European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs & MC Meeting at SOFIA (BG), 16-18 December 2015

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

Remote sensing of biogas methane employing tracking – gas analyser on powerful pulsed laser diodes

Dr. Stoyan Penchev

Function in the Action (WG Member, Sub-WG Leader, SIG or WG Leader, Chair)

Institute of Electronics, BAS, Bulgaria

Email **spenchev@ie.bas.bg**

Scientific context and objectives in the Action

- General method of spectral analysis using dual-wavelength sensor of optical interaction

Topic 1. Electronic, ionic and optical techniques for development of new materials and methods for their characterization. Nanomaterials and nanotechnologies.

1.3. New magnetic materials and superconductivity;

Topic 2. Photonics for quality of life improvement: photonic techniques for analysis of media and structures.

2.2. Remote sounding of the atmosphere: remote studies of aerosol processes, cloud formations and gaseous pollution in the atmosphere over Republic of Bulgaria and across Europe

Scientific context and objectives in the Action

AGU PUBLIC

Geophysical Resea

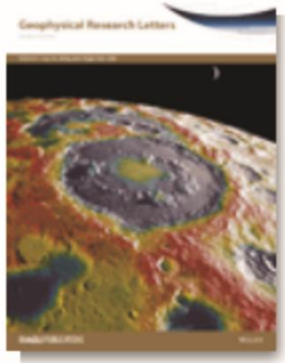
RESEARCH LETTER

10.1002/2014GL059650

The author is also Master of physics from St. Kliment Ohridski University in Sofia, Bulgaria, Doctor of physics and mathematics from A. M. Prohorov General Physics Institute, Moscow, associate researcher with the Institute of Physical and Chemical Research, RIKEN, Japan, bilateral research fellow of Bulgarian and Japanese ministries of education, laureate of the institutional Academician Djakov Award for achievements in science, with expertise in theoretical solid state physics, laser physics and spectroscopy, laser photo-thermal techniques for material science, and lidar remote sensing.

Key Points:

Geophysical Research Letters



Impact Factor: **4.196**

ISI Journal Citation Reports © Ranking: 2012: 11/172 (Geosciences Multidisciplinary)

Online ISSN: 1944-8007

All Issues | Early View Articles | Accepted Articles

2014 | 2013 | 2012 | 2011 | 2010 | All Issues (1974 - 2014)

2014 - Volume 41 Geophysical Research Letters

Volume 41, Issue 10, Pages i-vi, 3323-3689, 28 May 2014

Volume 41, Issue 9, Pages i-v, 3017-3321, 16 May 2014

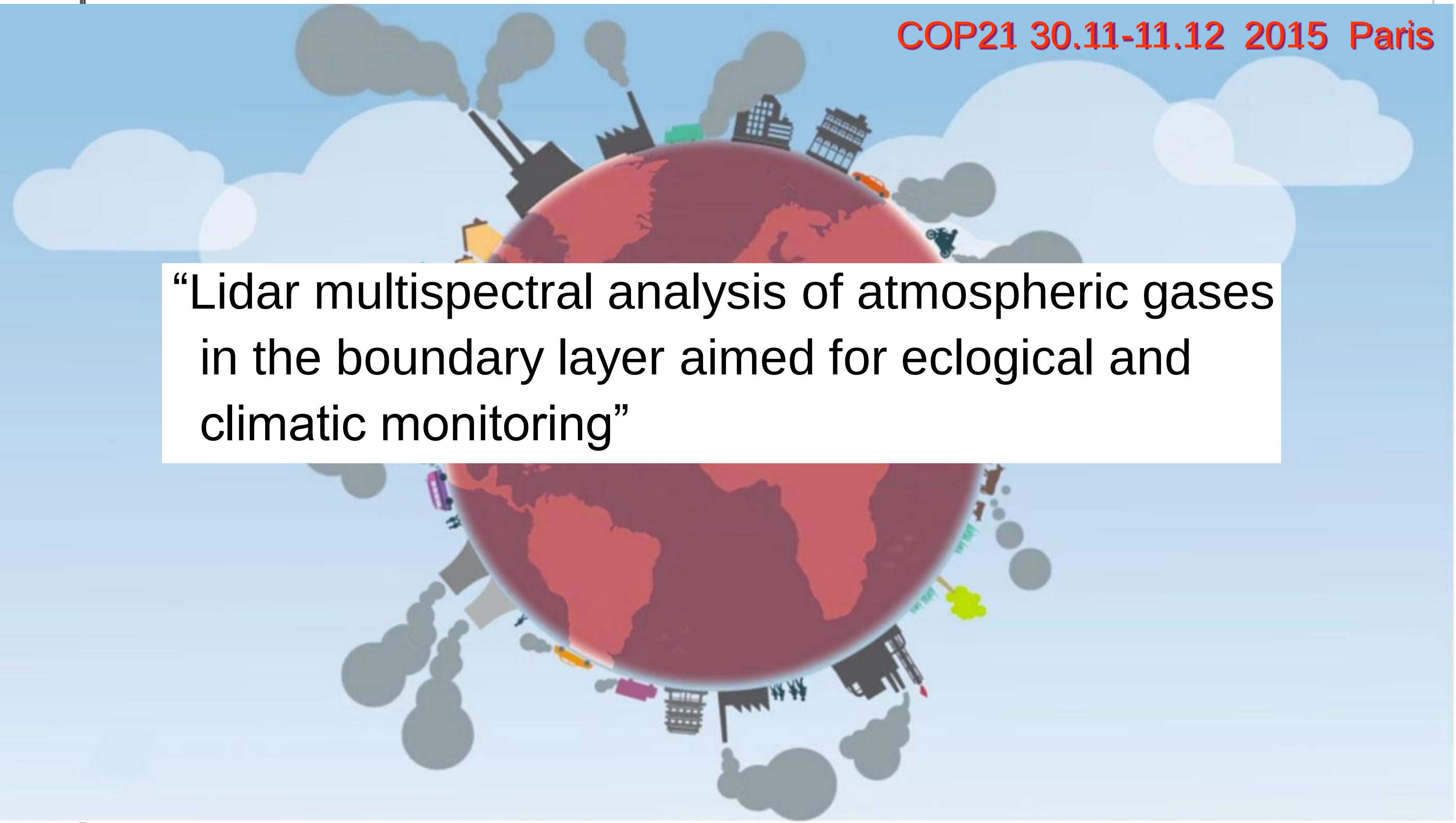
Volume 41, Issue 8, Pages i-vi, 2671-3016, 28 April 2014

