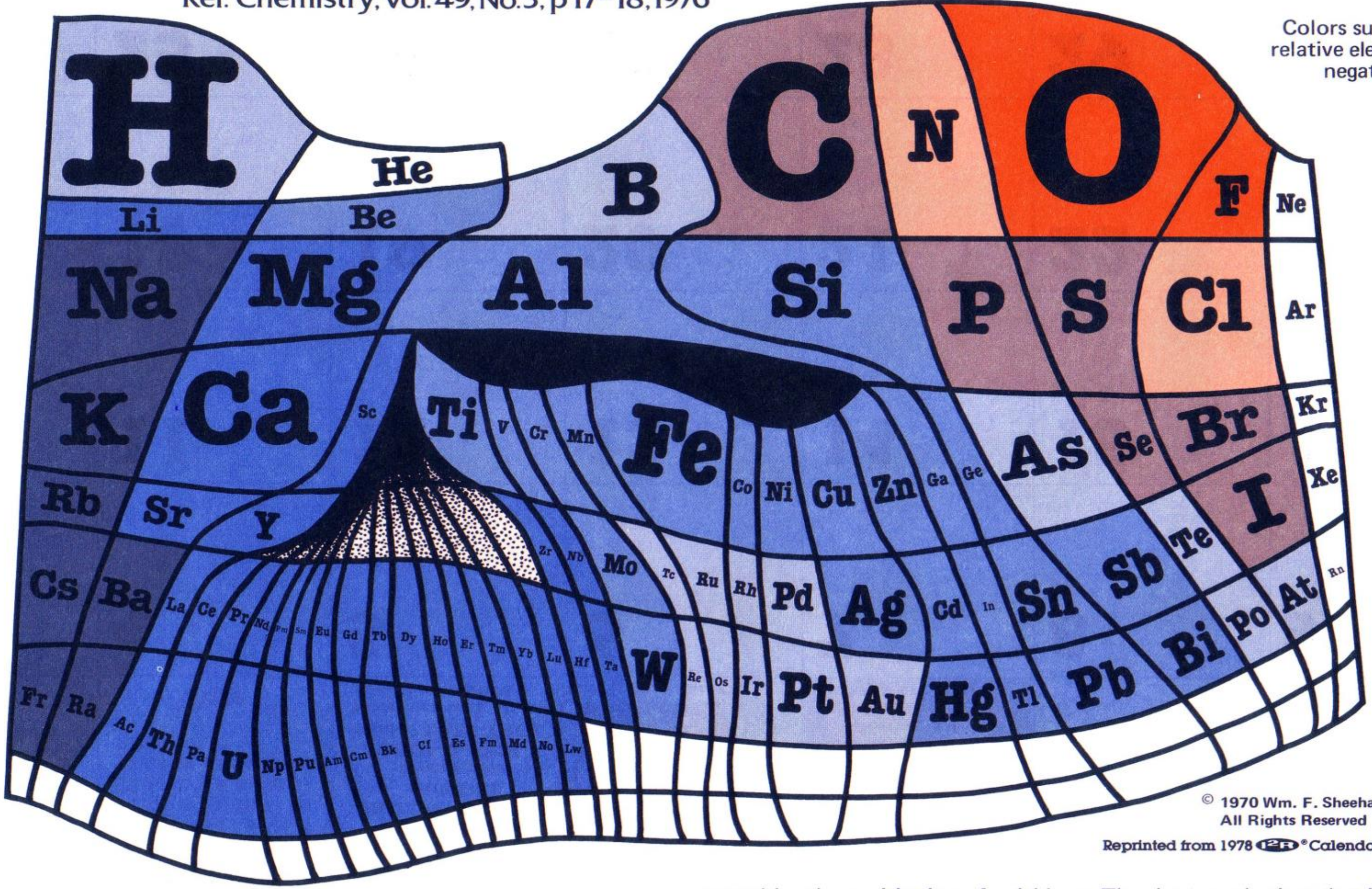
MARS



The Elements According to Relative Abundance

A Periodic Chart by Prof. Wm. F. Sheehan, University of Santa Clara, CA 95053

Ref. Chemistry, Vol. 49, No. 3, p 17–18, 1976

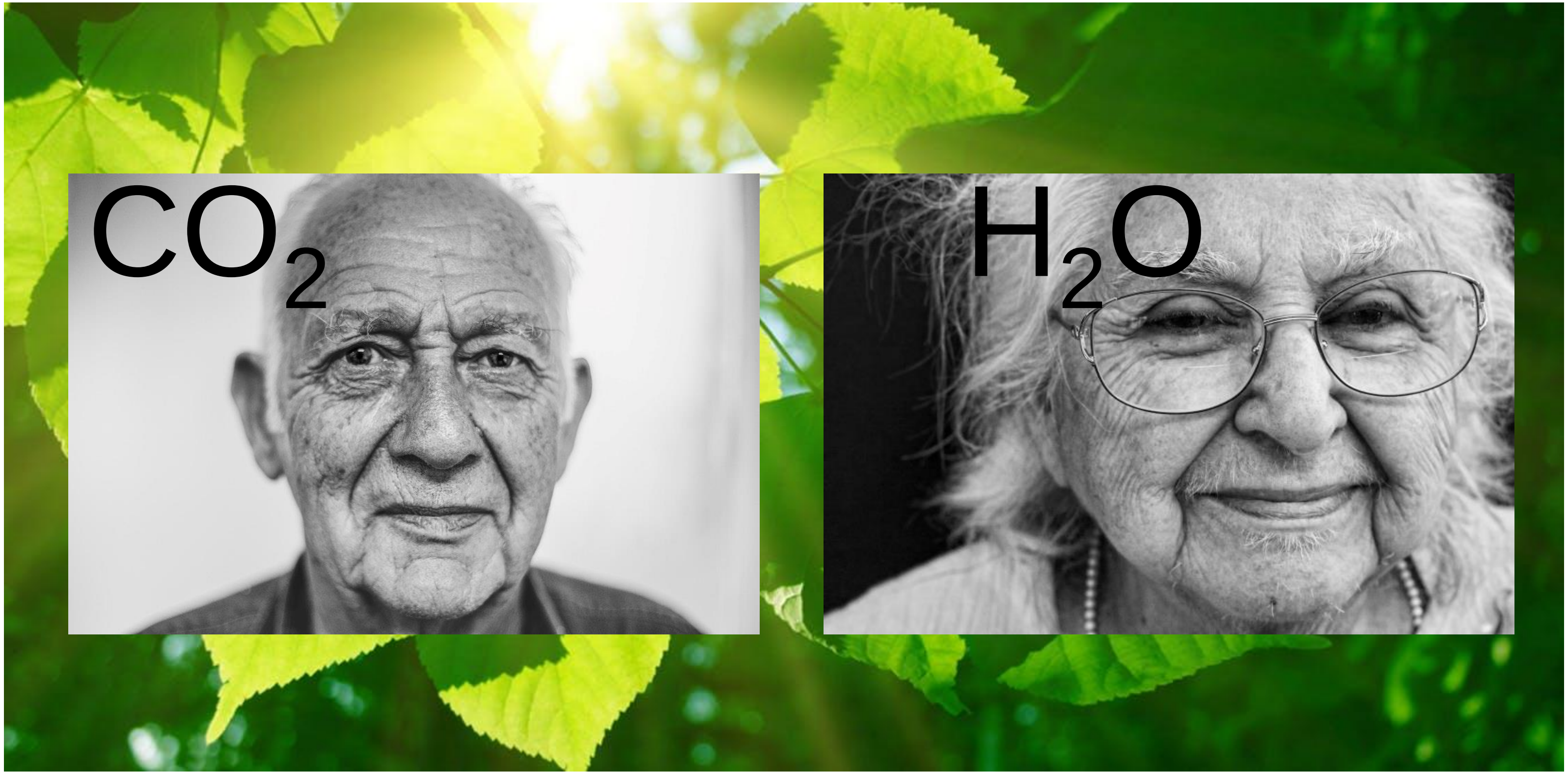


Reprinted from 1978 I2R ® Calendar.

