

Interesting organic molecules for life



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LIFE...

- **NO** scientific definition, no lab reproducibility
- Earth, n =1
- **Thermodynamics:** an organized system kept under minimum energy state, against entropy
- **Statistics:** 10^{23} stars and counting...



ALMA,
in search of our cosmic origins...

ASTROBIOLOGY,
in search of life's cosmic origins...

in fact,
we were born on a life-friendly
Universe!

*Indeed, everything started
when a molecule said 'yes'
to another molecule... LET'S HEAR IT WITH LLAMA*

Clarice Lispector

Elemental abundances in the Universe

Element	ppm
Hydrogen	739,000
Helium	240,000
Oxygen	10,700
Carbon	4,600
Neon	1,340
Iron	1,090
Nitrogen	950
Silicon	650
Magnesium	580
Sulphur	440



C



N



O



Ne



Si



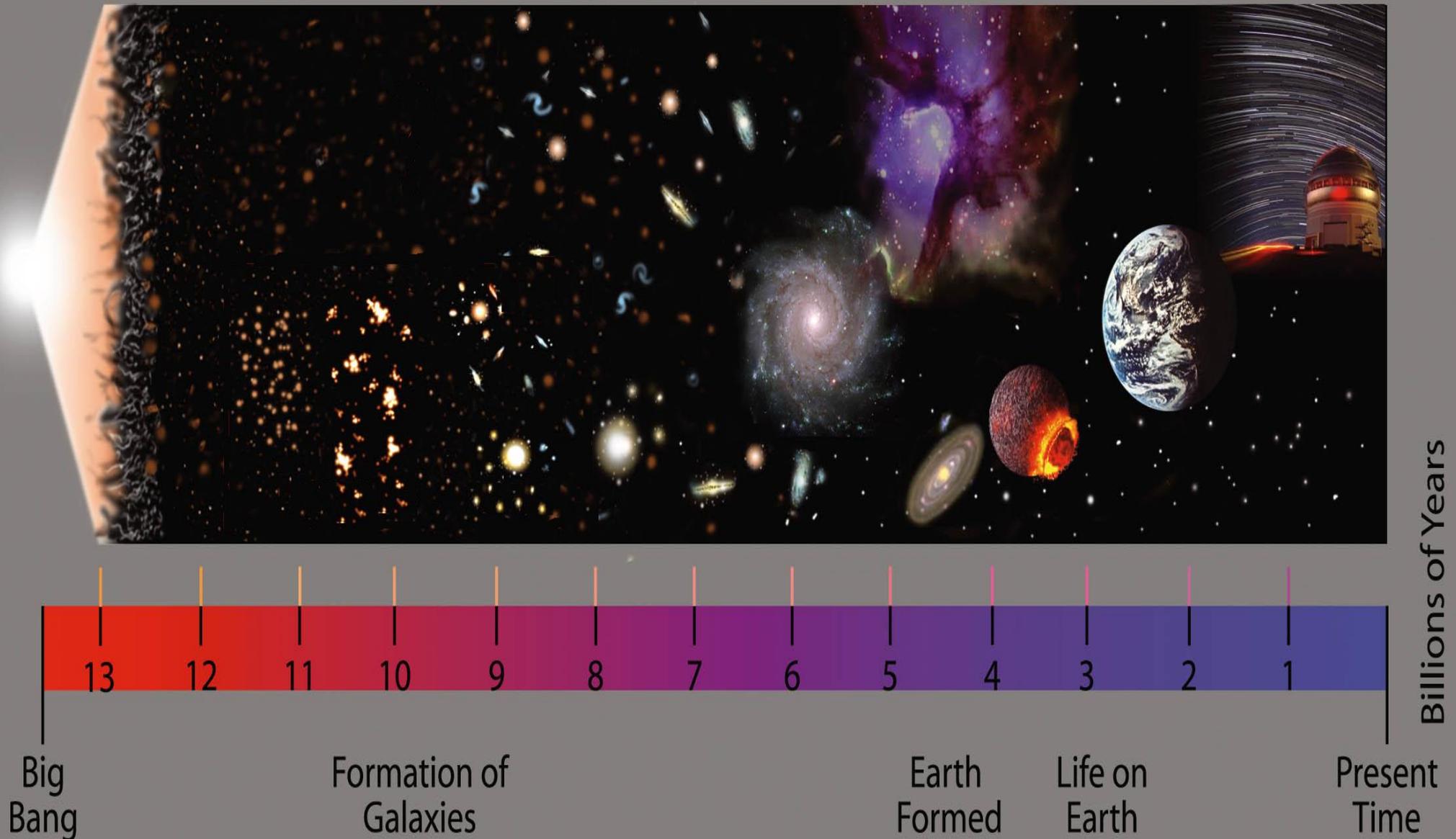
S



Ar

Fe

Our 4.5Gyr old Solar System appears in a ~10Gyr old Universe !!