Volume 41, Issue 7, Pages i-vi, 2237-2670, 16 April 2014

Volume 41, Issue 6, Pages i-vi, 1817-2235, 28 March 2014

Scientific context and objectives in the Action

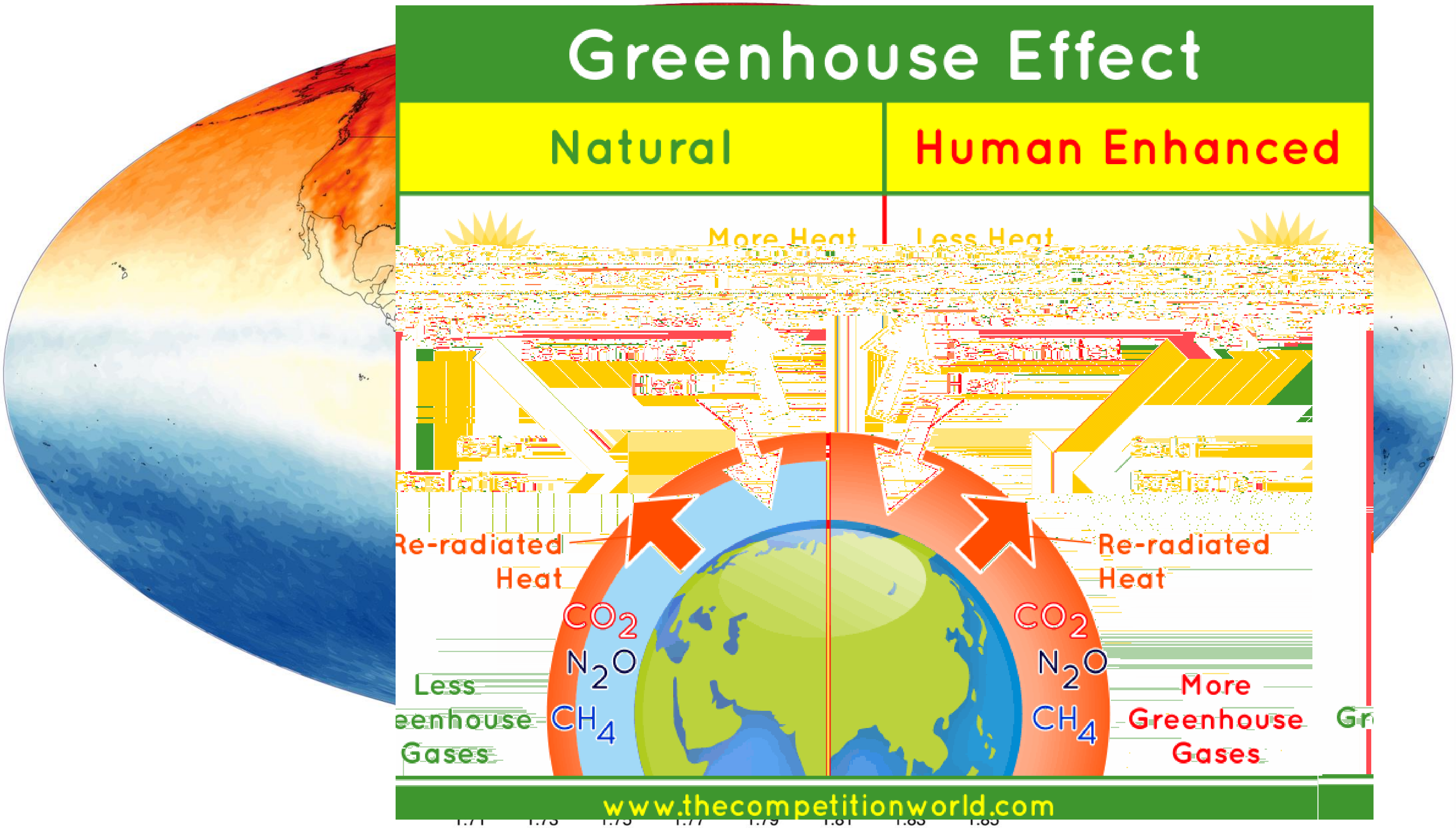
Vacuum 96 (2013) 7–11



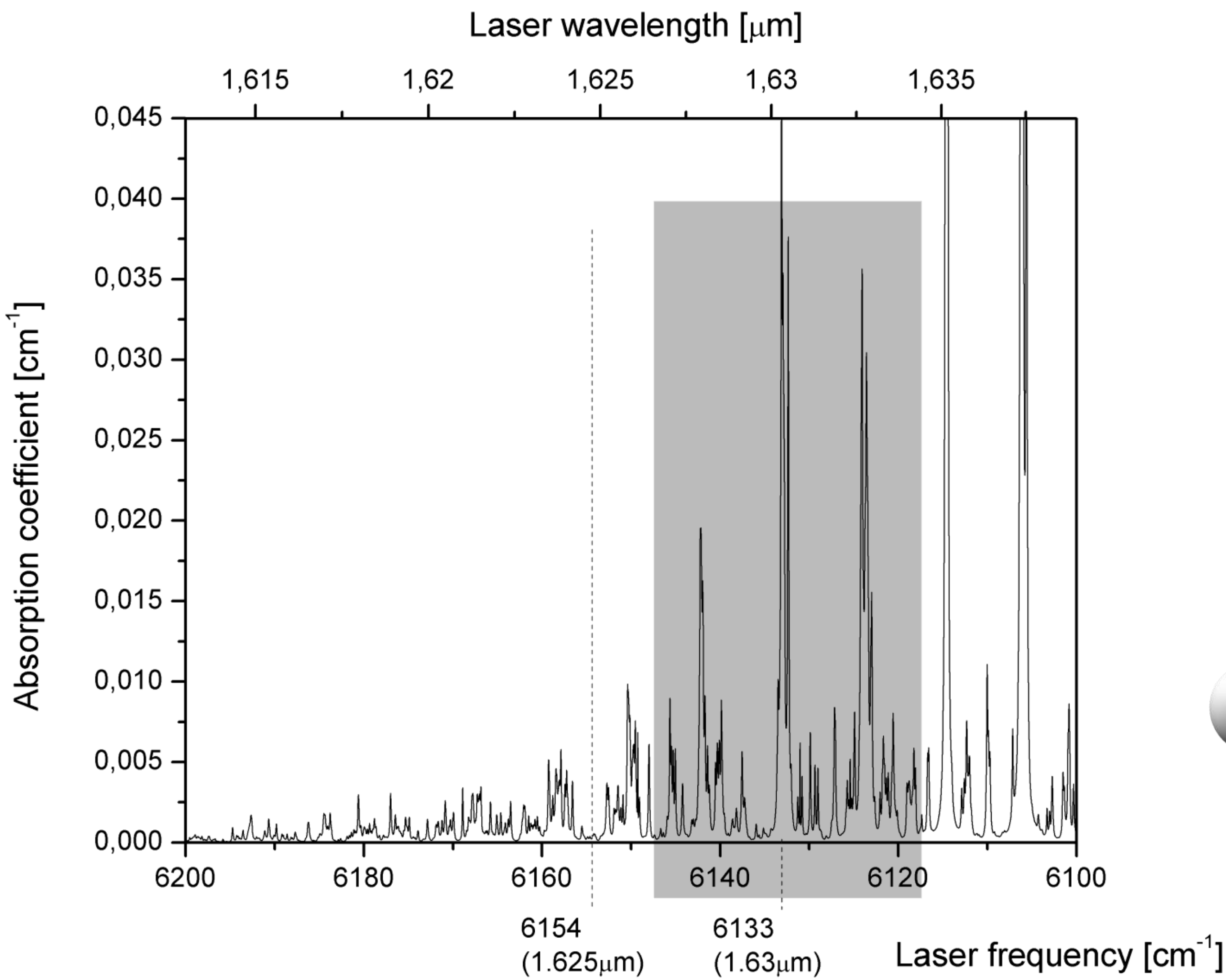
COP21 30.11-11.12 2015 Paris

"Lidar multispectral analysis of atmospheric gases in the boundary layer aimed for eclogical and climatic monitoring"