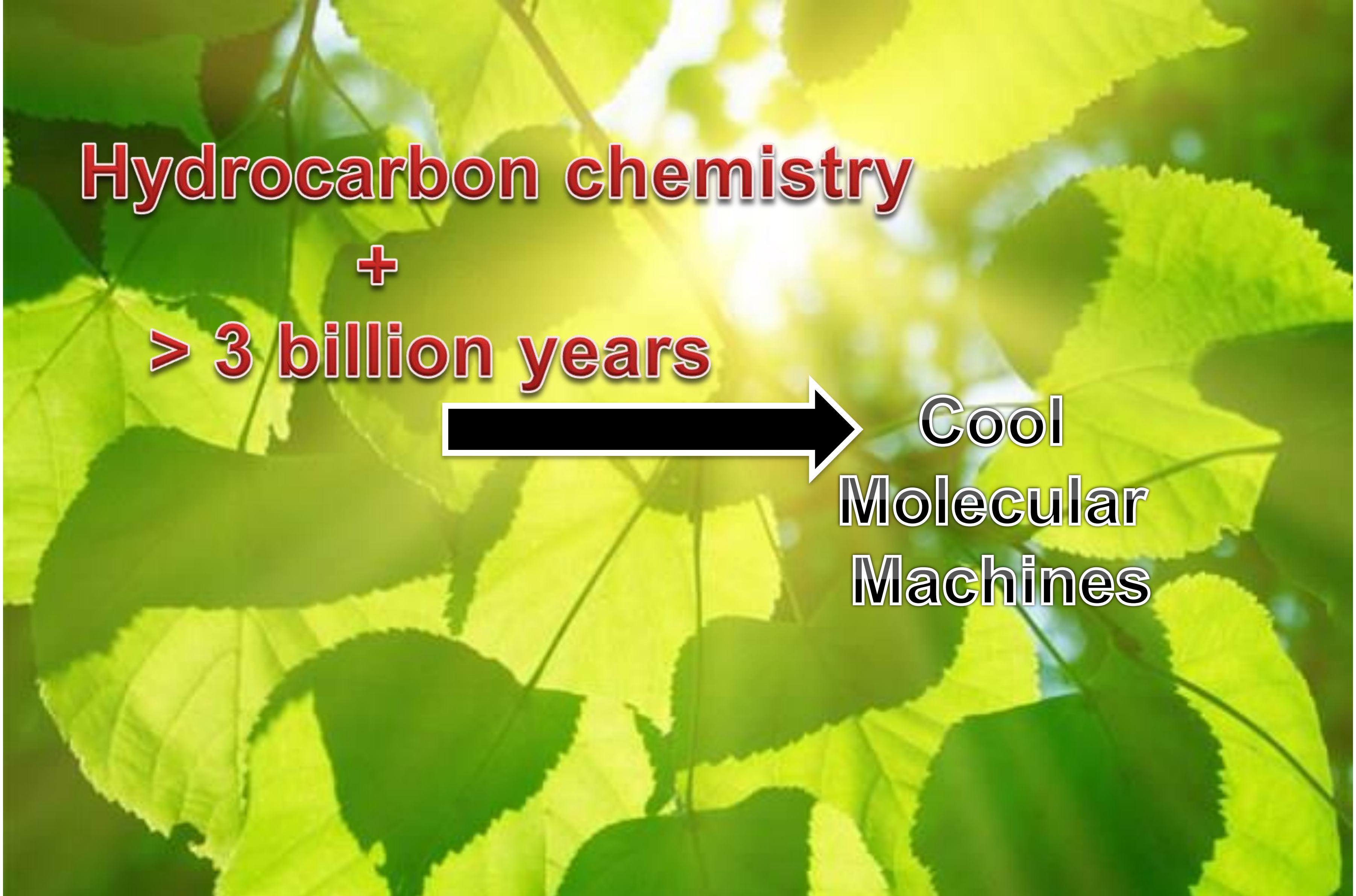
Roughly, the size of an element's own niche ("I almost wrote square") is proportioned to its abundance on Earth's surface, and in addition, certain chemical similarities (e.g., Be and Al, or B and Si) are suggested by the positioning of neighbors. The chart emphasizes that in real life a chemist will probably meet O, Si, Al, . . . and that he better do something about it. Periodic tables based upon elemental abundance would, of course, vary from planet to planet. . . **W.F.S.**

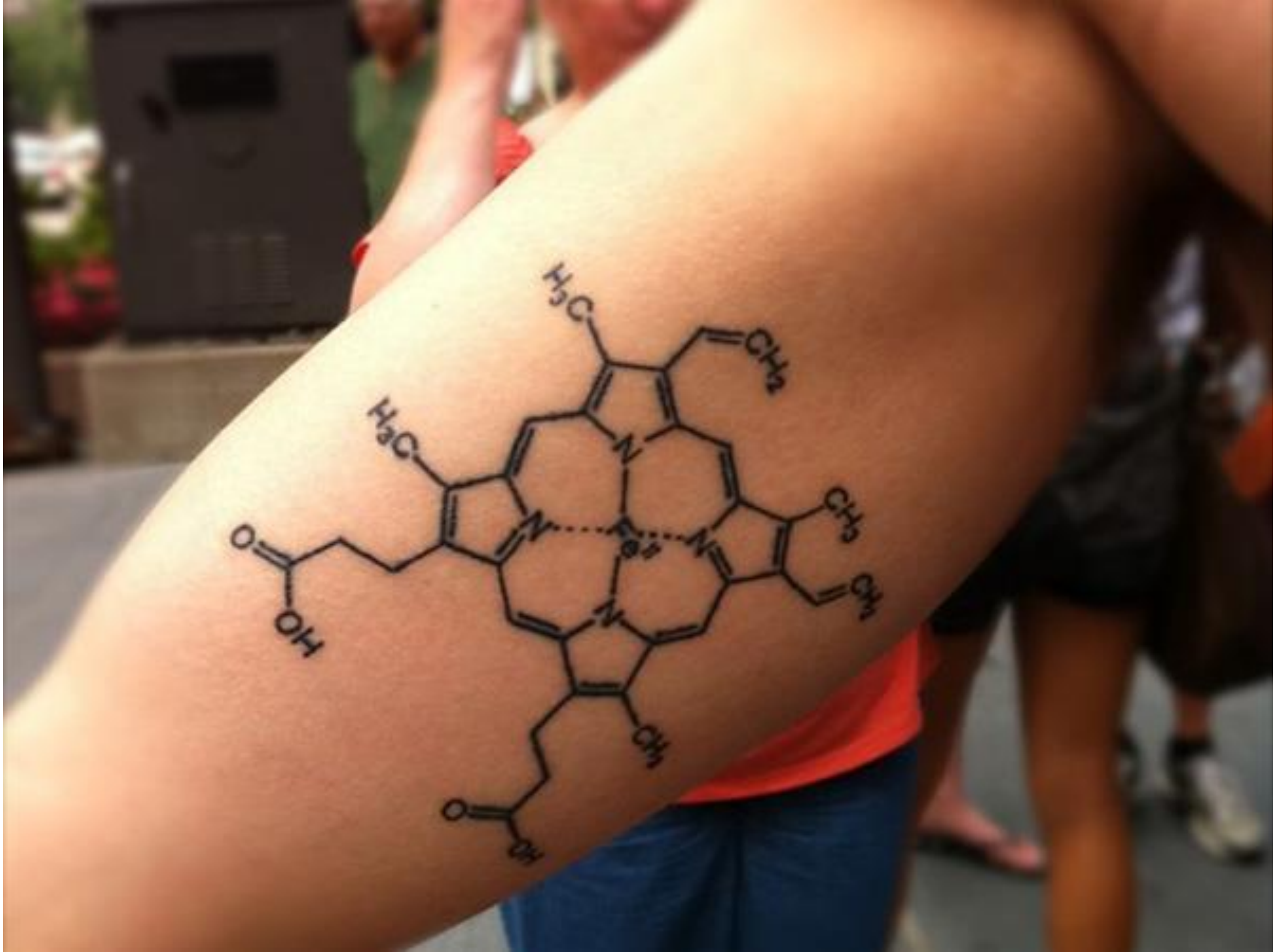
NOTE: TO ACCOMMODATE ALL ELEMENTS SOME DISTORTIONS WERE NECESSARY, FOR EXAMPLE SOME ELEMENTS DO NOT OCCUR NATURALLY.

