

Department of Spectroscopy Overview

Full Time Equivalents (FTE)

PhD. or CSc. employees: 10.1 FTE (Senior scientists: 6 FTE)
 Master-level employees: 6.8 FTE (Students: 4.8 FTE)
 Undergraduate: 2 FTE (Students)

Team members

Head and vice-head

Dr. Ferus and Prof. Civiš

Junior Scientists

Dr. Saeidfirozeh,
 Dr. Chilukoti, Dr. Suchánek

Experienced and Senior Scientists

Dr. Kubelík, Prof. Zelinger, Dr. Kubát, Dr. Heays

R&D Technical Researchers

Ing. Lenža, Ing. Tkachenko, Ing. Ivanek, CSc., Ing. Engst, CSc.

Students

PhD.: Mgr. Knížek, Ing. Křivková, Ing. Pastorek; Ing. Dostál,
 Mgr.: Bc. Kaiserová, Bc.: Laitl, High School: Bechynský, Křížová

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65
Number of members	1	3	6	2	0	1	0	0	4

High Resolution Spectroscopy

Applied Spectroscopy



Martin
Ferus



Homa
Saeidfirozeh



Alan
Heays



Libor
Lenža



Dmitry
Tkachenko



Antonín
Knížek



Ondřej
Ivanek



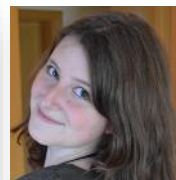
Vít
Bechynský



Lukáš
Petera



Anna
Křivková



Tereza
Kaiserová

Fundamental Spectroscopy



Svatopluk
Civiš



Petr
Kubelík



Ashok
Chilukoti



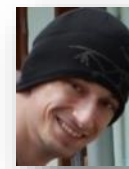
Vojtěch
Laitl



Jekatěrina
Zanozina



Radka
Křížová



Adam
Pastorek

Laser spectroscopy



Zdeněk
Zelinger



Michal
Dostál



Jan
Suchánek

Photo-physics



Pavel
Kubát



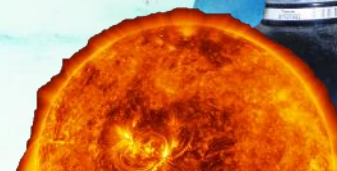
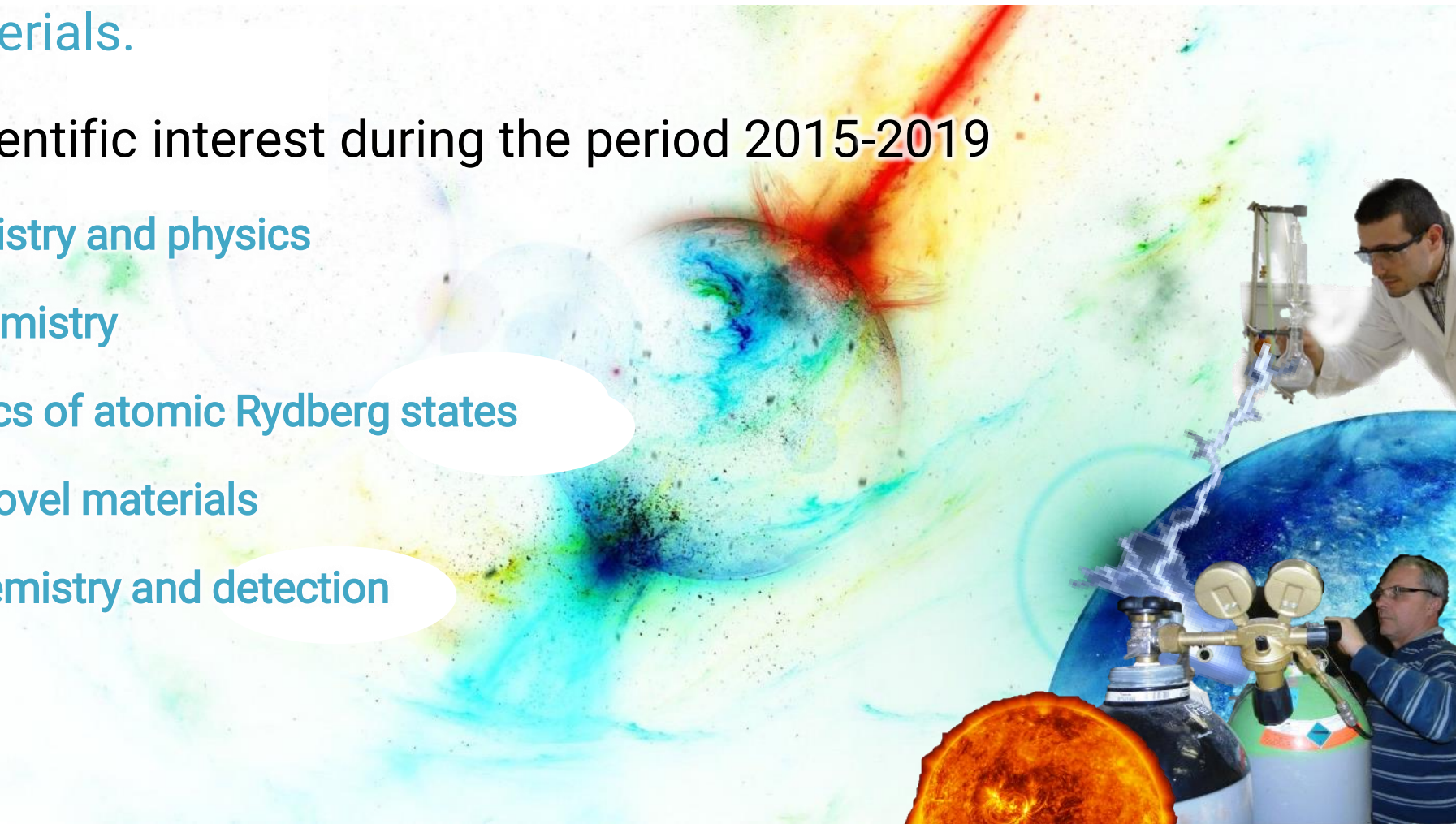
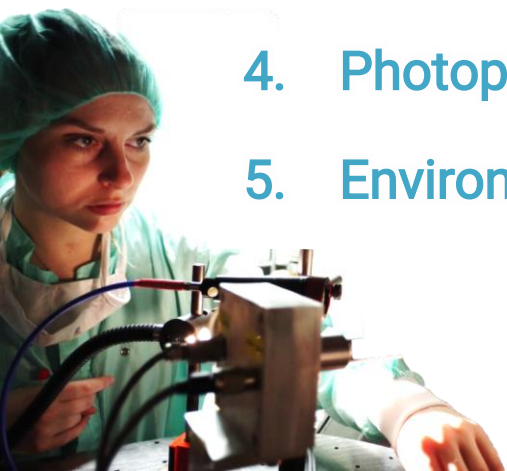
Pavel
Engst

Focus of the team: **mission** and **areas of interest**

Mission: To understand interstellar and planetary chemistry, to explore new transitions of atoms, molecules, ions and radicals, to discover novel detection techniques and new materials.