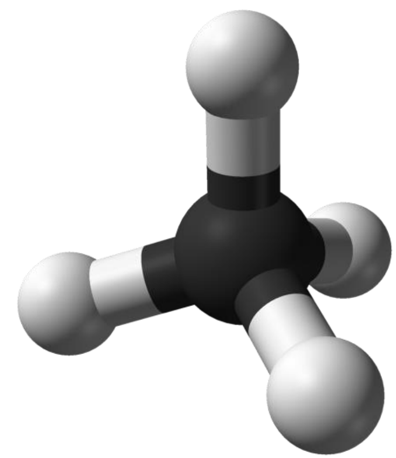
Current research activities of the Partner (1/4)



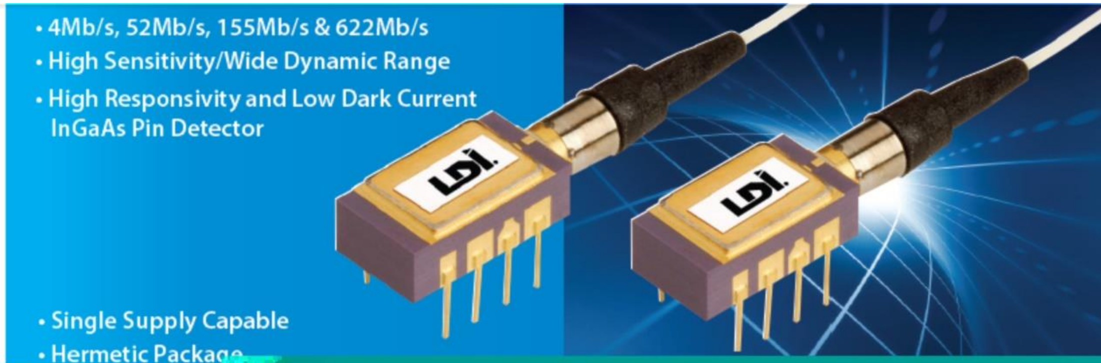
Current research activities of the Partner (2/4)



CH4



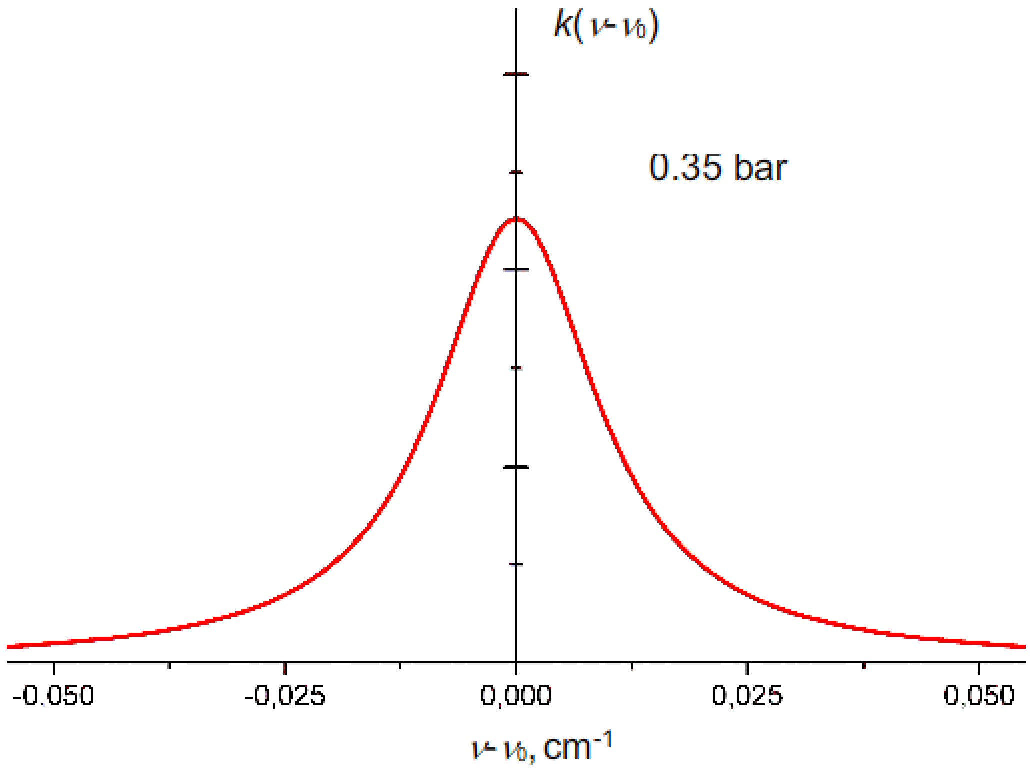
Suggested R&I Needs for future research



Current research activities of the Partner (3/4)