Basic chemistry, from simple to complex

- *life as we know it = life as we **CHON** it*

H C O N



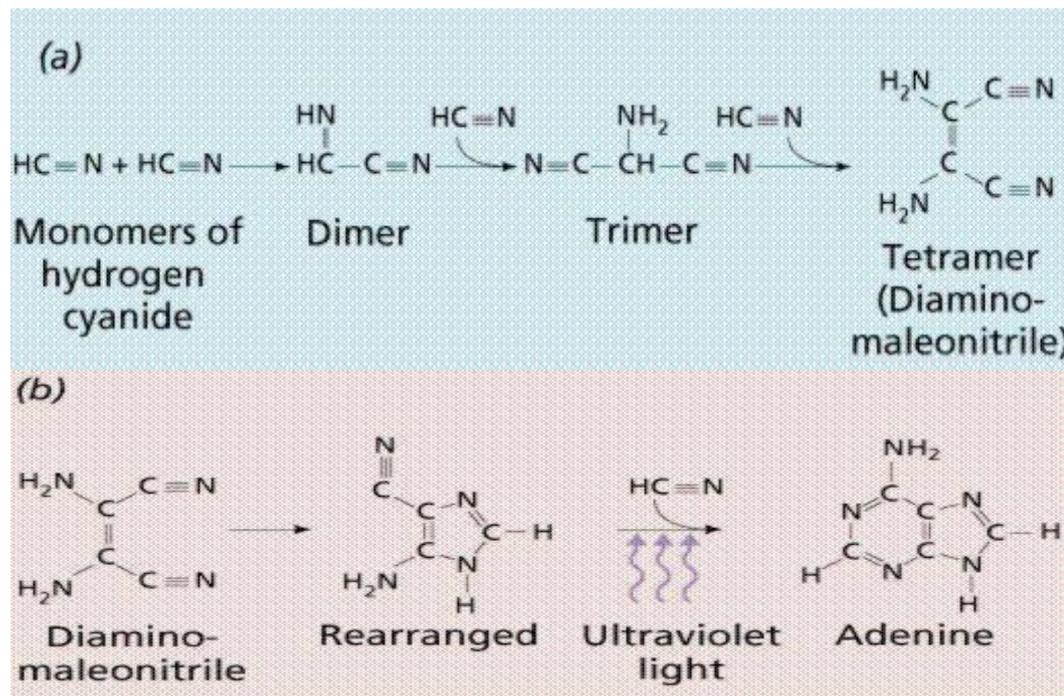
Building blocks assembling into...

Primitive synthetic reactions:

[HCN]₈ = purines

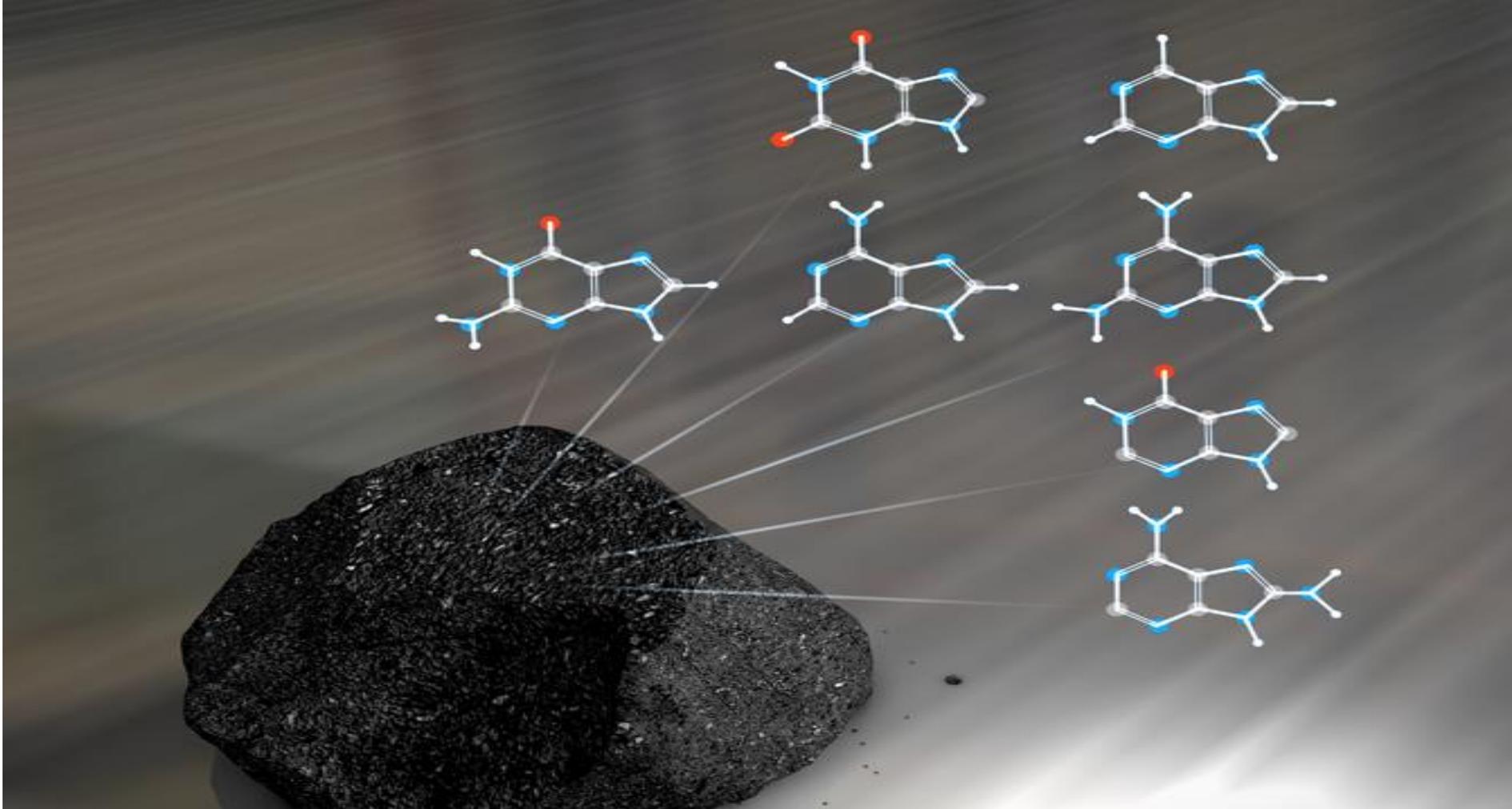
HCHO = simple sugars

HCN + HCHO = simple aminoacids



Saladino et al.,
2004

AMINO ACID	MURCHISON METEORITE	DISCHARGE EXPERIMENT
GLYCINE	• • • •	• • • •
ALANINE	• • • •	• • • •
α -AMINO-N-BUTYRIC ACID	• • •	• • • •
α -AMINOISOBUTYRIC ACID	• • • •	• •
VALINE	• • •	• •
NORVALINE	• • •	• • •
ISOVALINE	• •	• •
PROLINE	• • •	•
PIPECOLIC ACID	•	•
ASPARTIC ACID	• • •	• • •
GLUTAMIC ACID	• • •	• •
β -ALANINE	• •	• •
β -AMINO-N-BUTYRIC ACID	•	•
β -AMINOISOBUTYRIC ACID	•	•
γ -AMINOBUTYRIC ACID	•	• •
SARCOSINE	• •	• • •
N-ETHYLGLYCINE	• •	• • •
N-METHYLALANINE	• •	• •

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NASA Researchers: DNA Building Blocks Can Be Made in Space