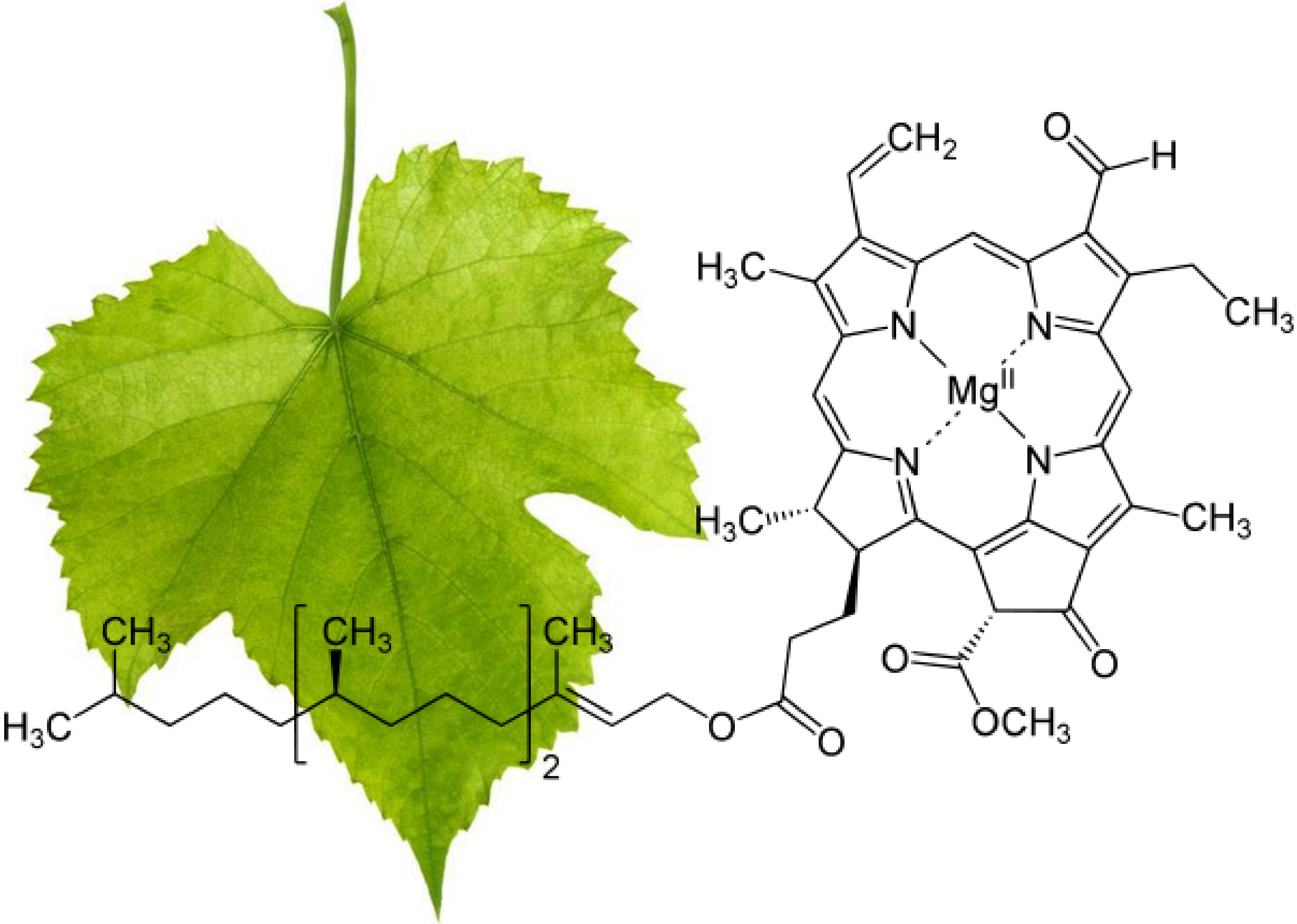

CO2


CO_2
H_2O

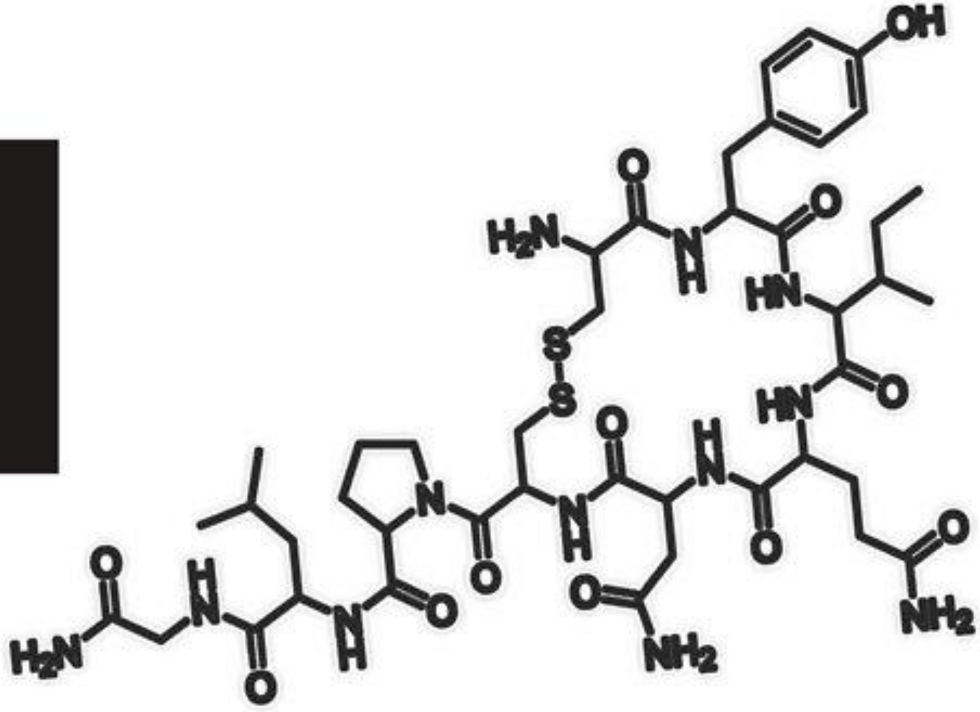

$C_6H_{12}O_6$
O_2


Hydrocarbon chemistry
+
> 3 billion years
Cool
Molecular
Machines


H3C
CH2
H3C
N
N
N
N
O
OH


CH2
O
H
H3C
CH3
N
N
Mg II
N
N
H3C
CH3
O
O
OCH3
CH3
CH3
CH3
H3C
2
O
O

I



YOU

"…the superb natural process without which the living world could not exist, i.e. the assimilation of carbon dioxide from the atmosphere by plants, seems even more interesting. This leads as we know to the formation of sugar, Nature's first organochemical product, from which all other constituents of the plant and animal body are formed."

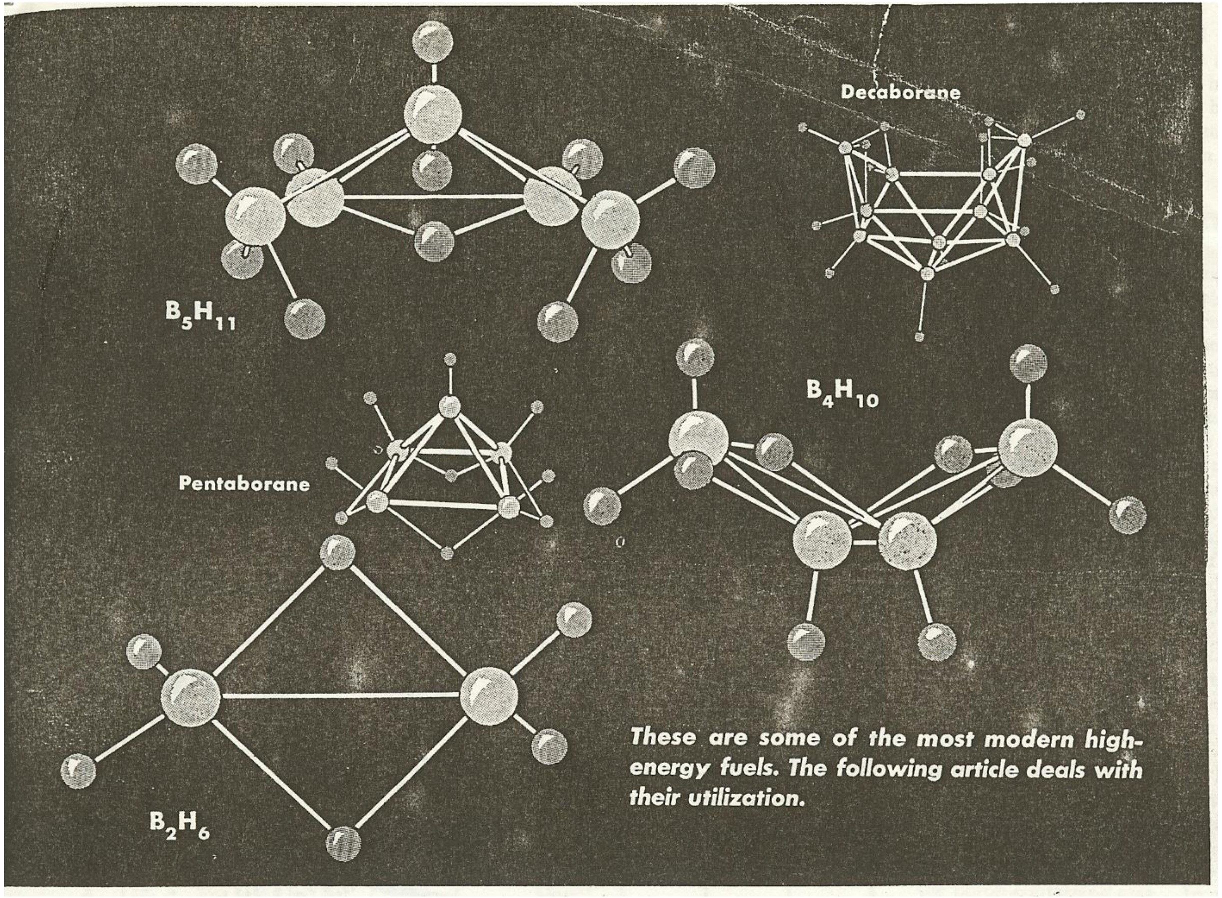
Nobel Lecture, December 12, 1902 E.FISCHER

"And so, progressively, the veil behind which Nature has so carefully concealed her secrets is being lifted where the carbohydrates are concerned…However, it is increasingly obvious that the one-sided study of carbon compounds cannot suffice to elucidate the nature of chemical processes in all its aspects."

