Spectroscopy of high pressure cesium discharge

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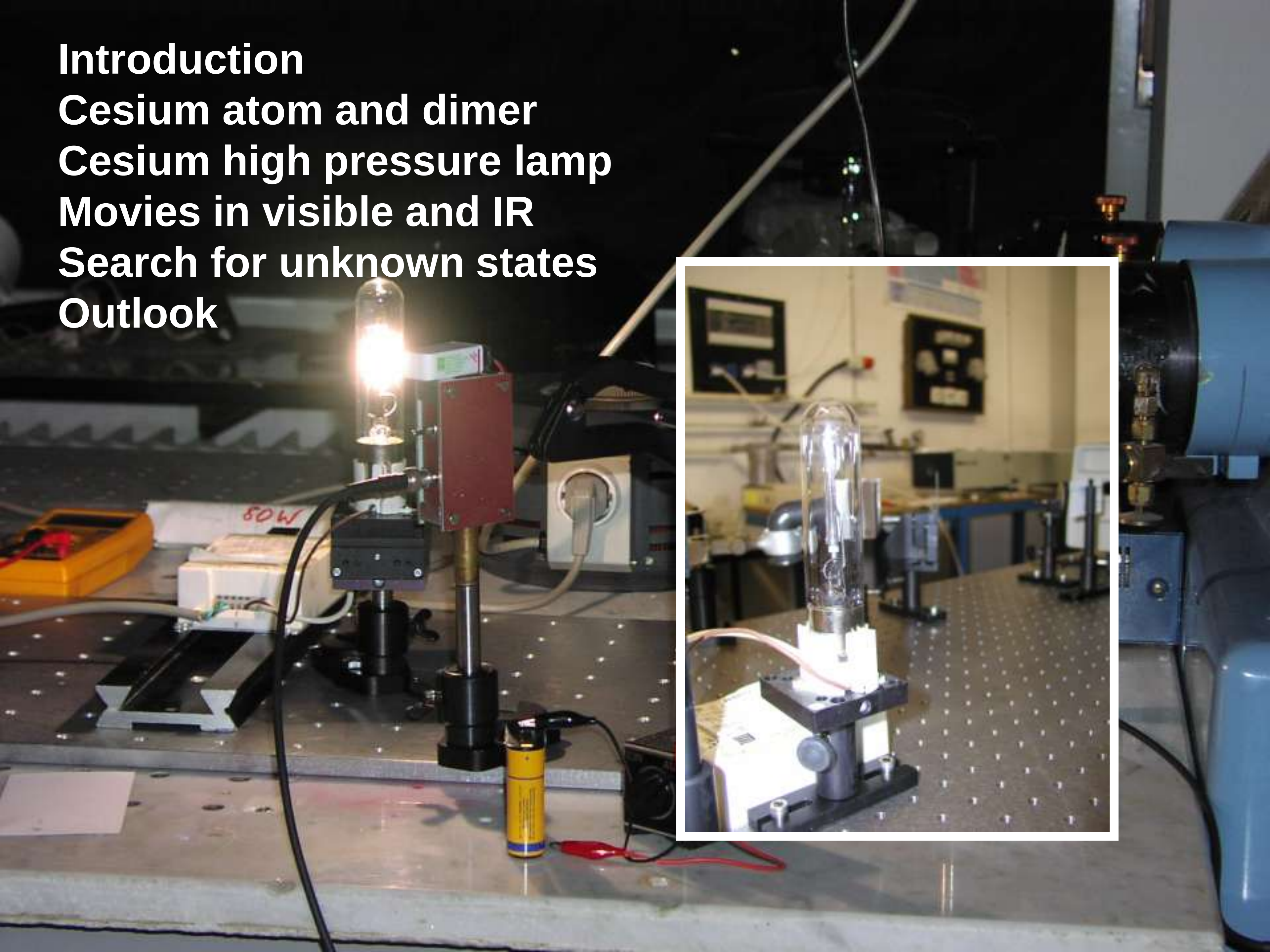
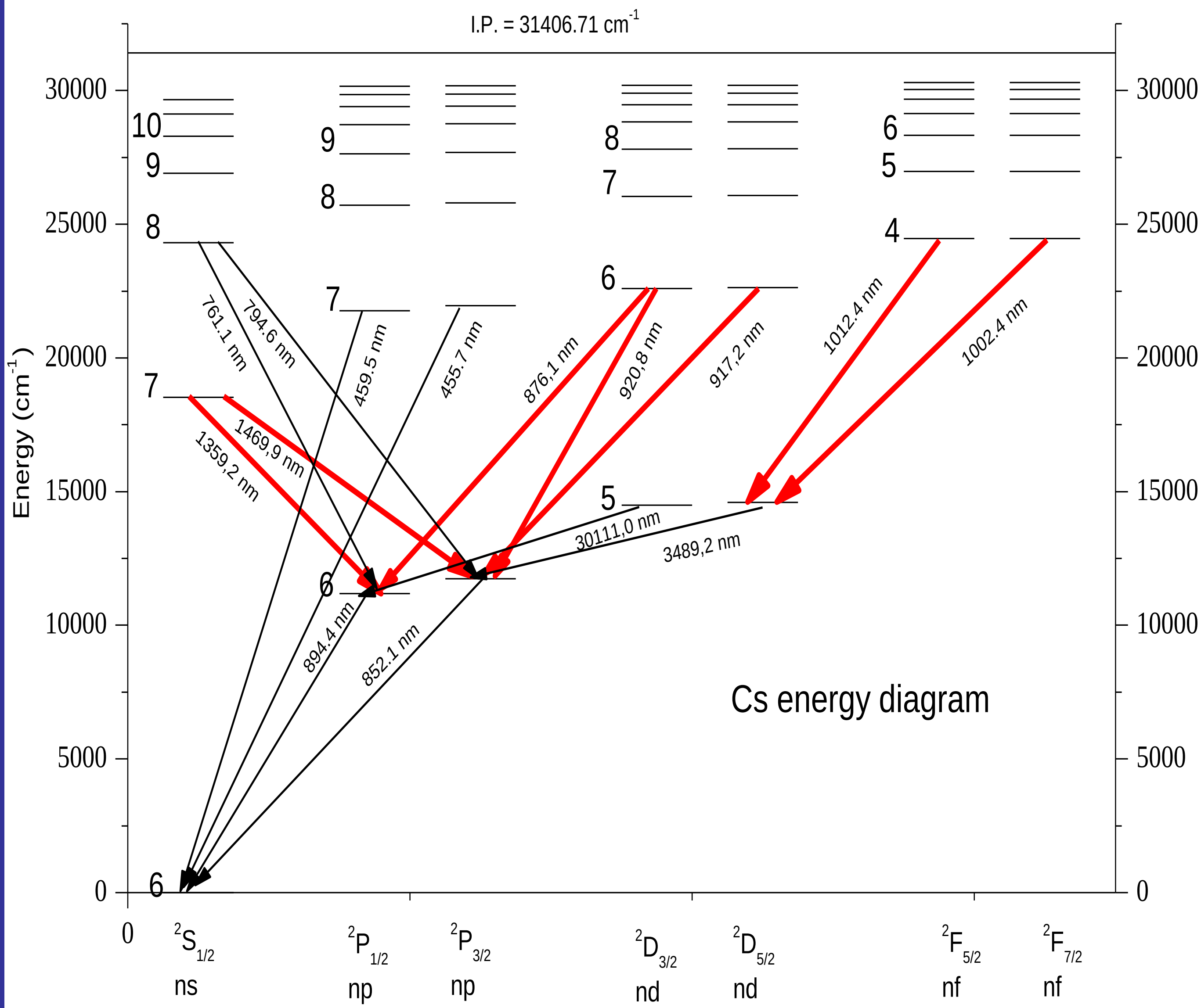