08.08.11

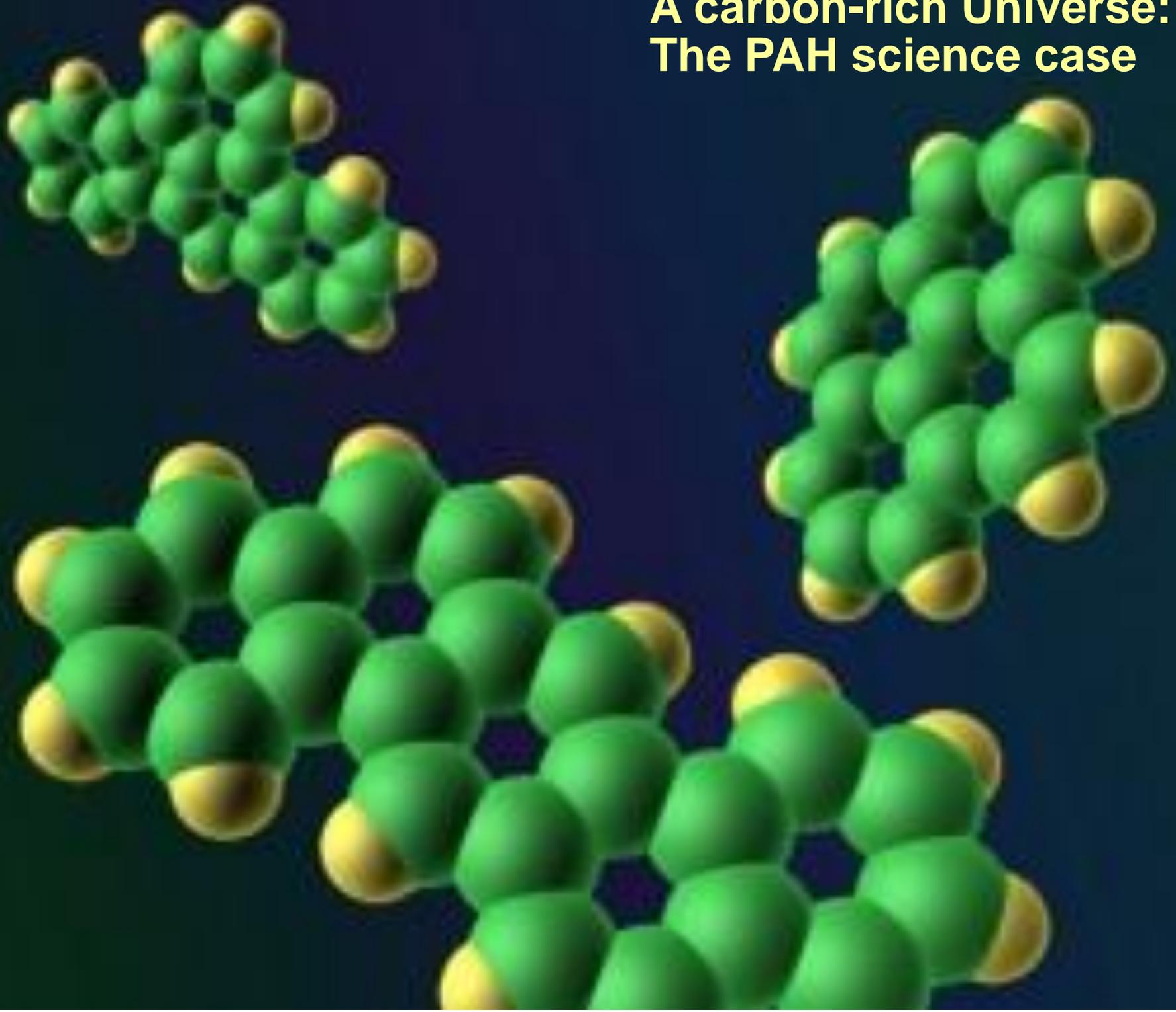
NASA-funded researchers have evidence that some building blocks of DNA, the molecule that carries the genetic instructions for life, found in meteorites were likely created in space. The research gives support to the theory that a "kit" of ready-made parts created in space and delivered to Earth by meteorite and comet impacts assisted the origin of life.

"People have been discovering components of DNA in meteorites since the 1960's, but researchers were unsure whether they were really created in space or if instead they came from contamination by terrestrial life," said Dr. Michael Callahan of NASA's Goddard Space Flight Center, Greenbelt, Md. "For the first time, we have three lines of evidence that together give us confidence these DNA building blocks actually were created in space." Callahan is lead author of a paper on the discovery appearing in Proceedings of the National Academy of Sciences of the United States of America.