Nobel Lecture, December 12, 1902 E.FISCHER

Emil Fischer

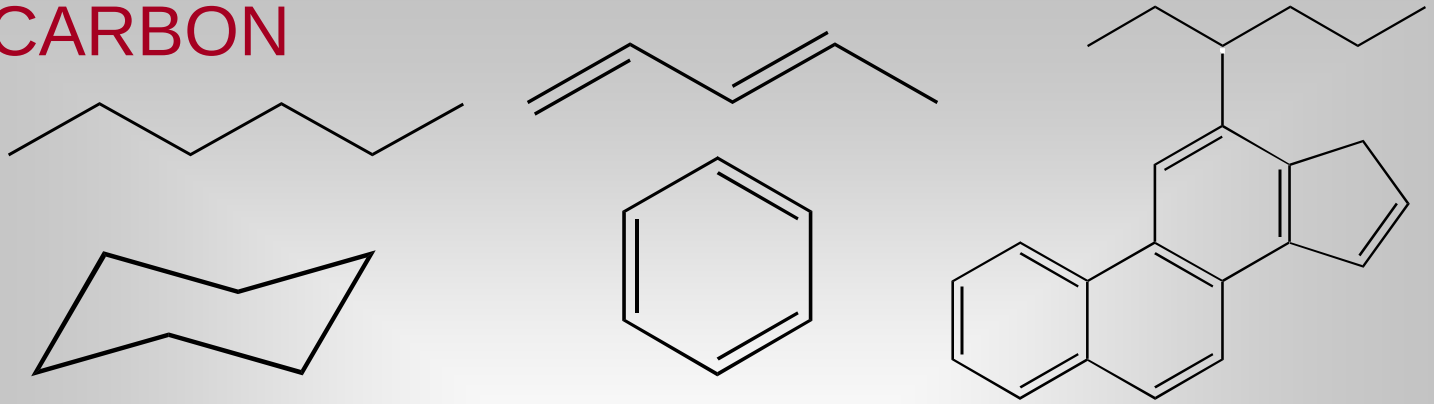

5
2
3
B
Boron
10,811


Decaborane
B_5H_{11}
B_4H_{10}
Pentaborane
B_2H_6
These are some of the most modern high-energy fuels. The following article deals with their utilization.

Wrocław

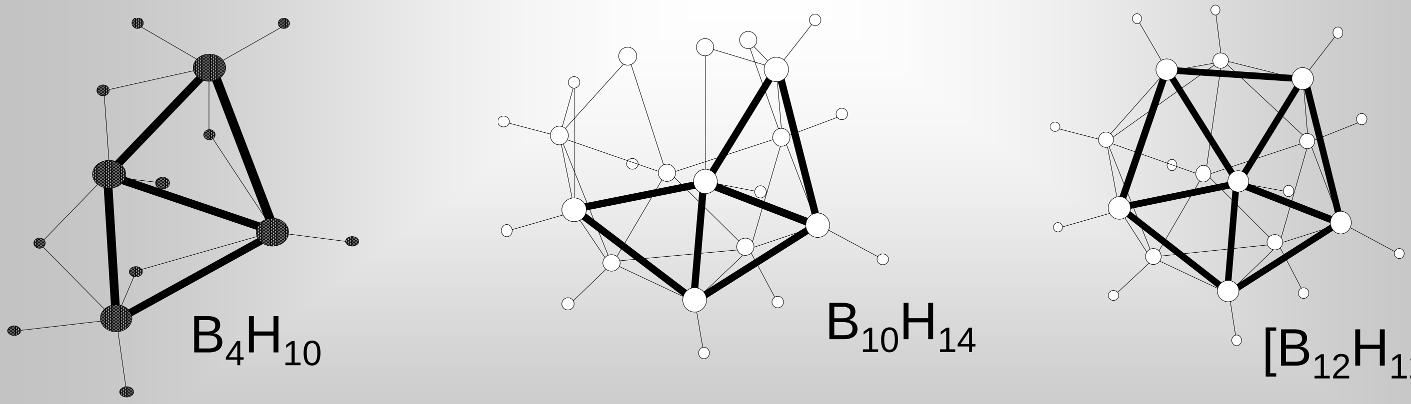

TYSKIE

CARBON



2-Dimensional Chains and Sheets...

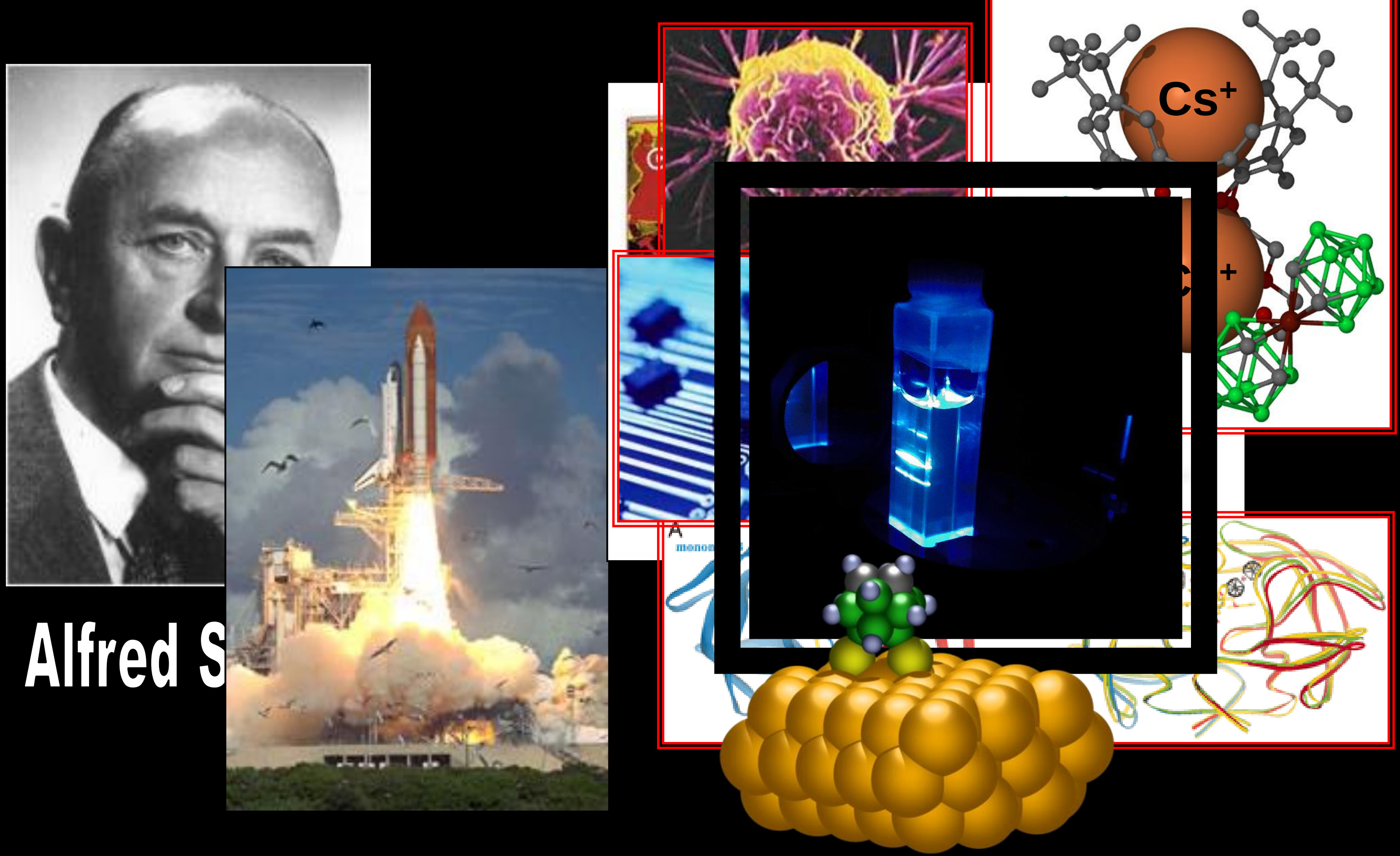
BORON



B_4H_{10} $B_{10}H_{14}$ $[B_{12}H_{12}]^{2-}$

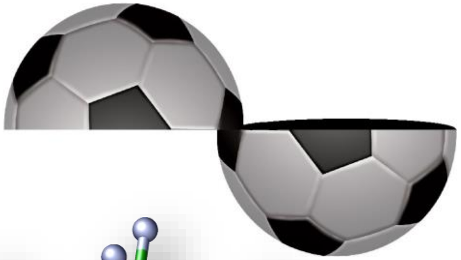
3-Dimensional POLYHEDRAL CLUSTERS...