The main areas of scientific interest during the period 2015-2019

1. High-energy chemistry and physics
2. Early prebiotic chemistry
3. Spectra and physics of atomic Rydberg states
4. Photophysics of novel materials
5. Environmental chemistry and detection

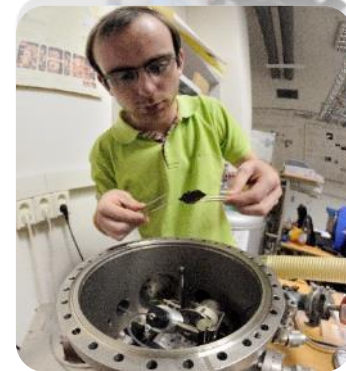


Focus of the team:

key methods and instruments

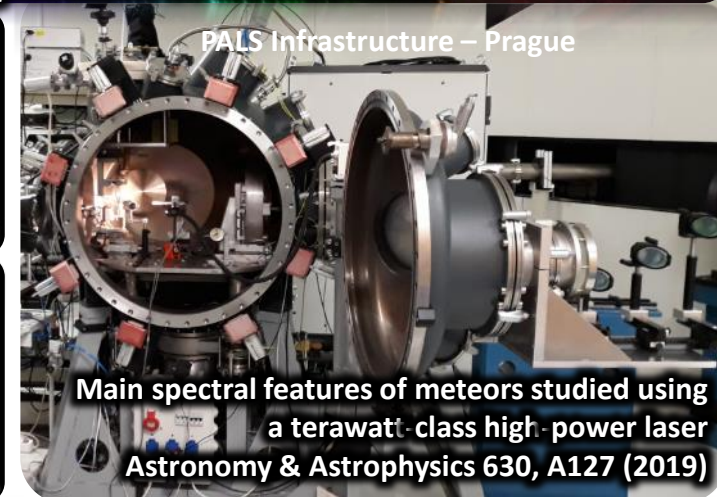
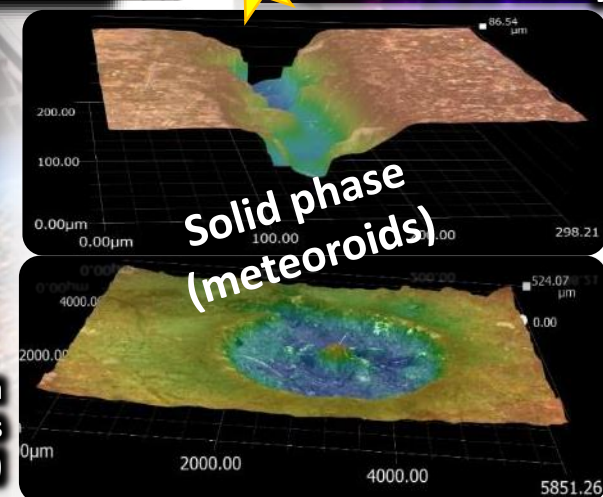
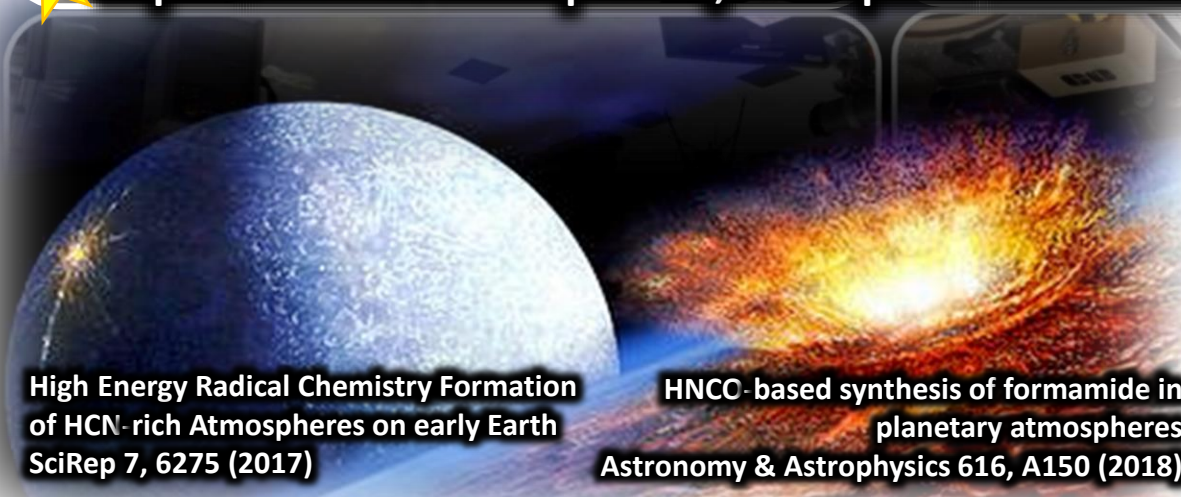
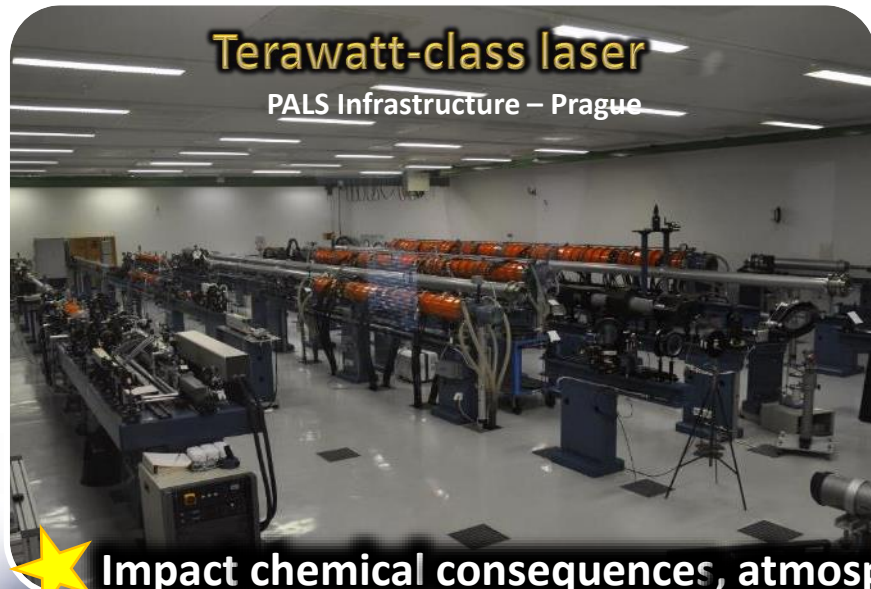
The key experimental methods and instruments used by the team are:

- High resolution FT Spectroscopy 650 to 35 000 cm^{-1} with resolution 10^{-3} cm^{-1}
(Bruker IFS 125, Bruker IFS 120, Bruker Vertex 80)
- High resolution echelle OES 200 – 780 nm (Echelle Butterfly with Andor ICCD)
- Gas chromatography / mass spectrometry (Thermo Scientific Trace 1310-ITQ 1100)
- Laser kinetic spectrometry in 280 - 900 nm and 1270 nm
(Applied Photophysics LKS 20)
- Laser spectrometry 9.6 - 1.5 μm (Laser Analytics LS-3 and FC/APC spectrometers, IR diode and quantum cascade lasers).
- Photoacoustic spectrometer (Gasera with PA201 PA Detector)
- Lasers 193, 308, 355, 360-790, 532 and 1064 nm (Compex 102 XeCl, Lambda Physics FL 3002 dye laser, 2 x Nd:YAG Laser Quantel, Lambda Physics and Excistar ArF lasers)
- CO_2 laser 9 – 11 μm
- Meteor observation cameras and sudden ionospheric disturbance monitors on cooperating observatories (Observatory Valašské Meziříčí and Krejčí Observatory in Carlsbad (Karlovy Vary, CZ)).
- Access to high power laser Prague Asterix Laser System (PALS, 1000 J, 1315 nm).
- Joined research and plasma diagnostics on (PALS)



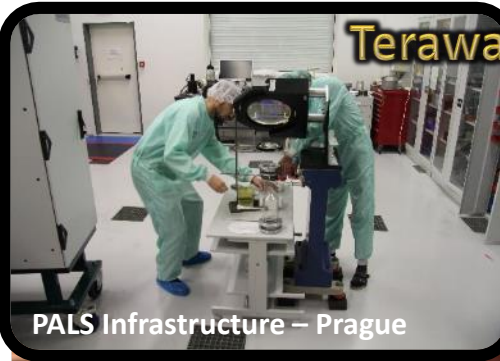
1. High-energy chemistry and physics

We are users of large laser infrastructures (PALS, HiLASE). The data are supported by our own table top laboratory experiments. We proceed with a modelling of planetary atmosphere chemistry. TC-LIBS supports estimation of meteoroid elemental meteoroids.