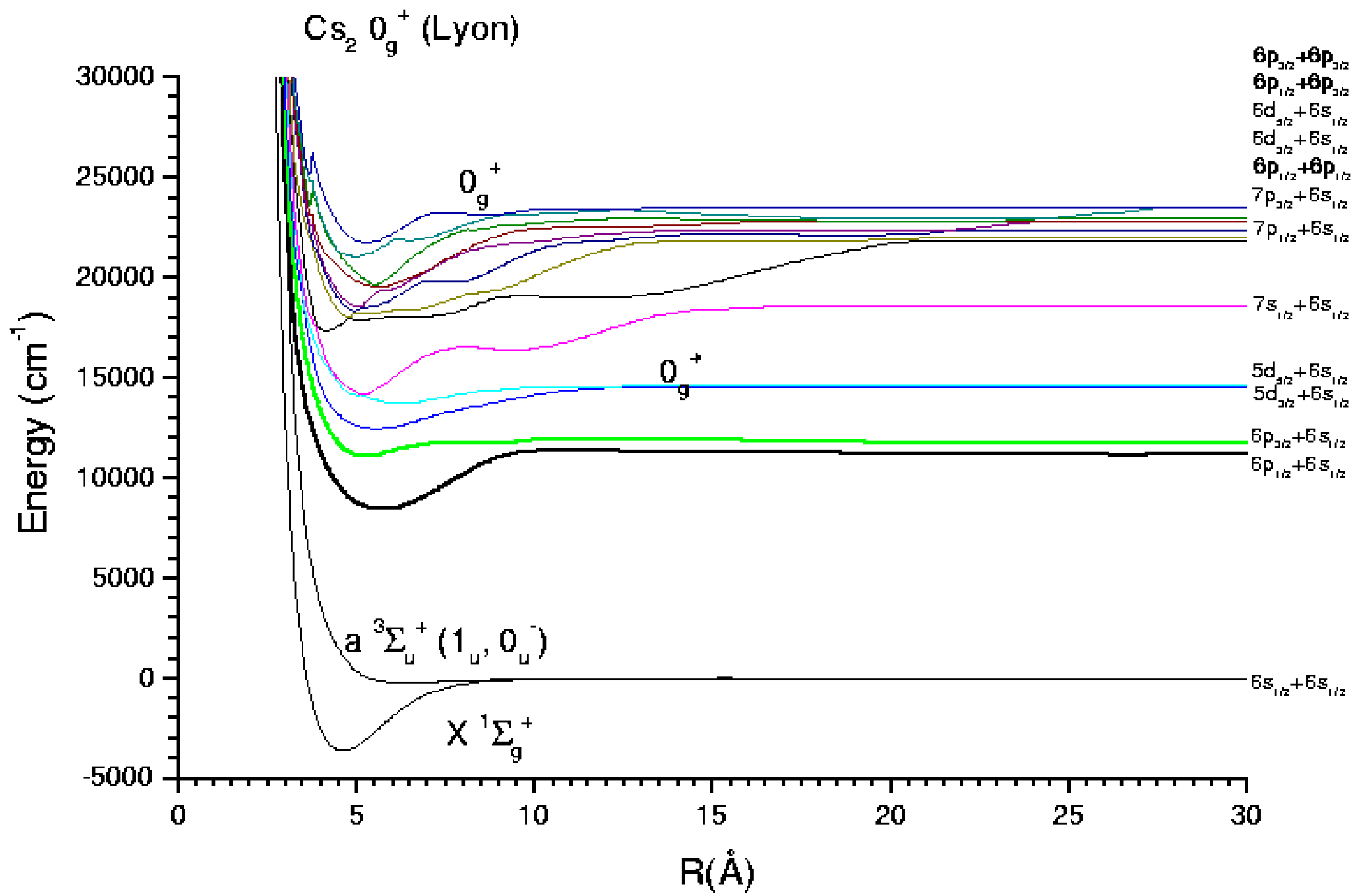
Collaboration with OSRAM burners and lamps
Jianping Liu and Klaus Günther