Featuring: CARBON

carbon bonding thermodynamics supports the spontaneous self-replication of monomers into larger polymers (Sievers & von Kiedrowski, Nature 1994)

A carbon-rich Universe: The PAH science case



FACTS (I)

They're radiation robust, the ring-shared electron clouds appear not to be splitted apart from the rings, displaying a relativistic behavior

FACTS (II)

They have been detected in the ISM, in star-forming regions, ~14% of low-mass pre-main-sequence stars, and, remarkably, they seem to be present in some 54% of intermediate mass stars (Geers et al., A&A 2009)

(a consequence of robustness???)

FACTS (III)

Consisting of a family of compounds with fused aromatic rings, the abundances of its larger members (50-100 carbon atoms) were estimated to be on top scores just after H_2 and CO (Geers et al., A&A 2009).

Polyaromatic hydrocarbons (PAHs) may represent a resilient way of accumulating carbon as a cosmic reservoir.

CONDITION:

To fulfil the PAHs' role under the astrobiological meaning of seeding prebiotic compounds in life-forming regions, it is imperative to unveil how chemically rich are PAH-harboring regions

PAH + WATER...

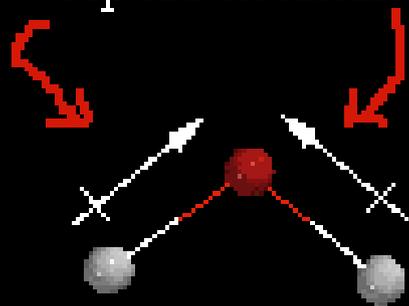
Importantly, PAHs were shown to be resistant against photolysis when exposed to UV as pure ash fragments in the laboratory

(Korfmacher et al., Science 1980)

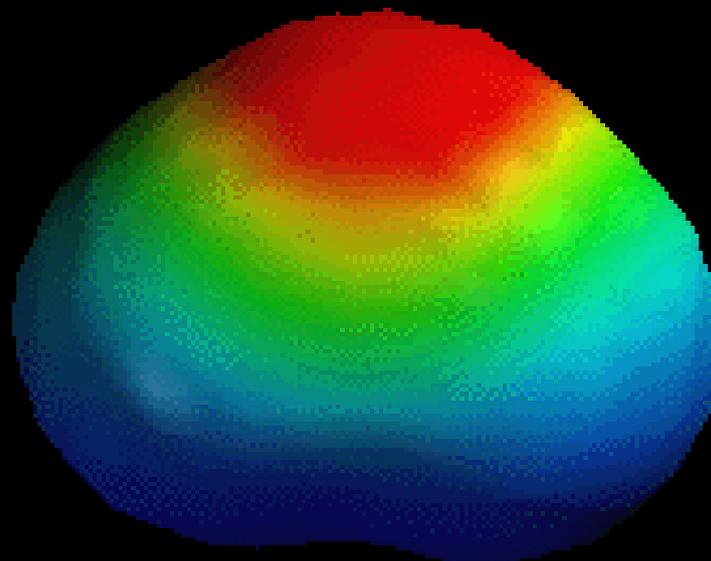
they were promptly photolysed into a family of radicals if exposed to UV in

water (Miller & Olejnik, Water Res 2001)

bond
dipole moments



1,85
molecular
dipole moment



H₂O (Water)