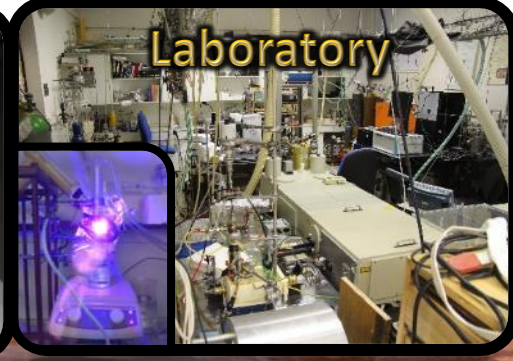
2. Early prebiotic chemistry

Subsequent complex laboratory studies show that origin of prebiotic substances during seconds in impact plasma is followed by chemistry taking place in impact crater for hundreds thousand of years.

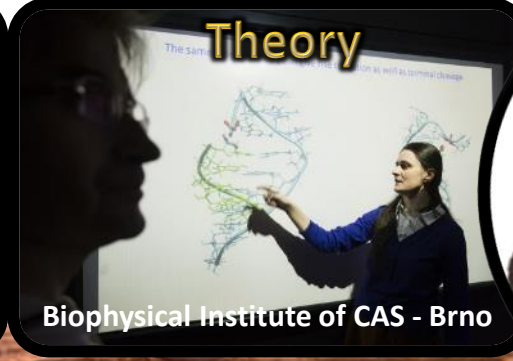


Terawatt-class laser

PALS Infrastructure – Prague

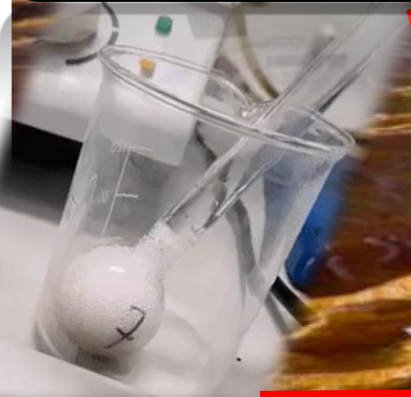


Laboratory



Theory

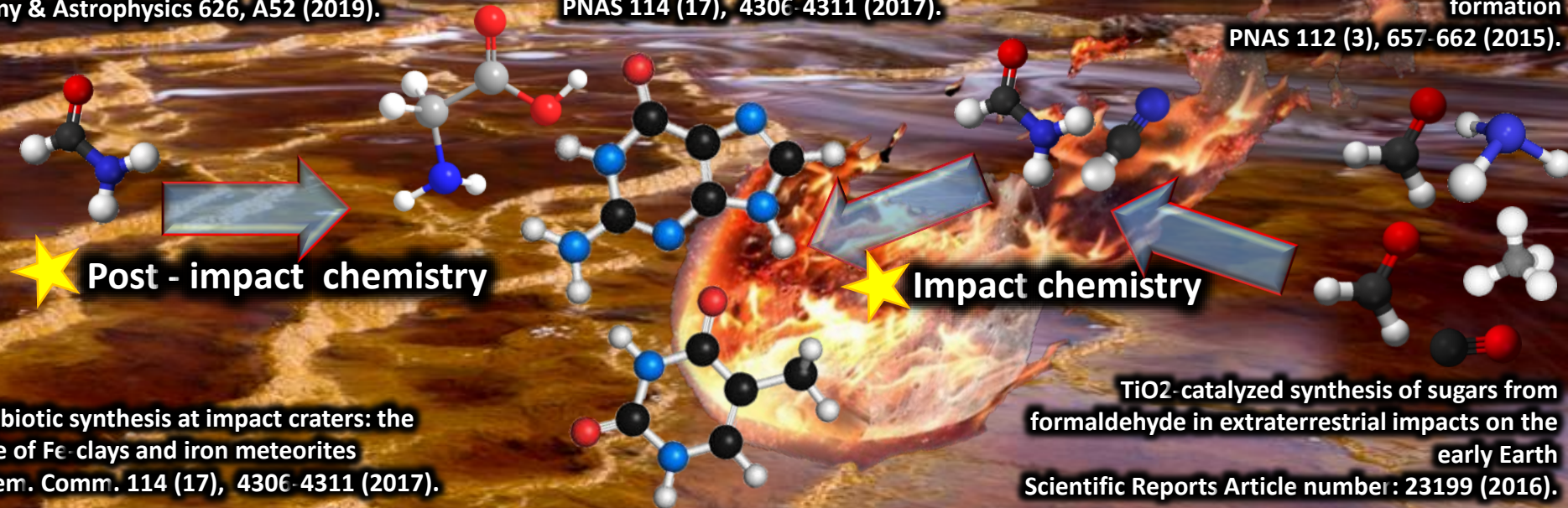
Biophysical Institute of CAS - Brno



Prebiotic synthesis initiated in formaldehyde by laser plasma simulating high-velocity impacts
Astronomy & Astrophysics 626, A52 (2019).

Formation of nucleobases in a Miller-Urey reducing atmosphere
PNAS 114 (17), 4306-4311 (2017).

High-energy chemistry of formamide: A unified mechanism of nucleobase formation
PNAS 112 (3), 657-662 (2015).



Prebiotic synthesis at impact craters: the role of Fe-clays and iron meteorites
Chem. Comm. 114 (17), 4306-4311 (2017).

TiO₂-catalyzed synthesis of sugars from formaldehyde in extraterrestrial impacts on the early Earth
Scientific Reports Article number: 23199 (2016).

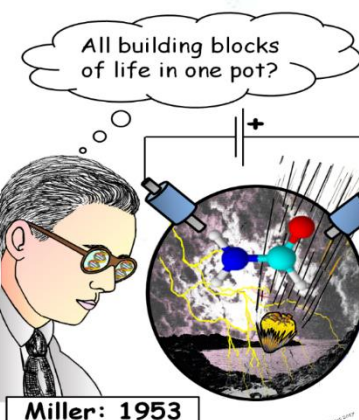


Early Mars

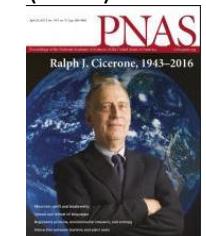
2. Early prebiotic chemistry

Direct Impact Chemistry

Post Impact Chemistry



PNAS
112:657-662
(2015).