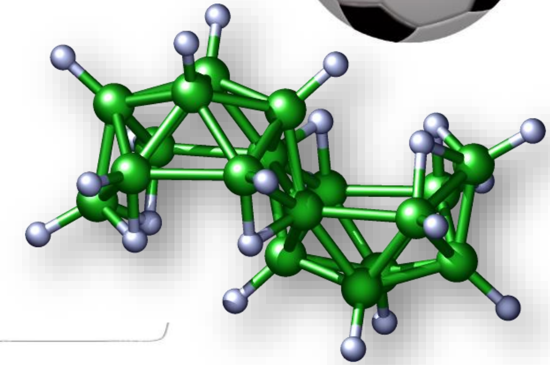

CONGRATULATIONS TO THE
INSTITUTE OF INORGANIC SYNTHESES
AT REZ NEAR PRAGUE
IN RECOGNITION OF THE CONCEPTION AND ORGANIZATION OF THE FIRST INTERNATIONAL MEETING ON BORON COMPOUNDS, WE EXPRESS THE DEEPEST APPRECIATION TO OUR CZECHOSLOVAKIAN COLLEGUES. THIS SIGNAL EVENT IS NOW AN IMPORTANT PART OF RECENT CHEMICAL HISTORY AND WE HOPE THAT A TRADITION HAS BEEN ESTABLISHED.
R. W. ADAMS
H. BEALL
H. C. BROWN
T. P. FEHLNER
L. B. FRIEDMAN
D. F. GAINES
R. N. GRIMES
M. F. HAWTHORNE
W. N. LIPSCOMB
E. L. MUETTERTIES
A. L. POWELL
K. SCHELLER
S. G. SHORE
J. F. SIECKHAUS
E. A. SULLIVAN
S. TANNENBAUM
R. E. WILLIAMS

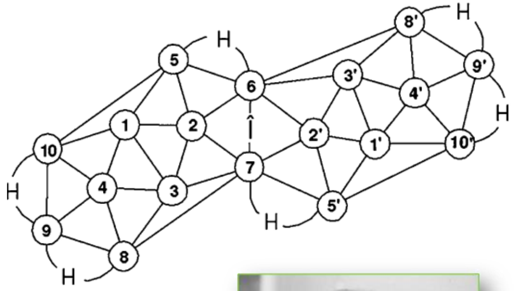


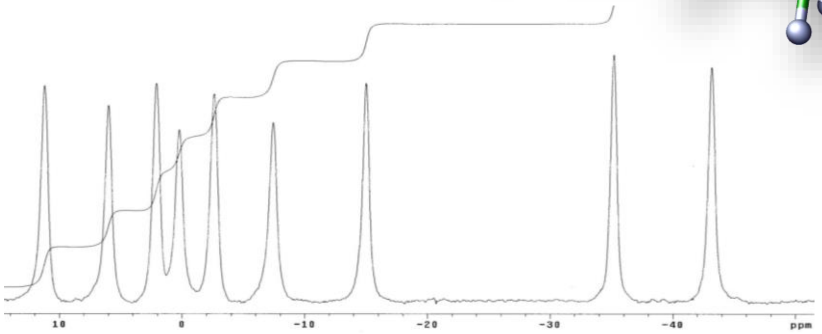
1912 1941 1965 2022

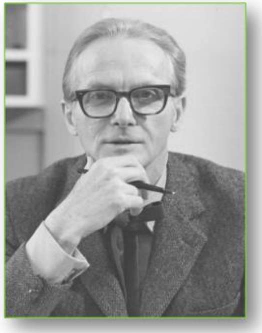
***anti*-$B_{18}H_{22}$**
T_t= 175,55+/-0,23°C



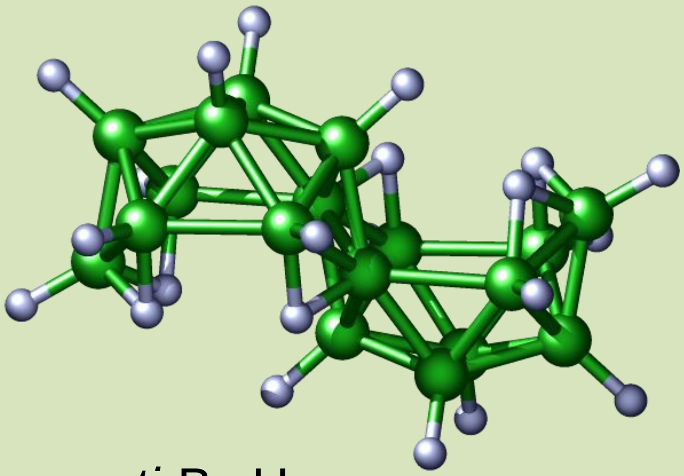




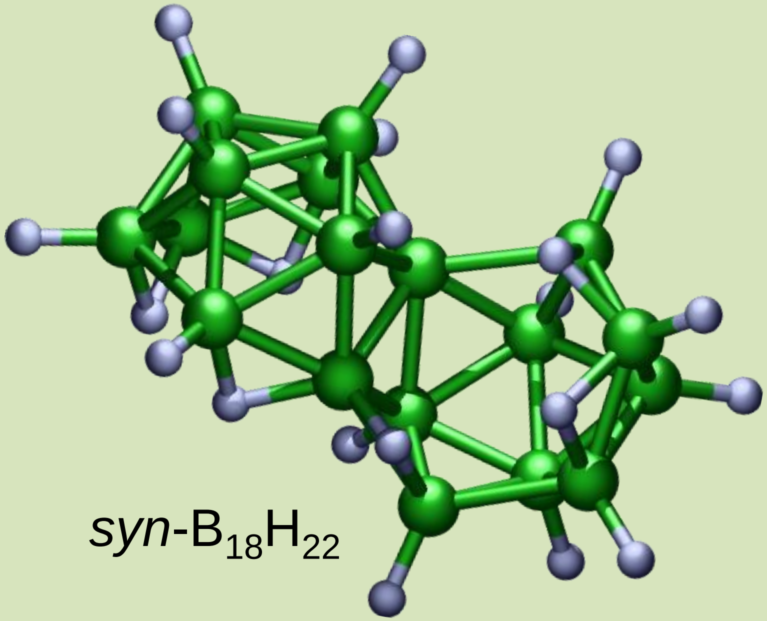




The isomers of $B_{18}H_{22}$



anti-$B_{18}H_{22}$



syn-$B_{18}H_{22}$

Figure S1. UV-vis absorption spectra of *anti*-$B_{18}H_{22}$ (a, red), *syn*-$B_{18}H_{22}$ (b, black) (left axis), and fluorescence emission spectra (c, blue) (λ_{exc} = 340 nm) of *anti*-$B_{18}H_{22}$ (right axis) in hexane.

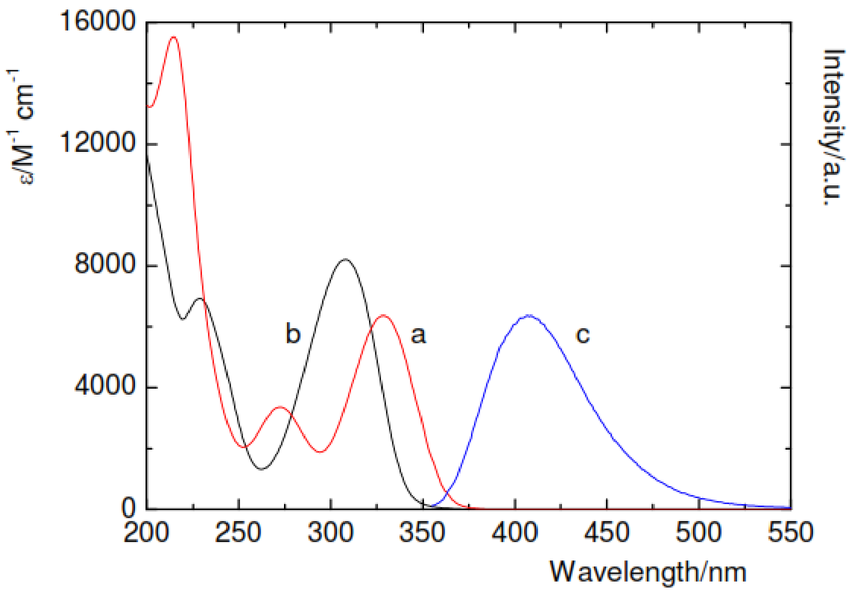


Figure taken from:
M.G.S Londesborough, K. Lang, J. Oliva, et al., "Distinct Photophysics of the Isomers of $B_{18}H_{22}$ Explained." *Inorg*. *Chem*. **2012**, 51, 1471-1479.