Resonance absorption (Beer's law) and linestrength
of a vibration-rotational excitation :

$$A(T)=\int_{\nu}\ln\frac{I_0}{I(T)}d\nu=\int_{\nu}k(\nu,T)l\,d\nu=S(T)Nl$$



- I_0/I - ratio of initial and absorbed intensity of the laser line
- ν - laser frequency [cm^{-1}]
- l - lidar path (double-pass) [cm]
- N - gas concentration [mol/cm^3]
- $k(\nu)$ - absorption coefficient [cm^{-1}]
- $S(T)$ - linestrength of a resonance absorption line [cm/mol]
- T - temperature

Current research activities of the Partner (3/4)

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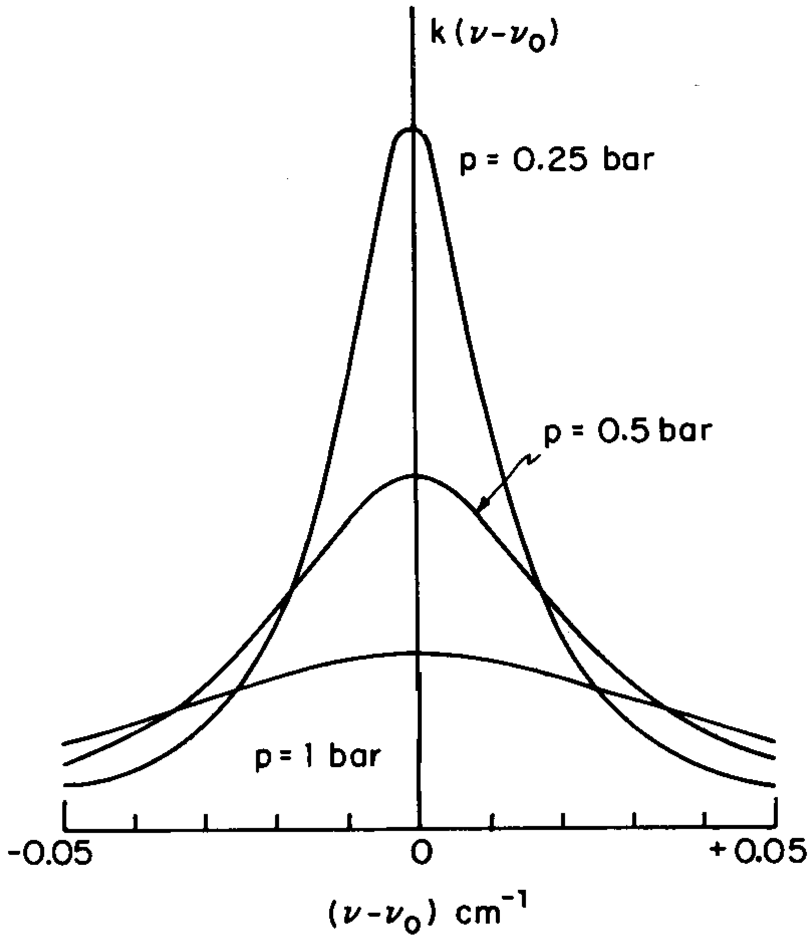

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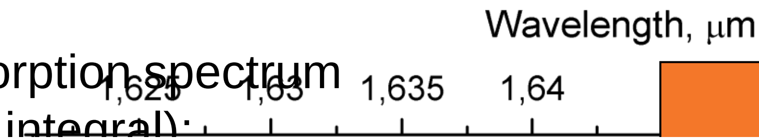
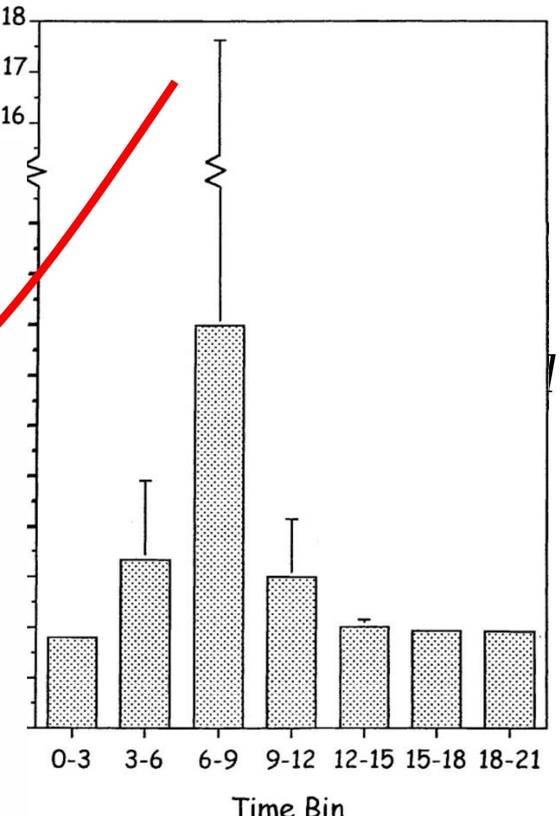
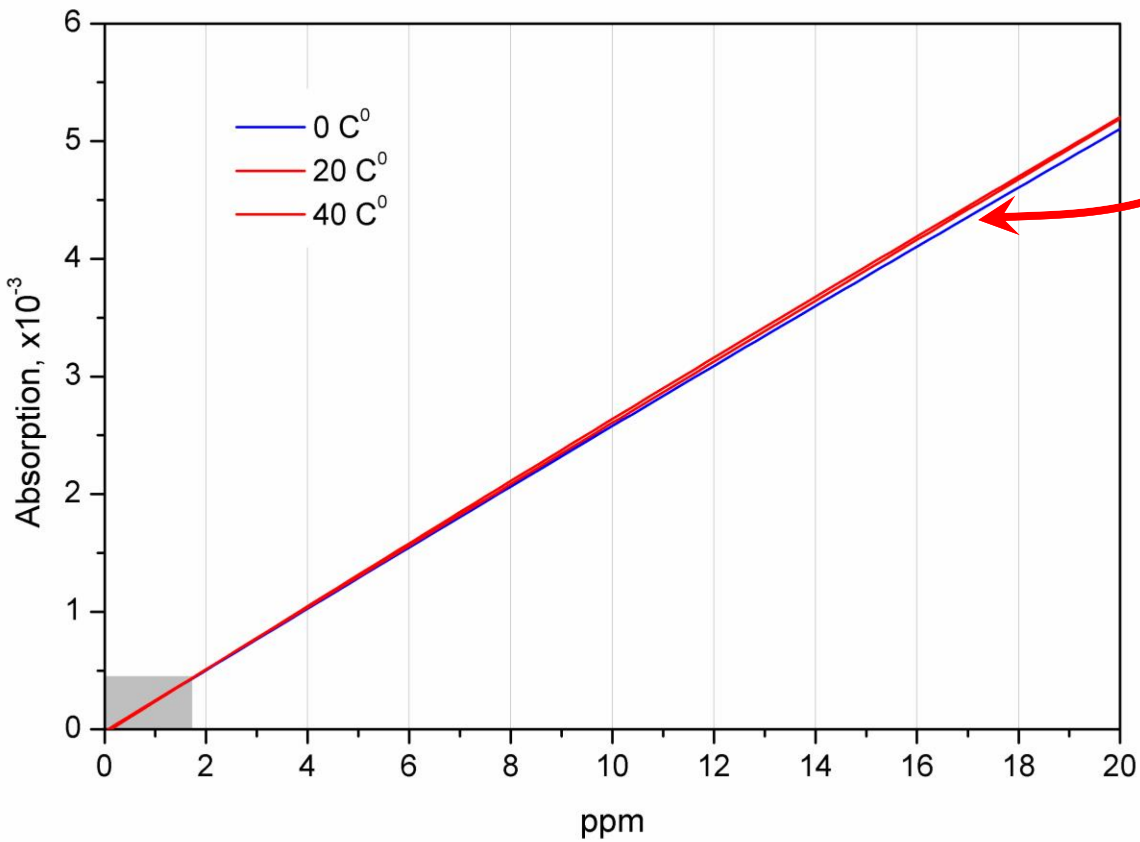
Current research activities of the Partner (4/4)