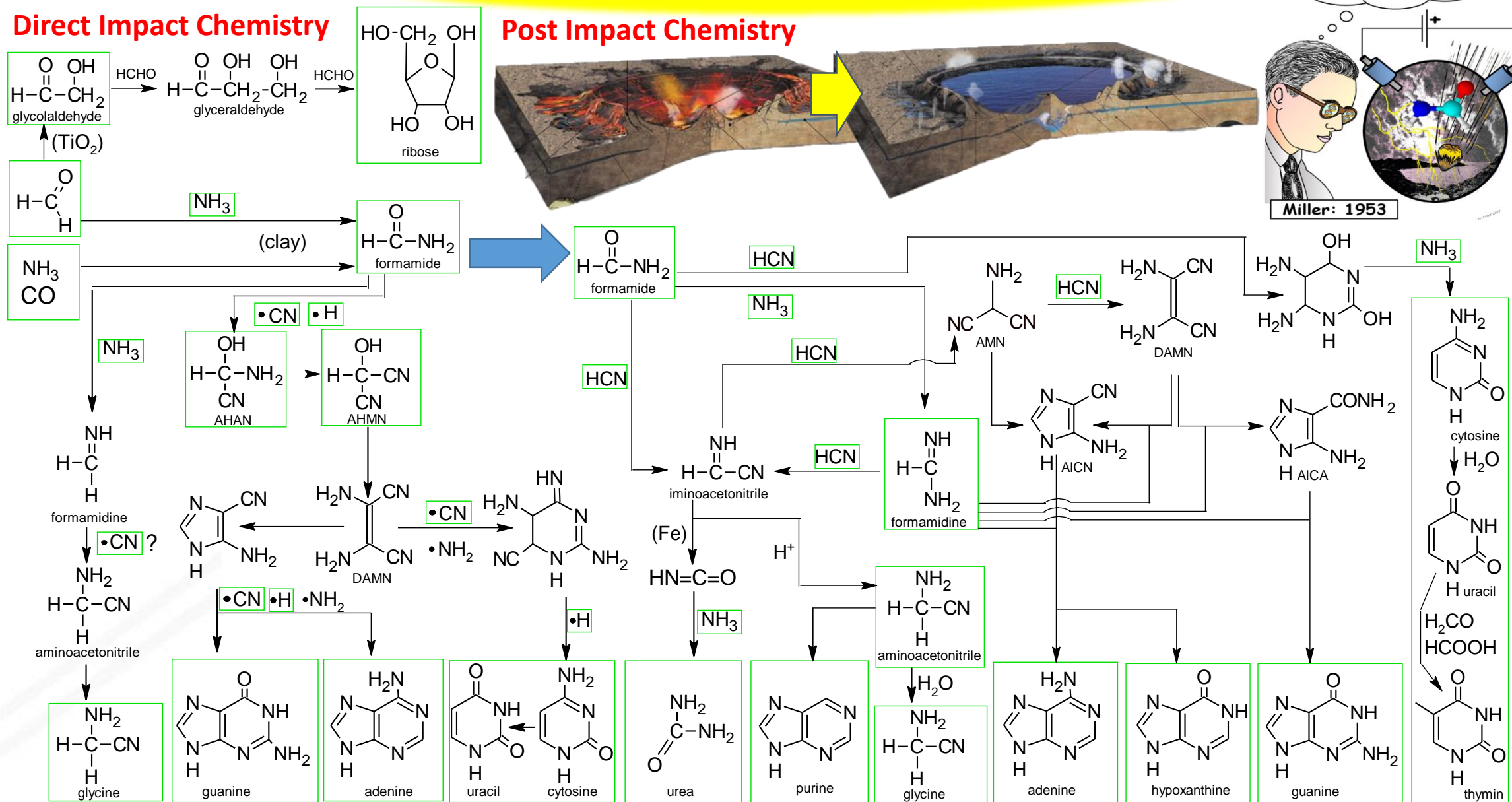
PNAS
114:4306-4311
(2017).