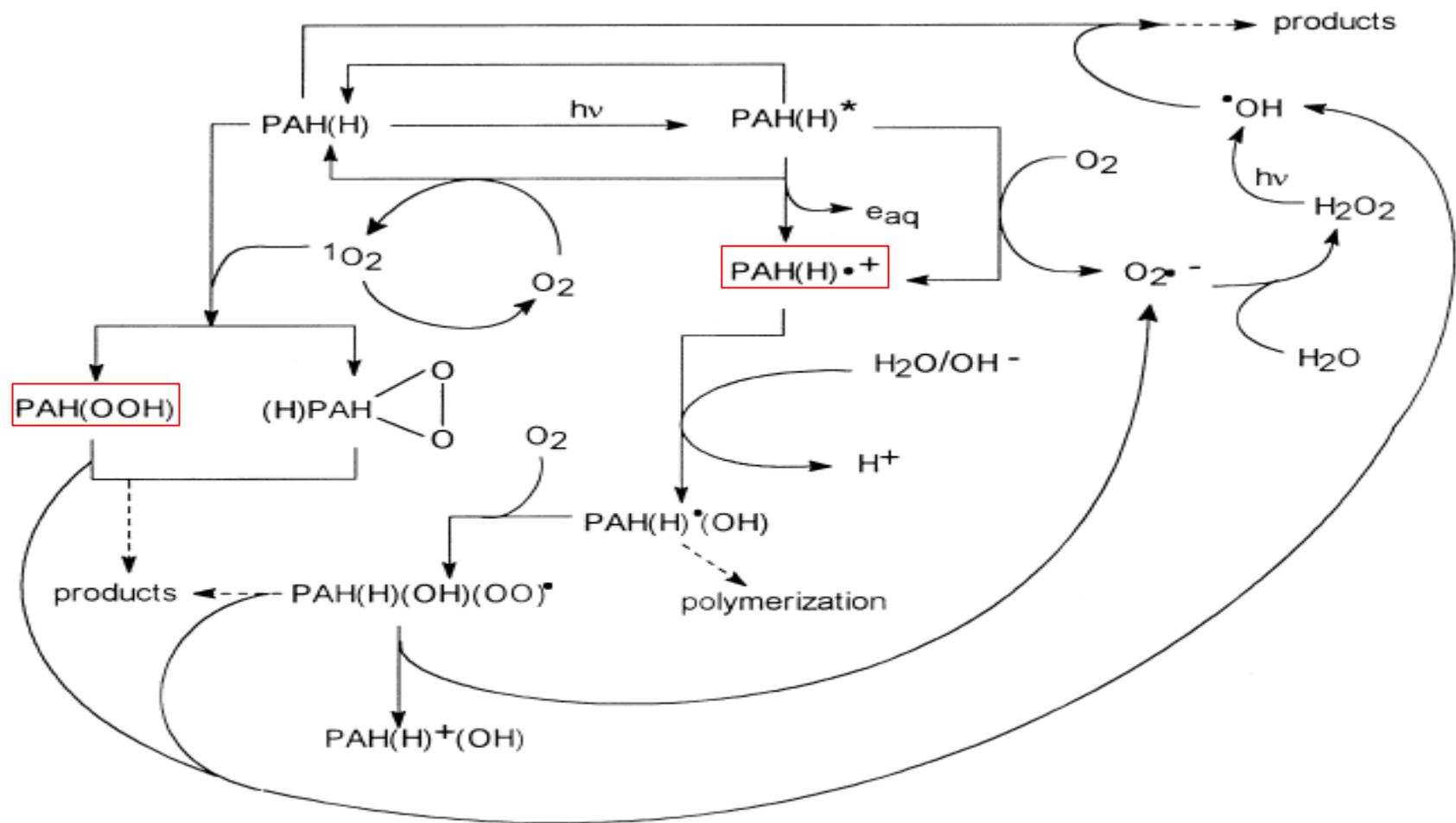


Fig. 7. Scheme of PAHs photodegradation pathways in the $\text{O}_2/\text{H}_2\text{O}$ system.

(Miller & Olejnik, Water Res 2001)

Oxygen (H_2O or OH^-) cause them to destabilize (electron-delocalization by deprotonation), as far as I am concerned, I saw just one paper reporting formation of CO-harboring groups as aromatic alcohols, ethers and ketones by irradiating PAHs+ H_2O ices in the lab

(Bernstein et al., Science 1999)

CONCLUSIONS (I)

Prebiotic C-O compounds as formaldehyde, methanol, methyl acetylene were never been reported as having appeared as byproducts of PAH photolysis, and, again as far as I am concerned, that's only history; that is a strong point to chase on

CONCLUSIONS (II)