Integral absorption spectrum
(convolution integral):







lν

~800 lines)

0.15

City

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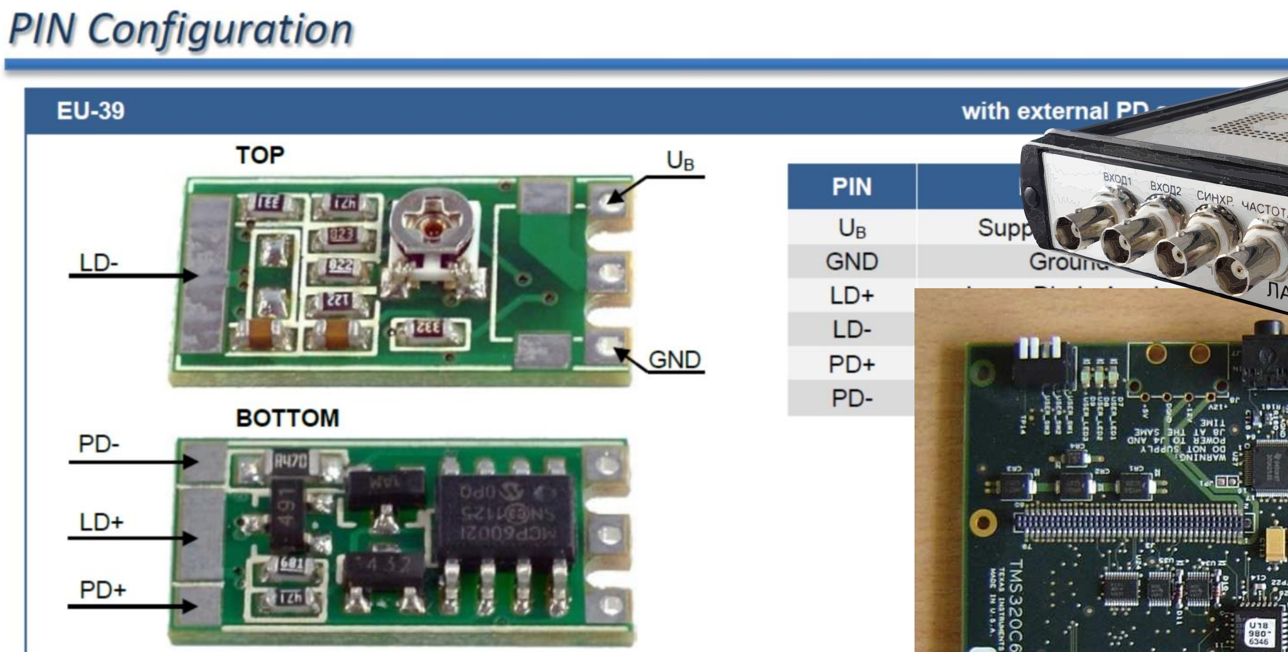
–461

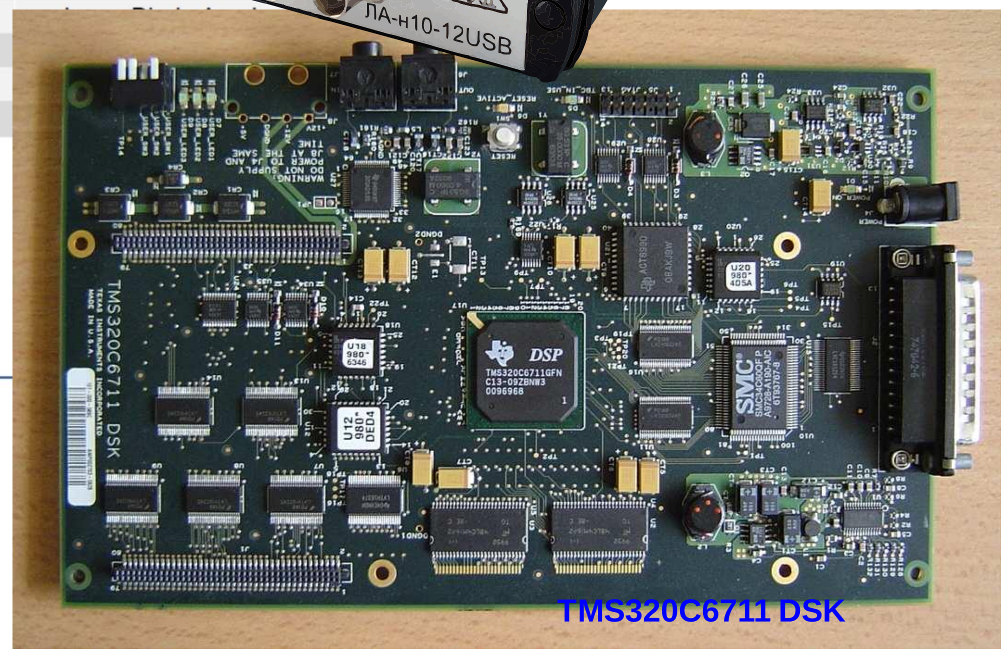
Research Facilities available for the Partner (1/2)