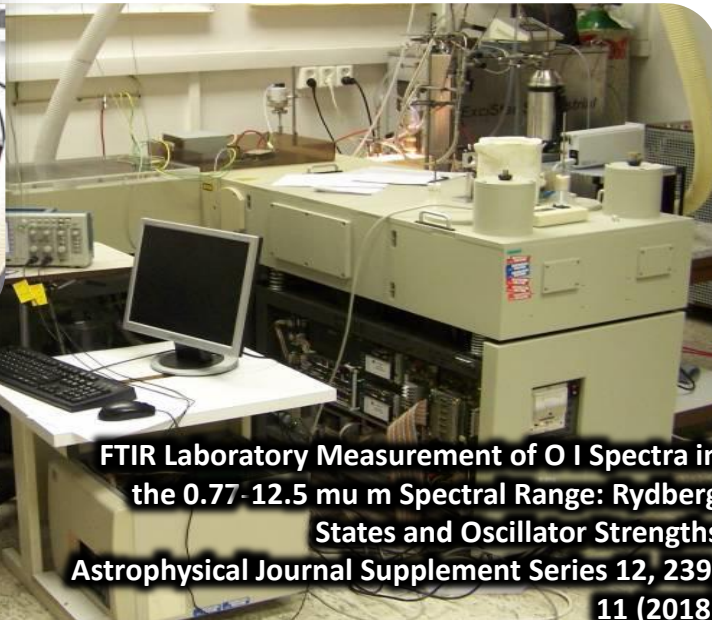
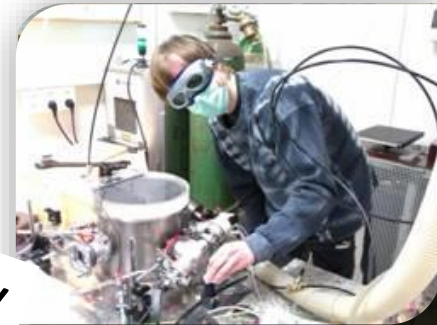
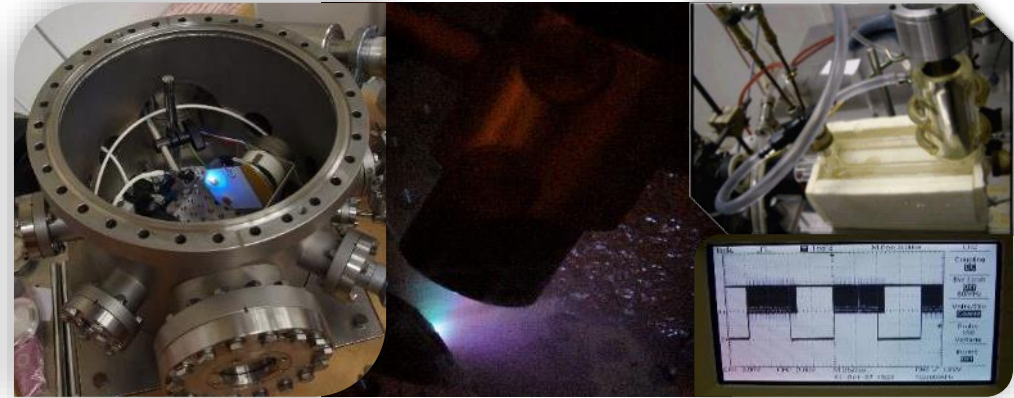
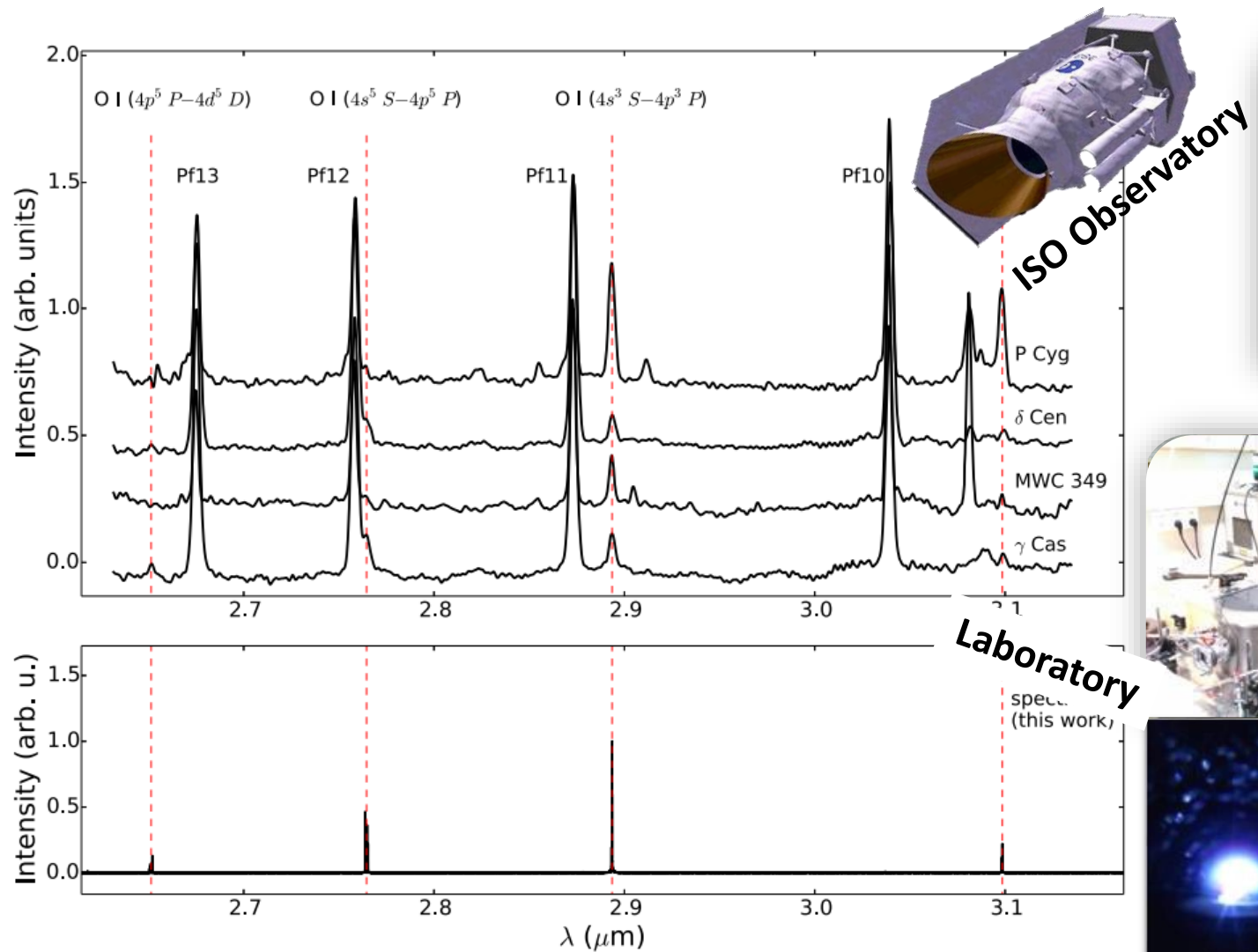
Nature Astronomy
1:721-726
(2017).



ChemComm
71:10563-10566
(2019).