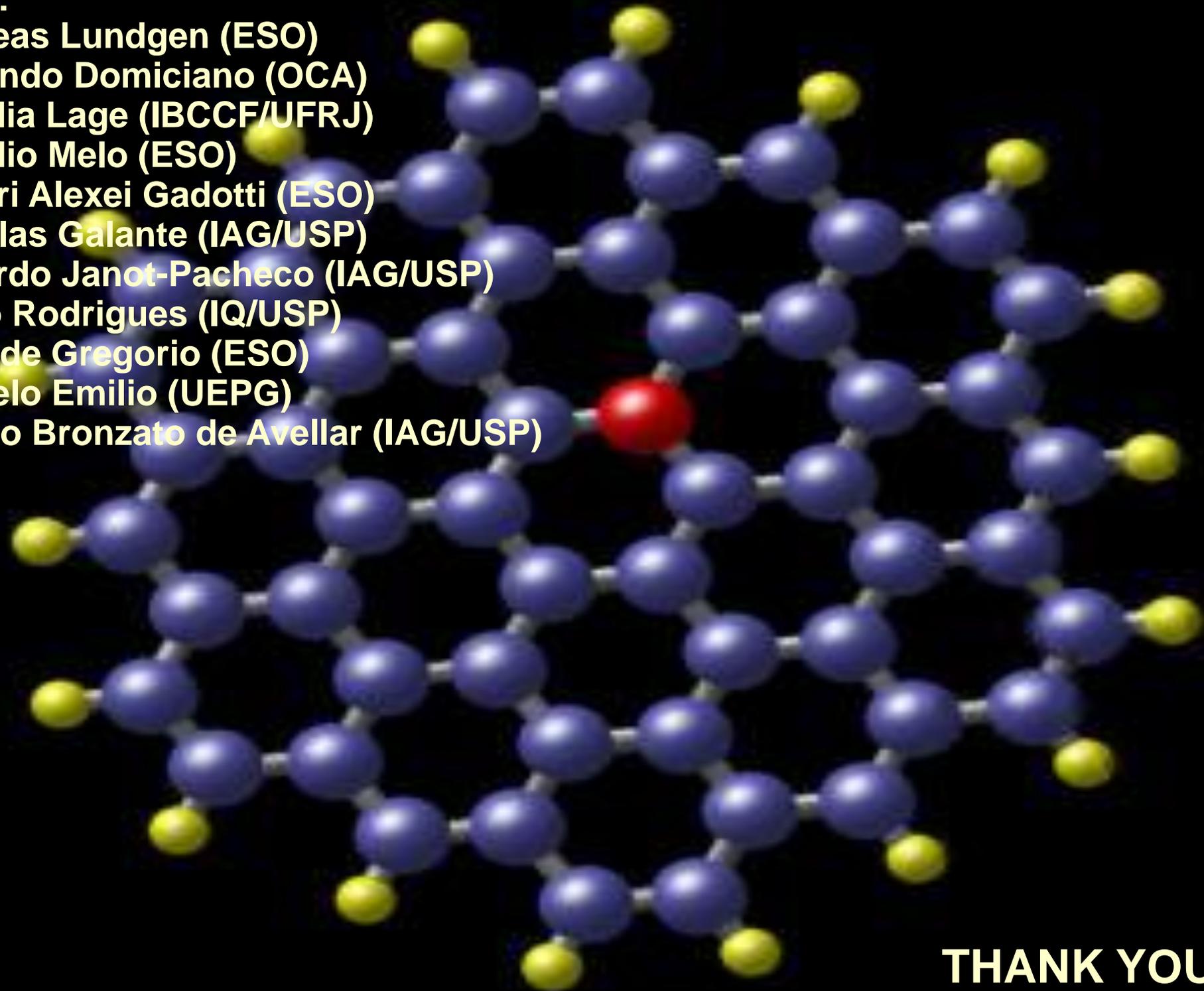
I invite our Astro team to look carefully the Spitzer database and other observational data on where, which and how much hydrocarbons were ever found to **MAP THEM TOGETHER**

Bands for some of the interesting compounds:

Methyl acetylene (CH_3CCH)	85GHz and 102.39GHz (range 1); 221.87 GHz (range 2)
Formylium (H^{13}CO^+)	86.67GHz (range 1)
Formylium (HCO^+)	88.89GHz (range 1)
Formaldehyde(H_2CO)	218GHz (range 2)
Formylium (H^{13}CO^+)	259.99GHz (range 2)
Formylium (HCO^+)	266.6GHz (range 2)
Formylium (H^{13}CO^+)	346.65GHz (range 3)
Formylium (HCO^+)	355.54GHz (range 3)
Methanol (CH_3OH)	241.46GHz (range 3) 241.53GHz (range 3) 241.55GHz (range 3) 241.60GHz (range 3)
Water vapor (H_2O)	324.83GHz (range 3) 620.08GHz (range 4)

Team:

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THANK YOU !!