Acquisition system and laser accessories



LD drivers

40 MHz 12 bit ADC – digital oscilloscope



TMS320C6711 DSK

Digital signal processor

Research Facilities available for the Partner (2/2)

Somebody would laboriously climb a mountain

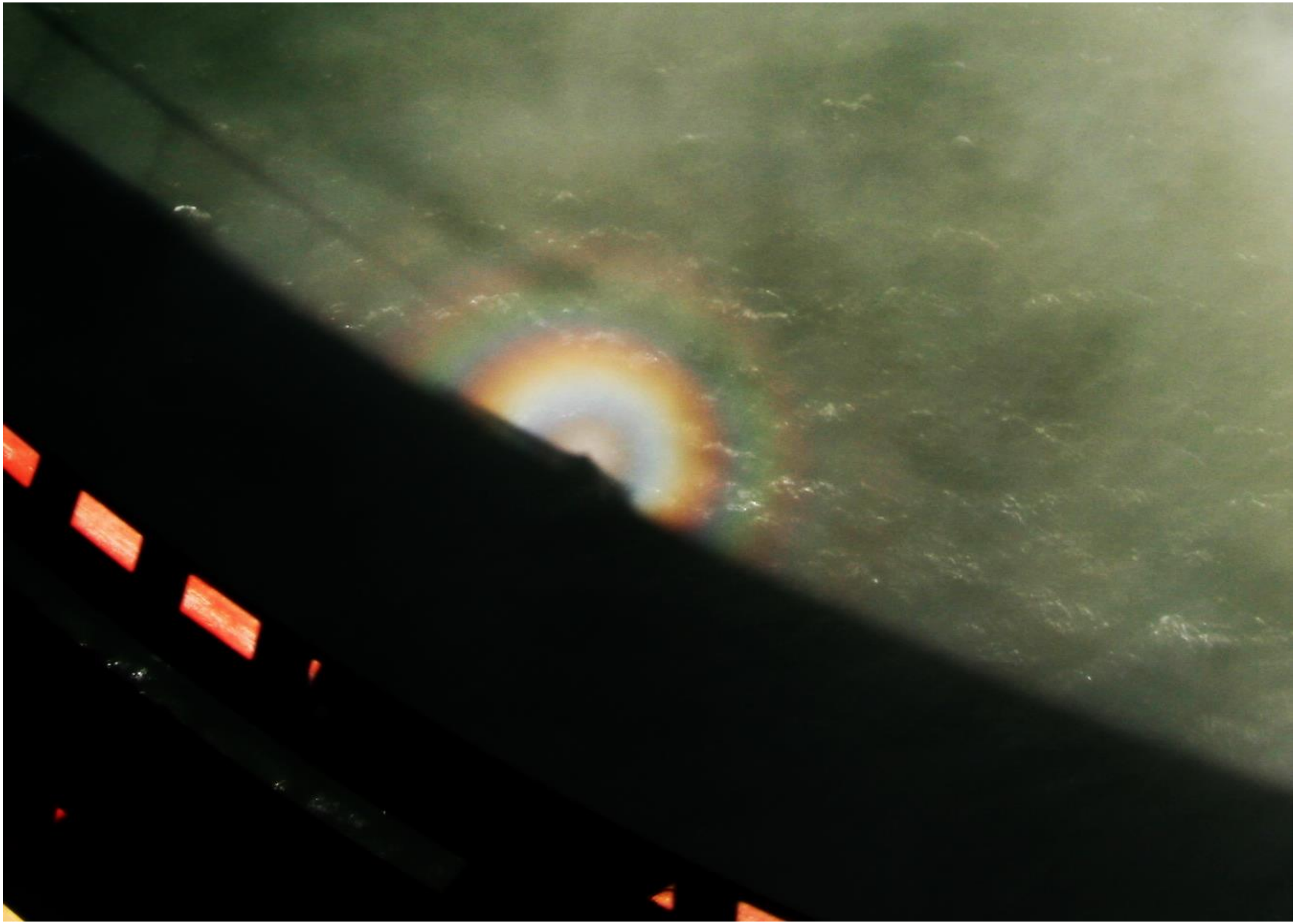
and then he would turn around and be confronted by