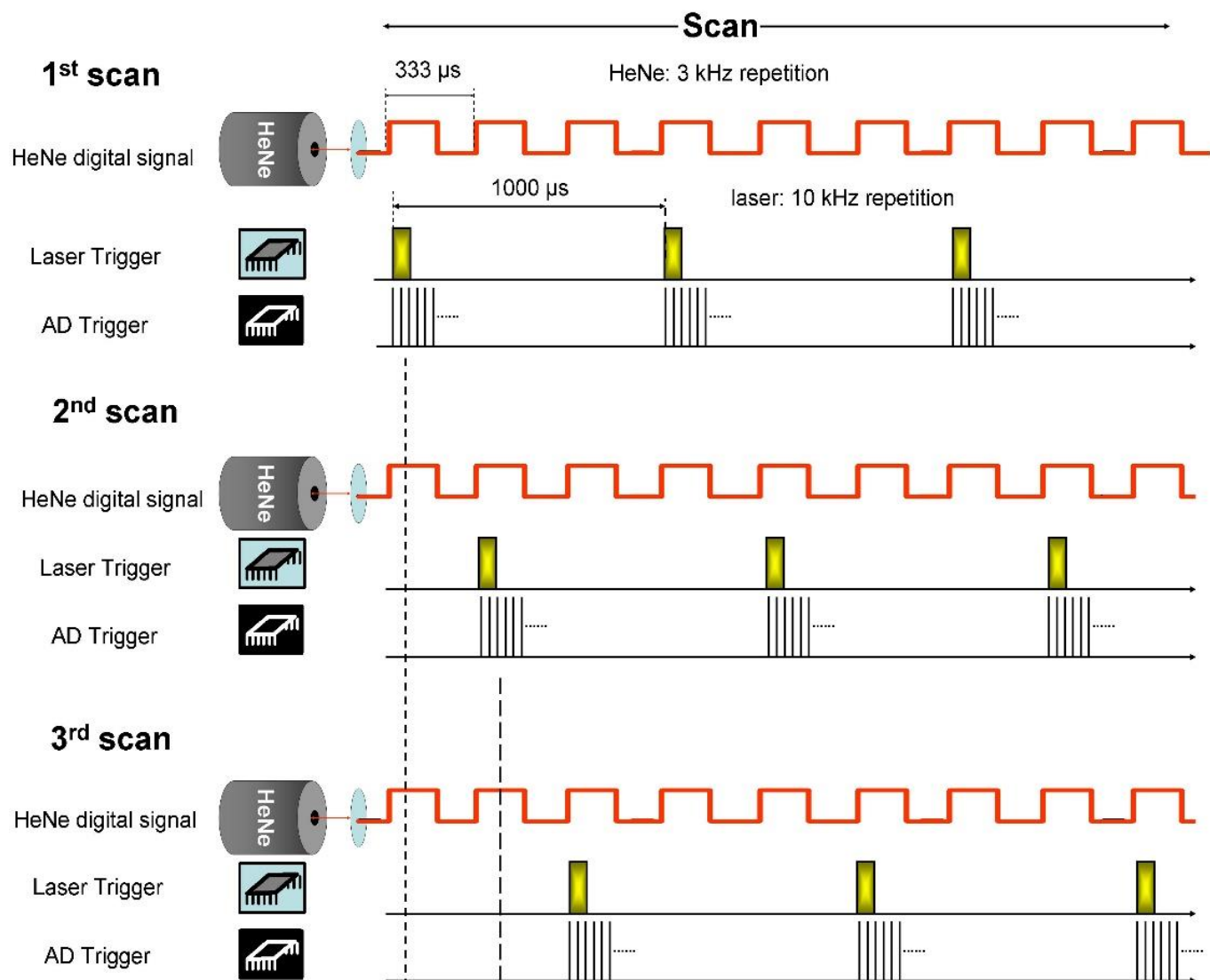
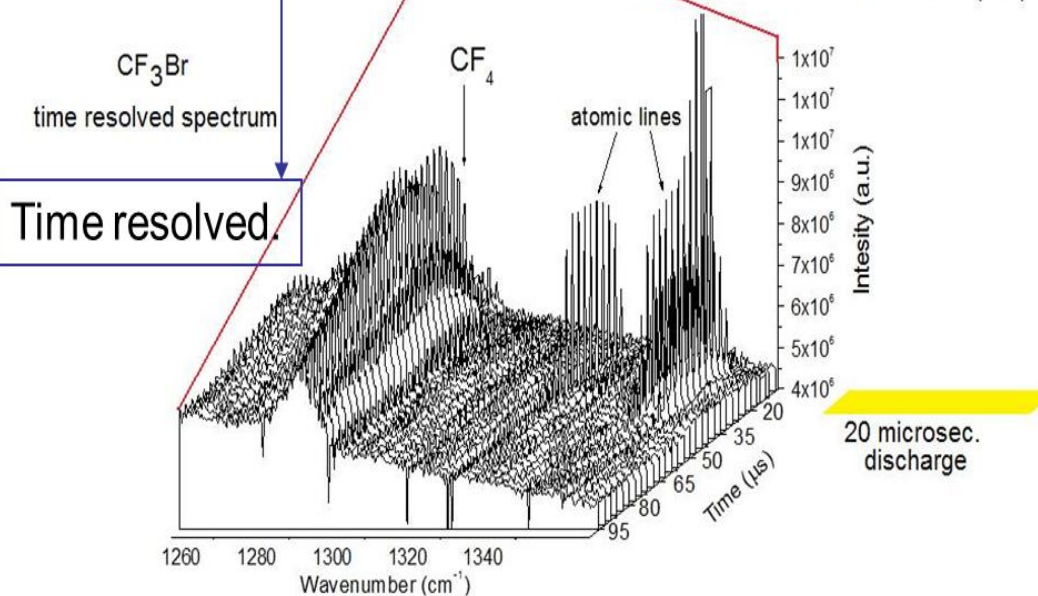
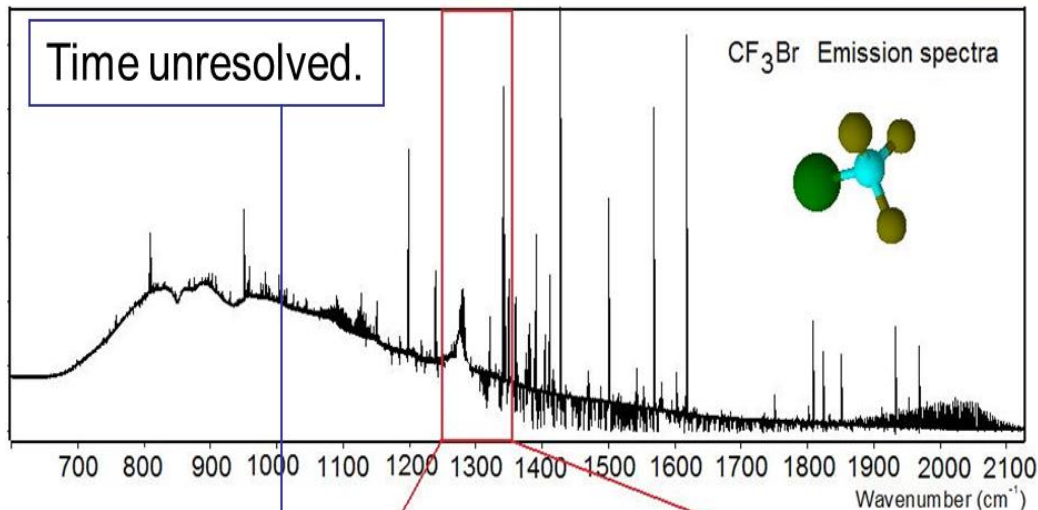
3. Spectra and physics of atomic Rydberg states



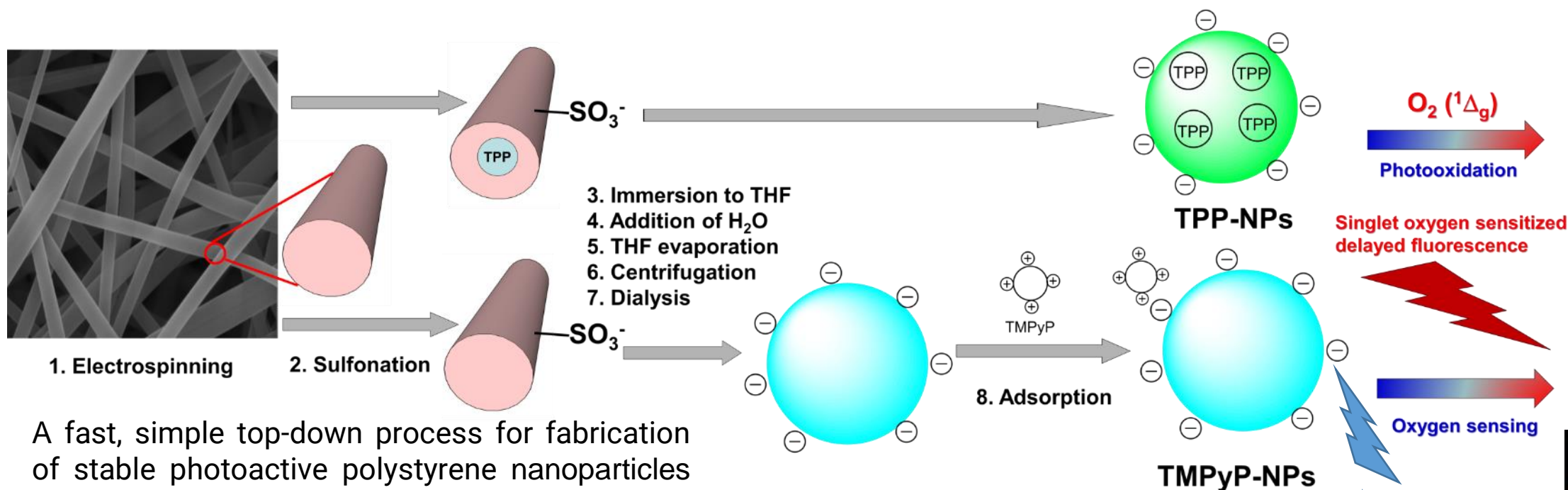
FTIR Laboratory Measurement of O I Spectra in the 0.77-12.5 μm Spectral Range: Rydberg States and Oscillator Strengths
 Astrophysical Journal Supplement Series 12, 239, 11 (2018)

Highlight of...