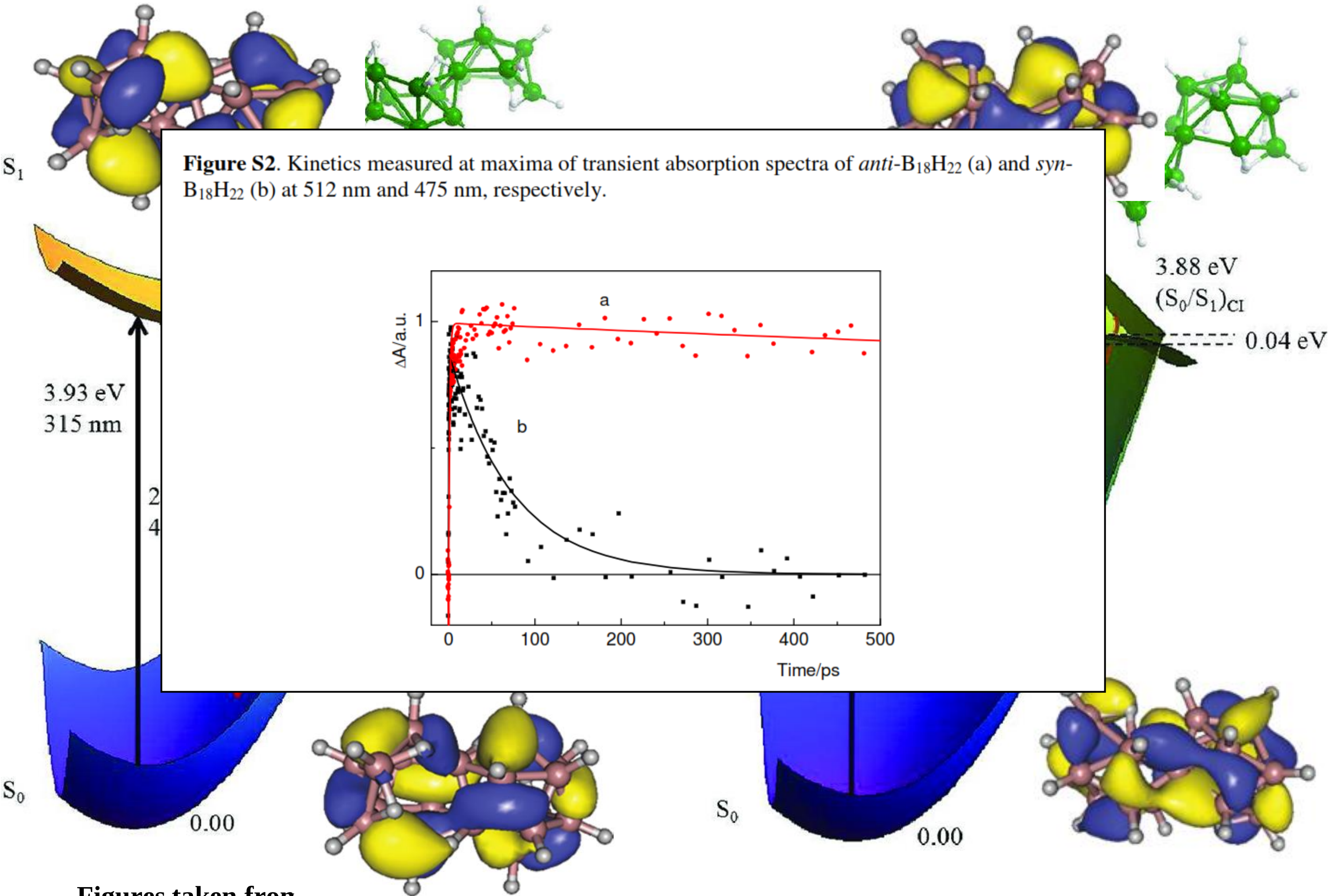
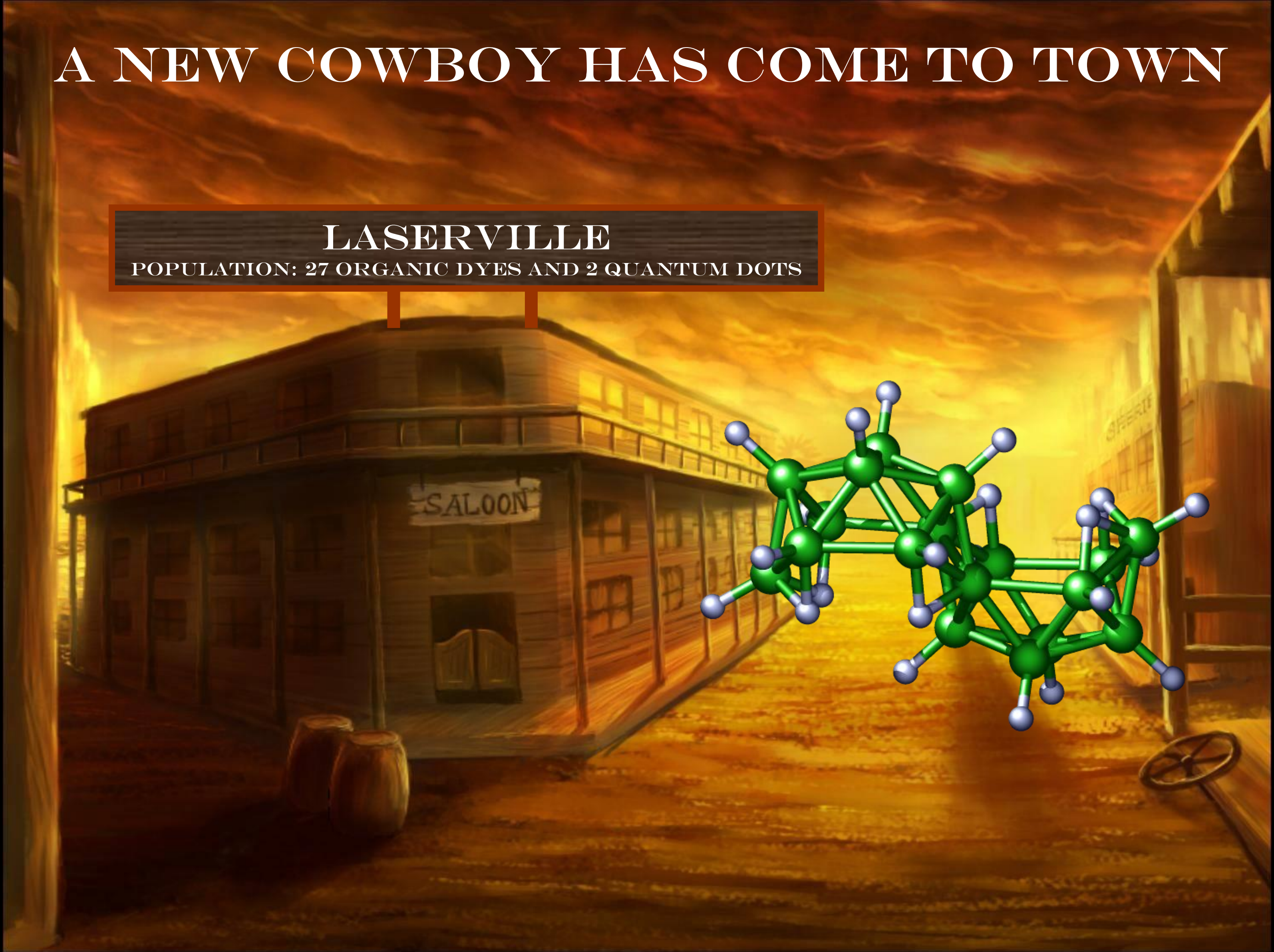
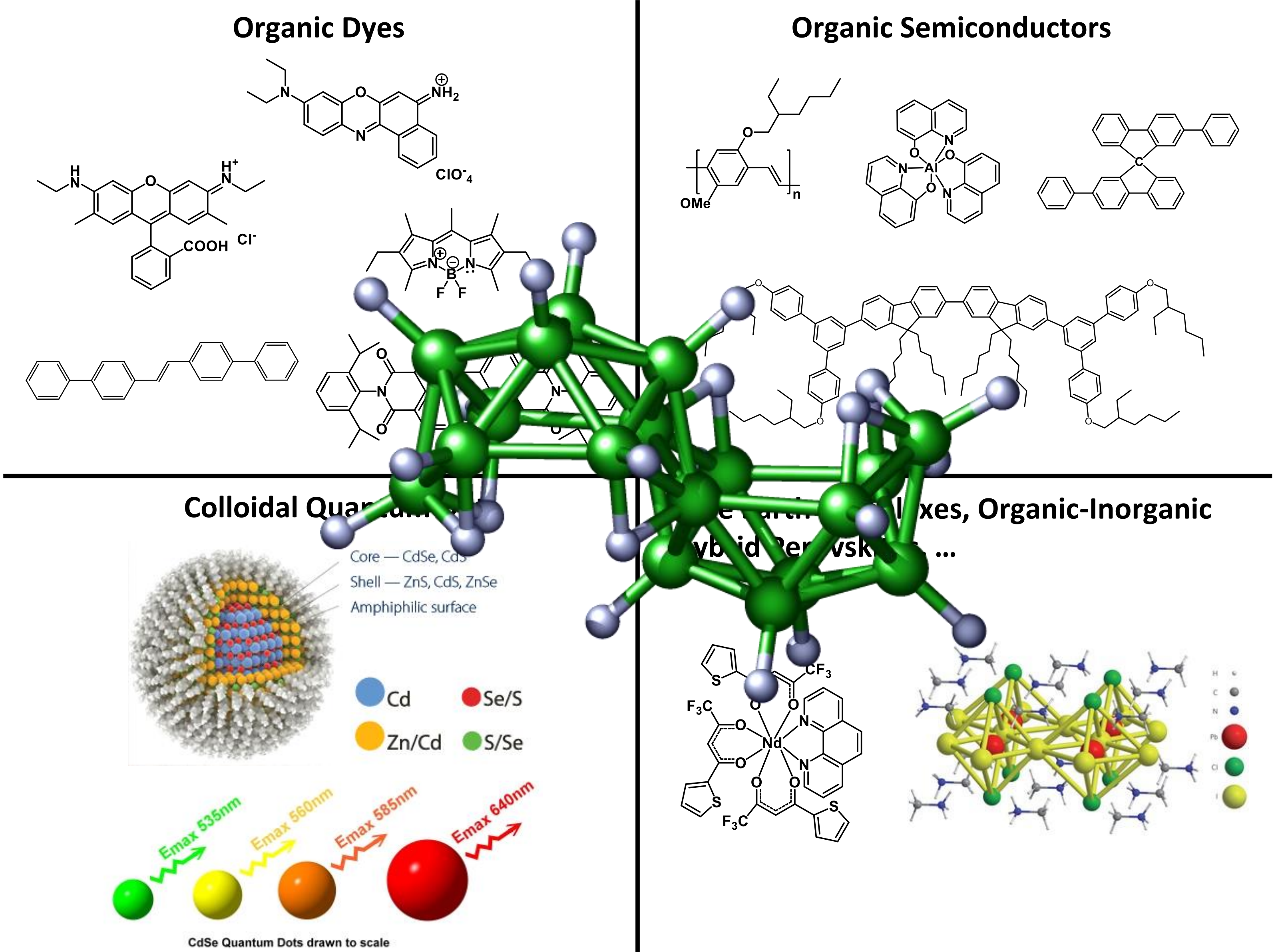