a giant with multi-colored rings around his head

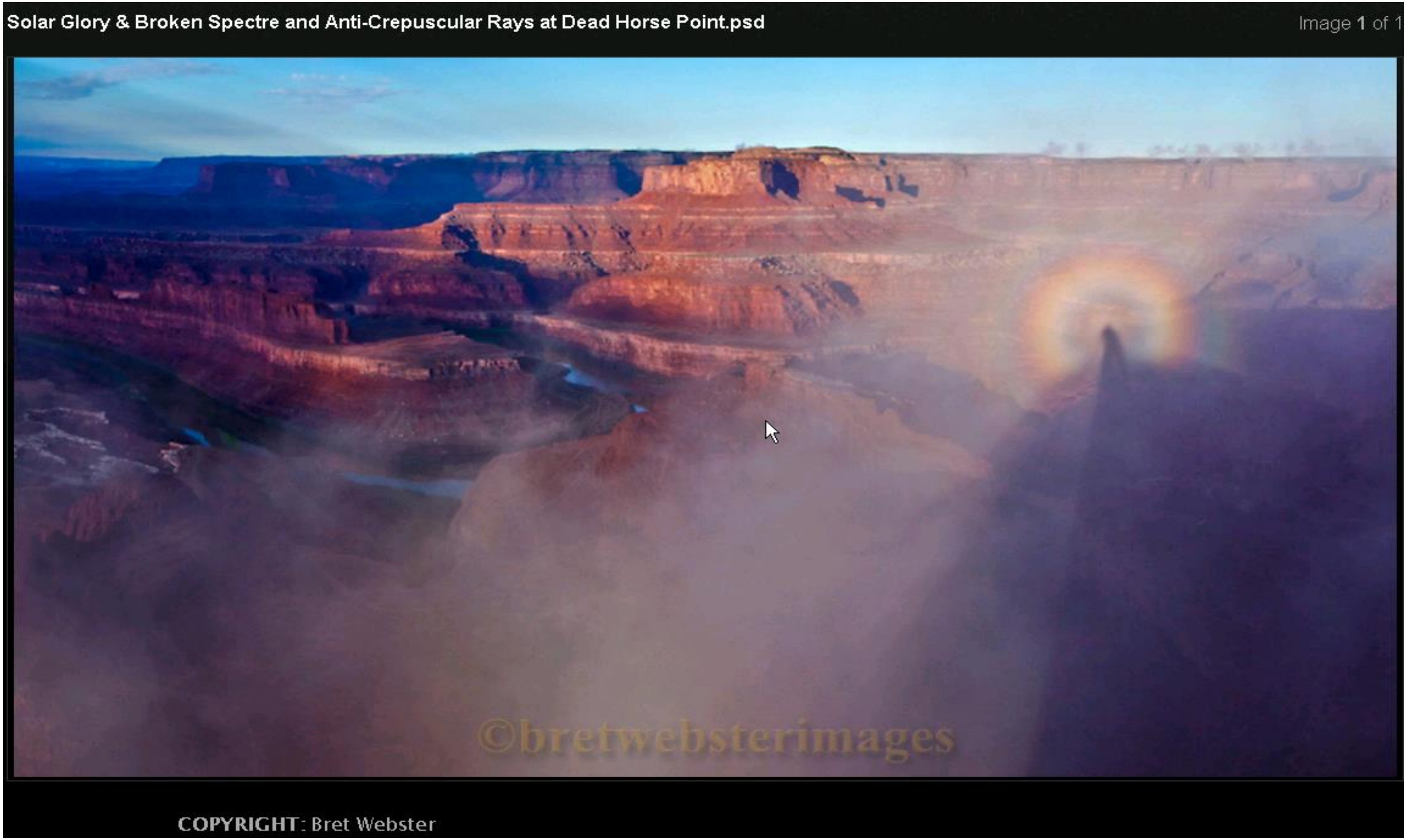
Nobel Laureate Charles Thomson Rees Wilson

was motivated by the solar glory

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



Guess where exactly is the observer?


Solar Glory & Broken Spectre and Anti-Crepuscular Rays at Dead Horse Point.psd
Image 1 of 1
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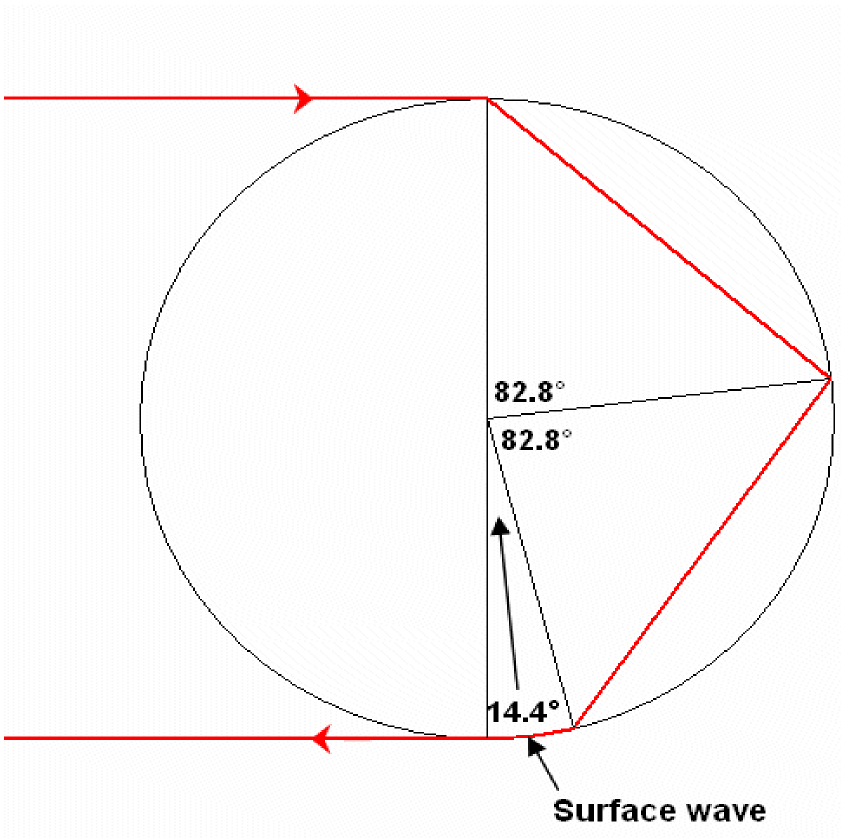
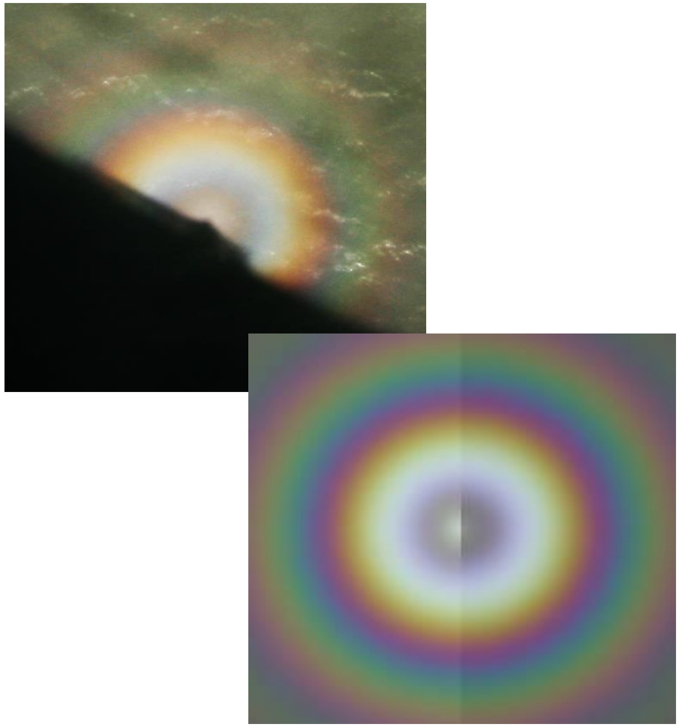
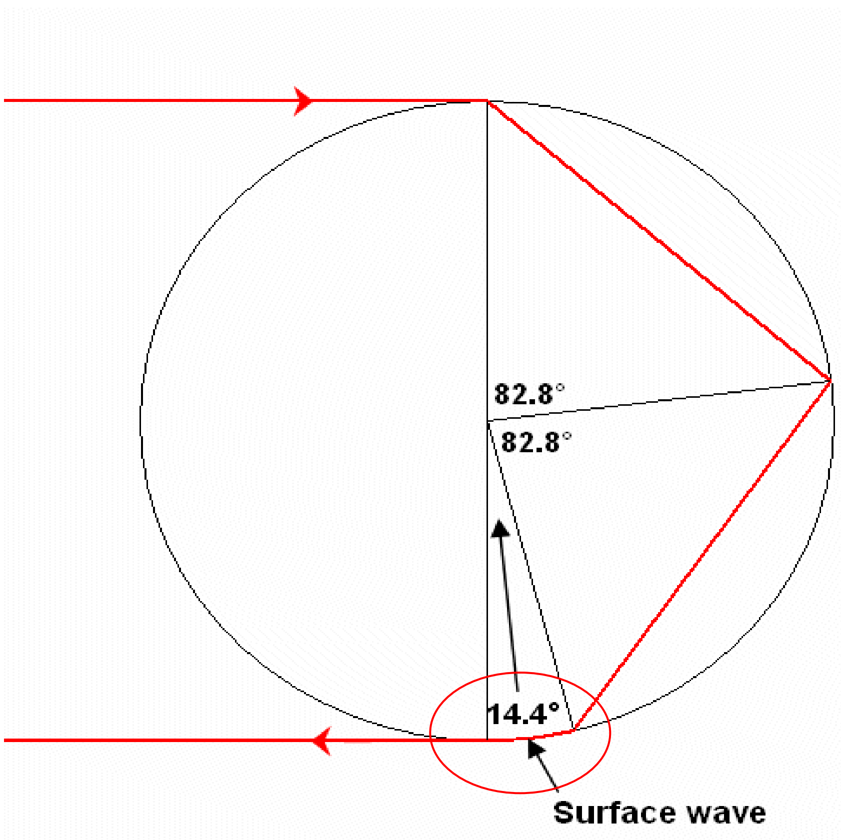
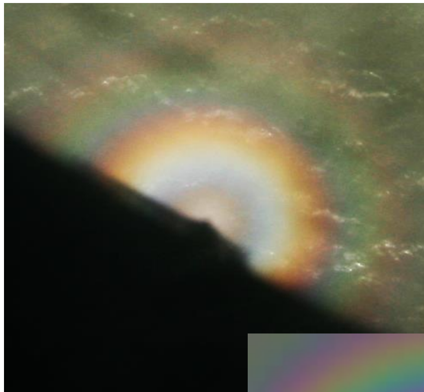
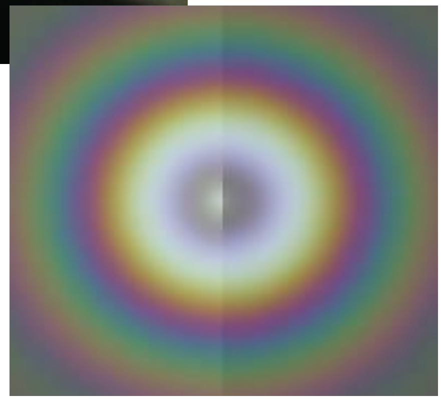




EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY







Surface wave introduced by Dutch astronomer Hendrik Christoffel van de Hulst in 1947

R. Greenler (1980), Rainbows, halos and glories, Cambridge U. Press, Cambridge, UK.

"In one sense, the glory is now well understood. A mathematical theory (Mie scattering theory) enables us to calculate the intensity variation in the glory pattern. Unfortunately, it gives us little physical insight into the process that produces the rings. I wonder if there is no simple model containing the physical essence of the glory."

D. K. Lynch and W. Livingston (2001), Color and Light in Nature, Cambridge U. Press, UK.

“Although the glory pattern is correctly predicted by Mie theory, a good physical explanation is, in our opinion, lacking. In some way light is backscattered after traversing the periphery of droplet. Examined in detail, each drop is found to shine uniformly around its edge with an annulus of light that is coherent (the waves are in phase).”

Nussenzveig H. M. (2002), “Does the glory have a simple explanation?”, Opt. Lett. 27, 1379-1381.

“Mie theory describes the glory by the sum of a large number of complicated terms within which the physical mechanisms cannot be discerned. CAM [Complex Angular Momentum] theory brings out the dominant physical effects and provides an accurate representation for each of them. I know of no other way of quantitatively representing tunneling.”

Laven P. (2005), “How are glories formed?” Appl. Opt. 44, 5675–5683.

“It is perplexing that the glory cannot be explained even by eminent scientists except by resorting to mathematical formulations that offer little insight into the mechanisms that actually cause the glory”.

Scientific context and objectives in the Action

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER

10.1002/2014GL059650

The author is also Master of physics from St. Kliment Ohridski University in Sofia, Bulgaria, Doctor of physics and mathematics from A. M. Prohorov General Physics Institute, Moscow, associate researcher with the Institute of Physical and Chemical Research, RIKEN, Japan, bilateral research fellow of Bulgarian and Japanese ministries of education, laureate of the institutional Academician Djakov Award for achievements in science, with expertise in theoretical solid state physics, laser physics and spectroscopy, laser photo-thermal techniques for material science, and lidar remote sensing.

Key Points:

Resonance scattering of sunlight by modulation of temporal coherence in microscale water aerosol

Stoyan Penchev[1]

[1]Emil Djakov Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Abstract Resonance scattering of sunlight is an effect deduced from a rare atmospheric phenomenon known as solar glory. Its impressive spectral appearance is established by optical interference at precise modulation of the temporal coherence of sunlight within delaylines of microscale water droplets confined by refractive index. A ray-tracing method is used in the study correlated with analysis of the simulated convolution spectrum of backscatter pattern. Resonance modes of low finesse are formed on spectrally isolated intracavity optical paths preventing their destructive interference. The relevant modal wavelengths and diffraction angles are derived for selected temperature and droplet size. Simultaneously, the model explains the alternating polarization of the successive diffraction series.