3. Spectra and physics of atomic Rydberg states

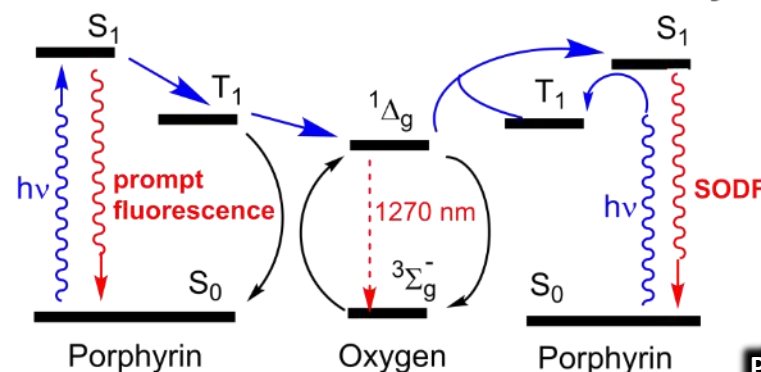


4. Photophysics of novel materials



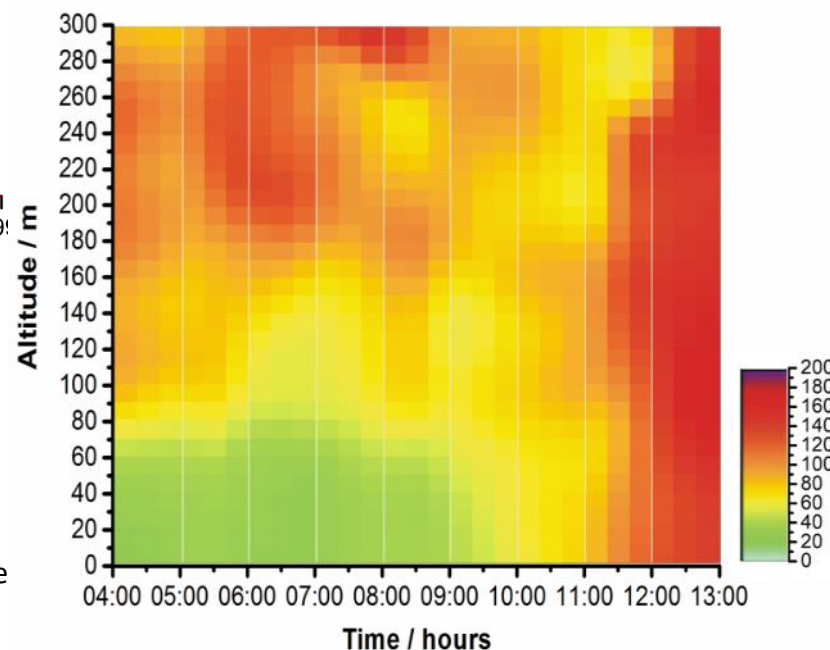
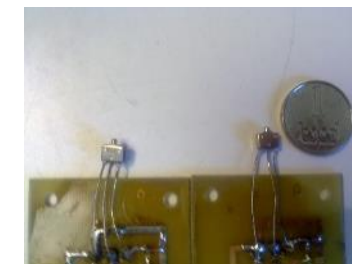
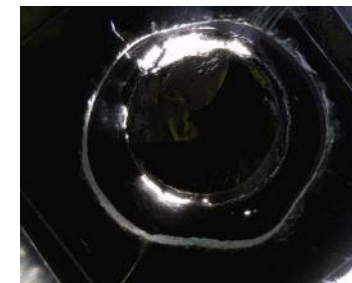
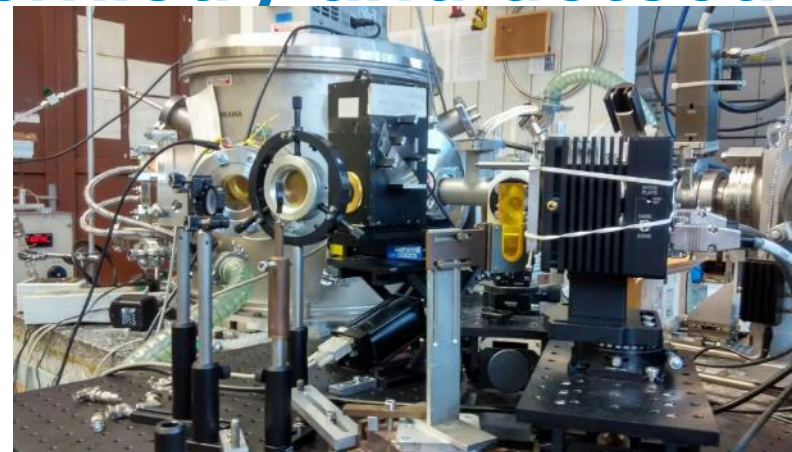
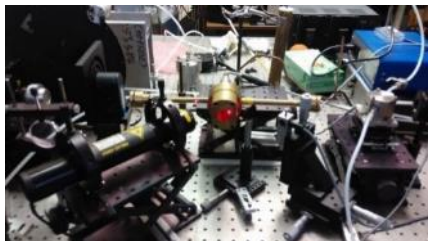
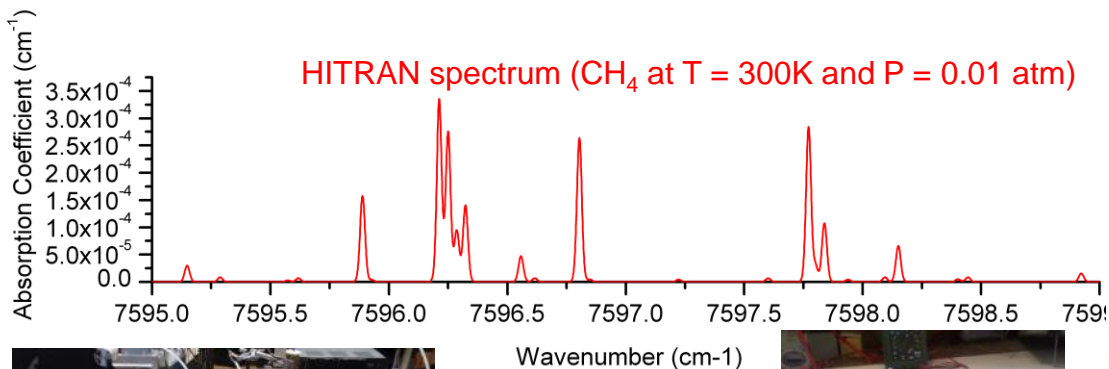
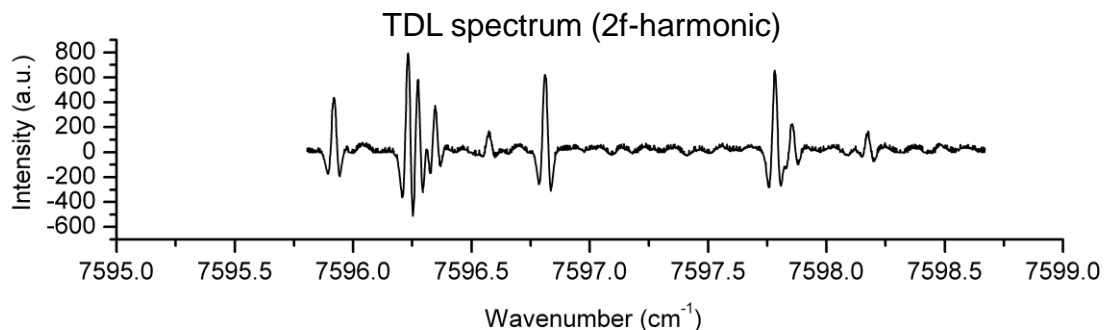
A fast, simple top-down process for fabrication of stable photoactive polystyrene nanoparticles with strong antibacterial and antiviral properties from polystyrene electrospun nanofiber material.

Description of a new sensitive method for measurement of oxygen and/or singlet oxygen concentrations based on singlet oxygen sensitized delayed fluorescence .