Figure S2. Kinetics measured at maxima of transient absorption spectra of *anti*-$B_{18}H_{22}$ (a) and *syn*-$B_{18}H_{22}$ (b) at 512 nm and 475 nm, respectively.

Figures taken fron..

M.G.S Londesborough, K. Lang, J. Oliva, et al., “Distinct Photophysics of the Isomers of $B_{18}H_{22}$ Explained.” *Inorg. Chem.* **2012**, 51, 1471-1479.


A NEW COWBOY HAS COME TO TOWN
LASERVILLE
POPULATION: 27 ORGANIC DYES AND 2 QUANTUM DOTS
SALOON



Organic Dyes
Organic Semiconductors
Colloidal Qua
Core — CdSe, CdS
Shell — ZnS, CdS, ZnSe
Amphiphilic surface
Cd
Se/S
Zn/Cd
S/Se
Emax 535nm
Emax 560nm
Emax 585nm
Emax 640nm
CdSe Quantum Dots drawn to scale
xes, Organic-Inorganic

nature COMMUNICATIONS

ARTICLE

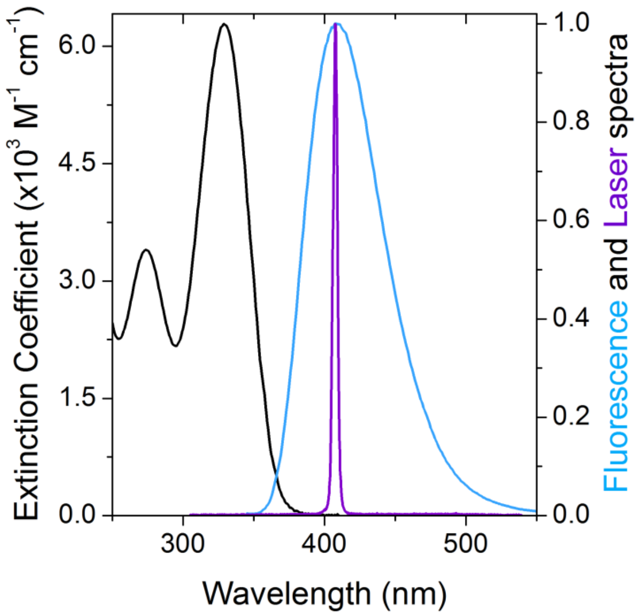
Received 23 Apr 2014 | Accepted 26 Nov 2014 | Published 13 Jan 2015

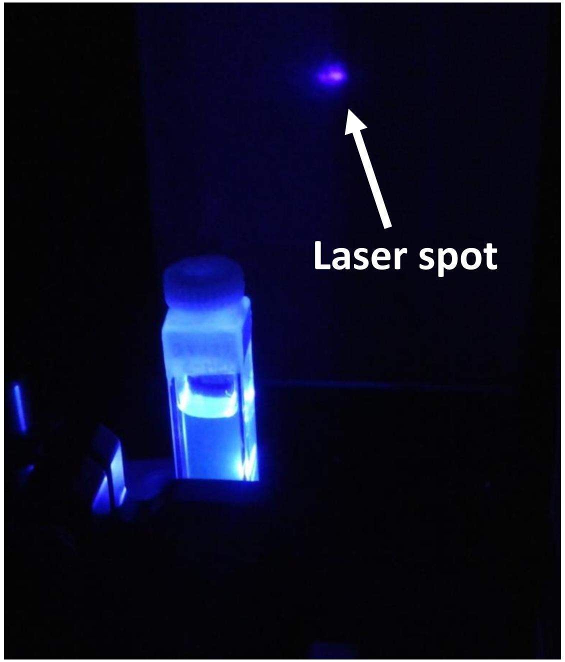
DOI: 10.1038/ncomms6958

A borane laser

Luis Cerdán[1], Jakub Braborec[2,3], Inmaculada Garcia-Moreno[1], Angel Costela[1] & Michael G.S. Londesborough[2,*]

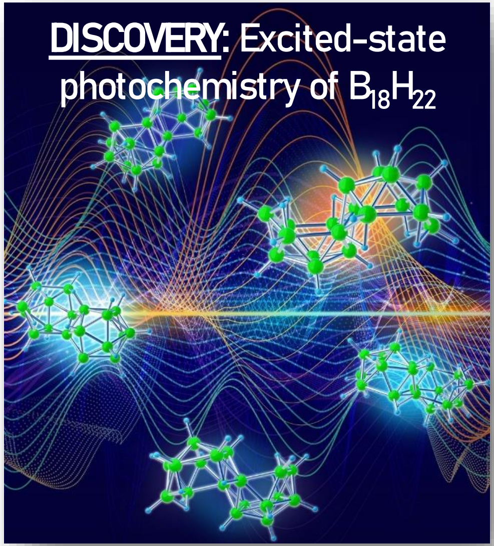
Laser wavelength: λ=406 nm





Experiment details:

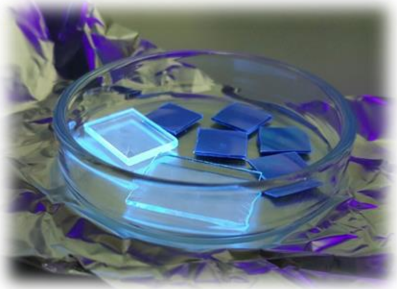
Cyclohexane solution 50 mM Pump: Nitrogen laser, λ_{pump}=337 nm



"Unveiling the role of upper excited electronic states in the photochemistry and laser performance of *anti*-$B_{18}H_{22}$" *J. Mater. Chem. C.* **2020**, 8, 12806.