Nanoparticles with Embedded Porphyrin Photosensitizers for Photooxidation Reactions and Continuous Oxygen Sensing
 ACS Appl. Mater. Interfaces 9, 36229-36238 (2017).

5. Environmental chemistry and detection



First application of multilayer graphene cantilever for laser photoacoustic detection Measurement, 101 (2017) 9-14.

Environmental influence of photochemical processes has been investigated in a particular urban street canyon. An approach using a photochemical reactor to describe processes in a street canyon atmosphere was developed and verified as a useful tool for prediction purposes.

The combination of sensitive microphones and **micromechanical elements** with advanced laser techniques offers us a precise method for the studies of chemical sensing possibilities.

Time development of ozone: vertical distribution in the canyon of Legerova Street measured by DIAL in July (sunny weather) in μgm^{-3} .

Grants (active 2015-2019)

21 grants were running at the department (most of them funded by GAČR and MEYS) during 2015-2019

Sorted by Agencies

- 9 grants funded by the **GAČR** (Czech Science Foundation)
- 5 grants funded by the **MEYS** (Czech Ministry of Education, Youth and Sports)
- 5 grants funded by the **CAS** (Czech Academy of Sciences)
- 2 grants funded by the **TAČR** (Czech Technological Foundation)

Sorted by Persons

- 6 grants CoPI or PI Prof. Civiš
- 7 grants CoPI or PI Dr. Ferus
- 5 grants CoPI or PI Prof. Zelinger
- 2 grants CoPI or PI Dr. Kubát
- 1 grant CoPI or PI Dr. Kubelík

International Collaboration: ARIEL

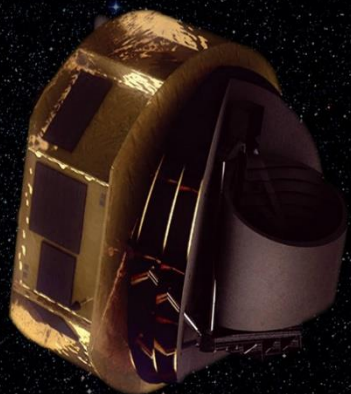


ariel-spacemission.eu

ARIEL consortium meeting

by ARIEL consortium

2.5 days meeting with scientific, technical and programmatic sessions to start ARIEL Phase B work



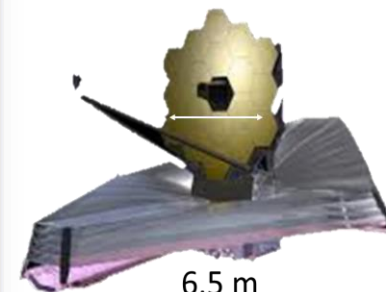
Prague

From Tuesday, 8 May 2018, 10:30 CEST
To Thursday, 10 May 2018, 16:00 CEST

More information about the event

<https://www.eventbrite.co.uk/e/ariel-consortium-meeting-tickets-44468379119>

Heyrovsky Institute of Physical Chemistry,
Czech Academy of Sciences
Dolejšková 2155/3, 182 23 Prague
Czech Republic



6.5 m

James Webb (2021 - ?)



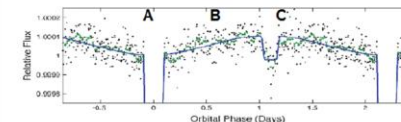
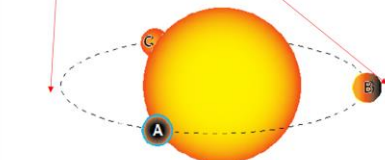
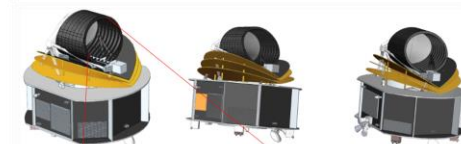
2.4 m

Hubble (1990 – 2030)



1.2 m

Ariel (2028 – 2032)



Awards (2015-2019)

- **M. Ferus: 2015:** The Josef Hlávka Award
- **M. Ferus: 2016:** The Otto Wichterle Award
- **M. Ferus: 2016:** The Award of the Czech Learned Society
- **P. Váňa: 2017:** The best secondary school thesis award (supervisor: M. Ferus)
- **P. Váňa: 2017:** The J. Heyrovský Award
- **V. Laitl: 2018:** The Czech Head Award for young students (supervisor: P. Kubelík)
- **A. Knížek: 2018:** The J. M. Marci Award for the best diploma thesis (supervisor: M. Ferus)
- **S. Civiš: 2018:** Doctor of Science
- **A. Knížek: 2019:** The Best Poster Award on EANA conference

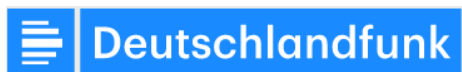


Outreach

The members of the team have positive attitude towards presentation of the most interesting results to general public.

National media

- Czech Television – Our original research has been repeatedly reported in main news „Události,“ morning show Studio 6 and popular scientific journal Hydepark Civilizace. Dr.Ferus has repeatedly commented on new discoveries concerning planetary chemistry of Mars and Venus.
- Czech Radio – Repeated interview on our original research in scientific shows Studio Leonardo and Meteor.
- Printed media: Popularization articles, interviews in popular journals and newspapers.
- **International media**
- More than 30 outputs mainly concerning research on origin of life published in PNAS.



Asteroideneinschläge

Notwendige Hitze für die Ursuppe des Lebens

Wie sind die ersten Organismen auf der Erde entstanden? Darüber gibt es viele Spekulationen – und ein tschechisches Forscherteam fügt nun eine weitere hinzu: Demnach wurden zentrale Bausteine des Lebens quasi gewaltsam gebildet, und zwar, als reihenweise Asteroiden auf der jungen Erde einschlugen.

газета.ru
Ученые нашли основания для ЖИЗНИ
 Ученые: удар астероида мог подтолкнуть к зарождению жизни на Земле
 Отдел «Наука» 24.04.2017, 17.36

DERSTANDARD

ENTSTEHUNG DES LEBENS
Überraschung bei neuen Experimenten mit der "Ursuppe" der Erde
 Simulierte Bedingungen auf der jungen Erde führten im Labor zur Entstehung von RNA-Grundbausteinen
 17. April 2017, 19:12 270 Postings



Publications: 60 in impacted journals (2015-2019)

Journal Classification	Number of publications
D1	13
Q1	13
Q2	13

Note: Evaluated by the CAS.

PHYSICAL REVIEW LETTERS

nature astronomy

Astronomy
&
Astrophysics

PNAS

Inorganic Chemistry

ChemComm

IF (2019)	Journal	Results
11.518	Nature Astronomy	1
9.412	Proceedings of the National Academy of Sciences of the United States of America	3
8.758	ACS Applied Materials and Interfaces	4
8.385	Physical Review Letters	1
8.374	Astrophysical Journal Letters	1
7.95	Astrophysical Journal. Supplement Series	1
7.632	ACS Sustainable Chemistry & Engineering	1
7.098	Topics in Current Chemistry	1
6.895	Nanoscale	1
6.205	Journal of Medicinal Chemistry	1
5.996	Chemical Communications	1
5.636	Astronomy & Astrophysics	5
5.047	Journal of Materials Chemistry B	1
4.85	Inorganic Chemistry	3
4.613	Dyes and Pigments	1
4.189	Journal of Physical Chemistry C	2
4.152	ACS BIOMATERIALS SCIENCE & ENGINEERING	1

Note: Conclusion made by the head of department: 50 % of papers appear in journals with IF > 4