DISCOVERY: A quantum yield of fluorescence 0.97

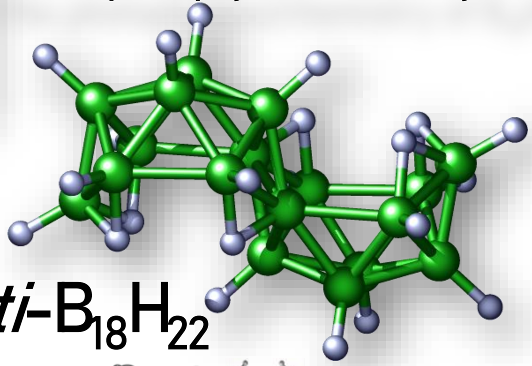
"Distinct Photophysics of the Isomers of $B_{18}H_{22}$ Explained." *Inorg. Chem.* **2012**, 51, 1471.



DISCOVERY: Luminescent properties of $B_{18}H_{22}$ in polymer matrices

"The Photostability of Novel Boron Hydride Emitters in Solutions and Polystyrene Matrix." *Materials*, **2021**, 14(3), 589.

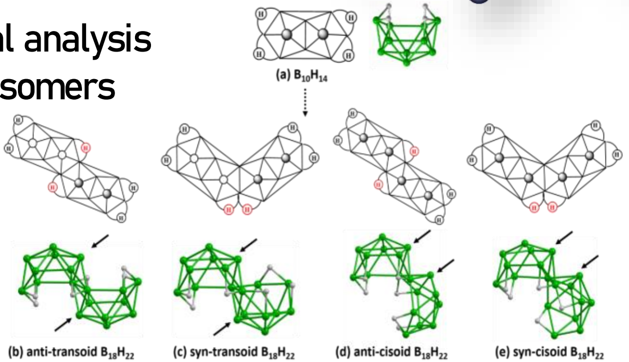
PHASE 1: Comprehensive understanding of the photophysics/chemistry of $B_{18}H_{22}$

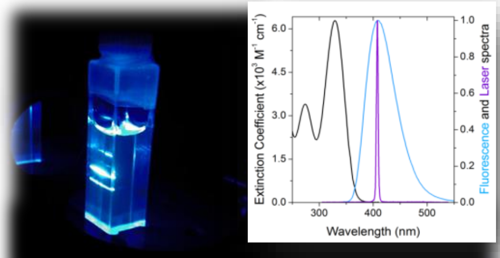


anti-$B_{18}H_{22}$

DISCOVERY: Theoretical analysis of $B_{18}H_{22}$ and $B_{26}H_{30}$ isomers

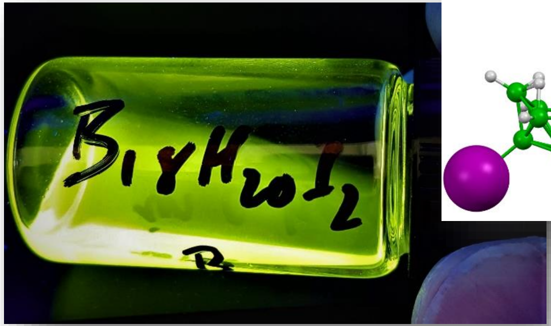
"A theoretical analysis of the structure and properties of $B_{26}H_{30}$ isomers. Consequences to the laser and semiconductor doping capabilities of large borane clusters" *Phys. Chem. Chem. Phys.* **2019**, 21, 12916.

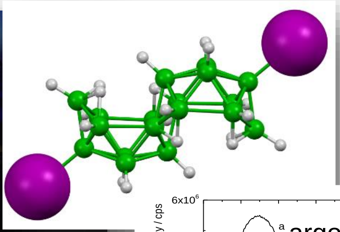


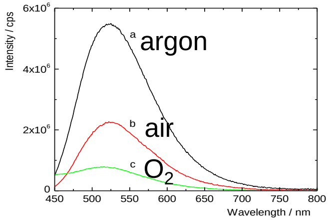


DISCOVERY: The first borane laser

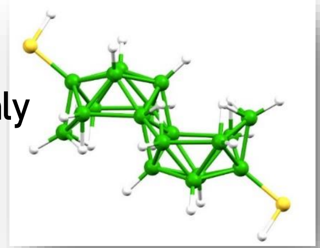
"A Borane Laser." *Nature Communications.* **2015**, 6, 5958.







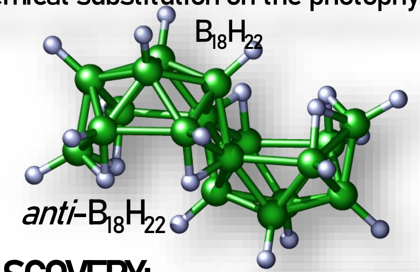
DISCOVERY: Iodination and thiolation of $B_{18}H_{22}$ gives highly efficient singlet-oxygen generators



"Effect of Iodination on the Photophysics of the Laser Borane *anti*-$B_{18}H_{22}$: Generation of Efficient Photosensitizers of Oxygen" *Inorg. Chem.* **2019**, 58, 15, 10248.

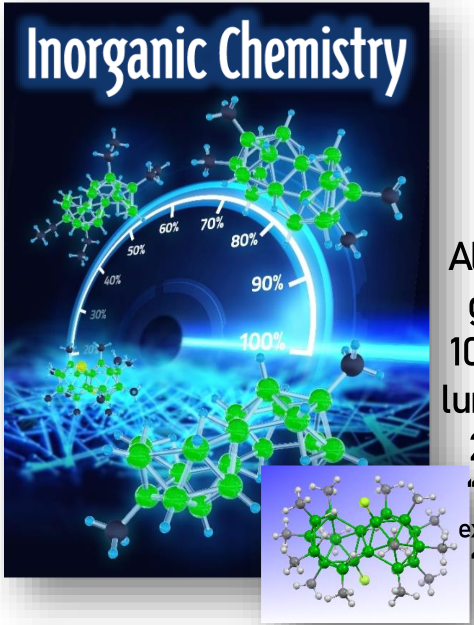
"Tuning the Photophysical Properties of *anti*-$B_{18}H_{22}$: Quantum Hopping between Excited Singlet and Triplet States in new 4,4'-$(HS)_2$-*anti*-$B_{18}H_{20}$" *Inorg. Chem.* **2013**, 52, 9266.

PHASE 2: Understanding of the effects of chemical substitution on the photophysics of $B_{18}H_{22}$

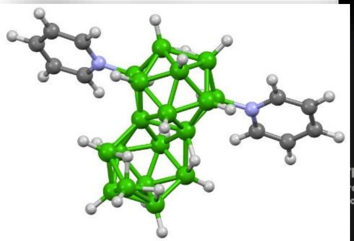


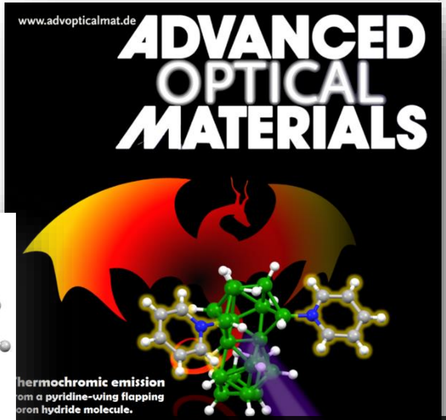
anti-$B_{18}H_{22}$

DISCOVERY: Pyridination of $B_{18}H_{22}$ gives thermochromic luminosity



DISCOVERY: Alkylation of $B_{18}H_{22}$ gives a series of 100% efficient blue luminophores and a 2nd borane laser





"Swollen Polyhedral Volume of the *anti*-$B_{18}H_{22}$ cluster via extensive methylation." *Inorg. Chem.* **2020**, 59, 5, 2651.

"Ultra-Efficient Blue Fluorophores from the Alkylation of *anti*-$B_{18}H_{22}$" *Inorg. Chem.* **2020**, 59, 23, 17058

"Thermochromic Fluoresence from $B_{18}H_{20}(NC_5H_5)_2$." *Adv. Opt. Mater.* **2017**, 5, 6, 1600694.

"Substitution of laser borane *anti*-$B_{18}H_{22}$ with pyridine" *Dalton Trans.*, **2018**, 47, 1709

PHASE 3: The FUTURE - A Step-change in the Search for Photoactive Macropolyhedral Borane Clusters: new thia-, selena-, and azaboranes

- New synthetic methods
- New cluster architectures
- New luminescent boranes