Introduction
Cesium atom and dimer
Cesium high pressure lamp
Movies in visible and IR
Search for unknown states
Outlook




I.P. = 31406.71 cm-1
Energy (cm-1)
30000
25000
20000
15000
10000
5000
0
10
9
8
7
6
9
8
7
6
8
7
6
5
6
5
4
761.1 nm
794.6 nm
459.5 nm
455.7 nm
876,1 nm
920,8 nm
917,2 nm
1012.4 nm
1002.4 nm
1469,9 nm
1359,2 nm
30111,0 nm
3489,2 nm
894.4 nm
852.1 nm
Cs energy diagram
2S1/2
ns
2P1/2
np
2P3/2
np
2D3/2
nd
2D5/2
nd
2F5/2
nf
2F7/2
nf



Cs2 0g+ (Lyon)
Energy (cm-1)
30000
25000
20000
15000
10000
5000
0
-5000
0
5
10
15
20
25
30
R(Å)
0g+
0g+
a 3Σu+ (1u, 0u-)
X 1Σg+
6p3/2+6p3/2
6p1/2+6p3/2
6d5/2+6s1/2
6d3/2+6s1/2
6p1/2+6p1/2
7p3/2+6s1/2
7p1/2+6s1/2
7s1/2+6s1/2
5d5/2+6s1/2
5d3/2+6s1/2
6p3/2+6s1/2
6p1/2+6s1/2
6s1/2+6s1/2

INSTITUTE OF PHYSICS PUBLISHING PLASMA SOURCES SCIENCE AND TECHNOLOGY

Plasma Sources Sci. Technol. 10 (2001) 1–9 www.iop.org/Journals/ps PII: S0963-0252(01)17072-6

Pulse modulated high-pressure caesium discharge lamp

H Gu, M E Muzeroll, J C Chamberlain and J Maya

Matsushita Electric Works, R&D Laboratory, 216 W Cummings Park, Woburn MA 01801, USA

Received 17 April 2000, in final form 25 August 2000

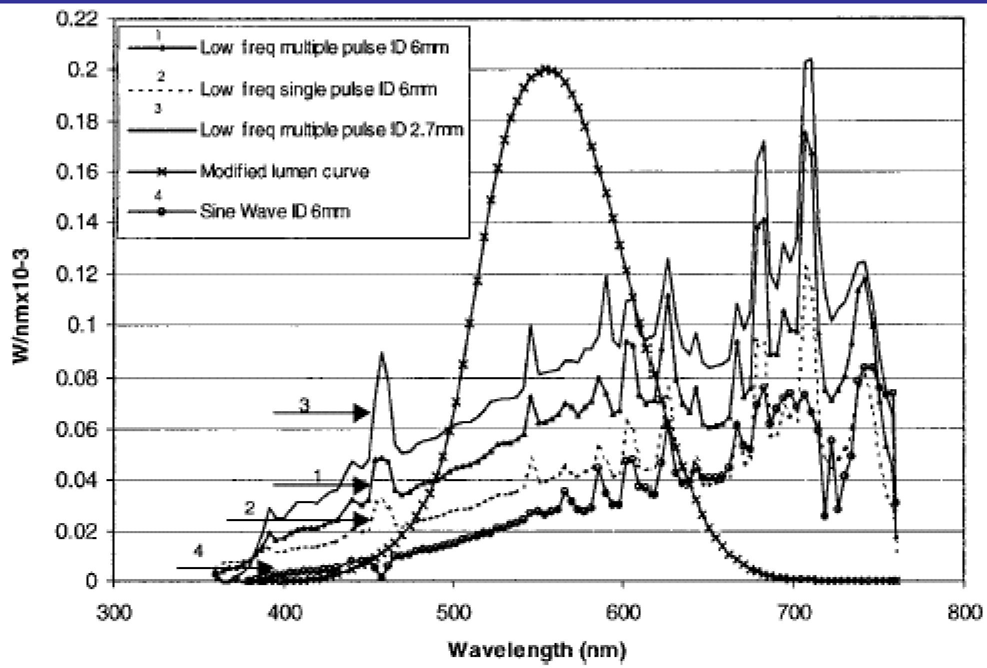


Figure 15. Spectral power distributions for the Cs lamp operated on various power sources.

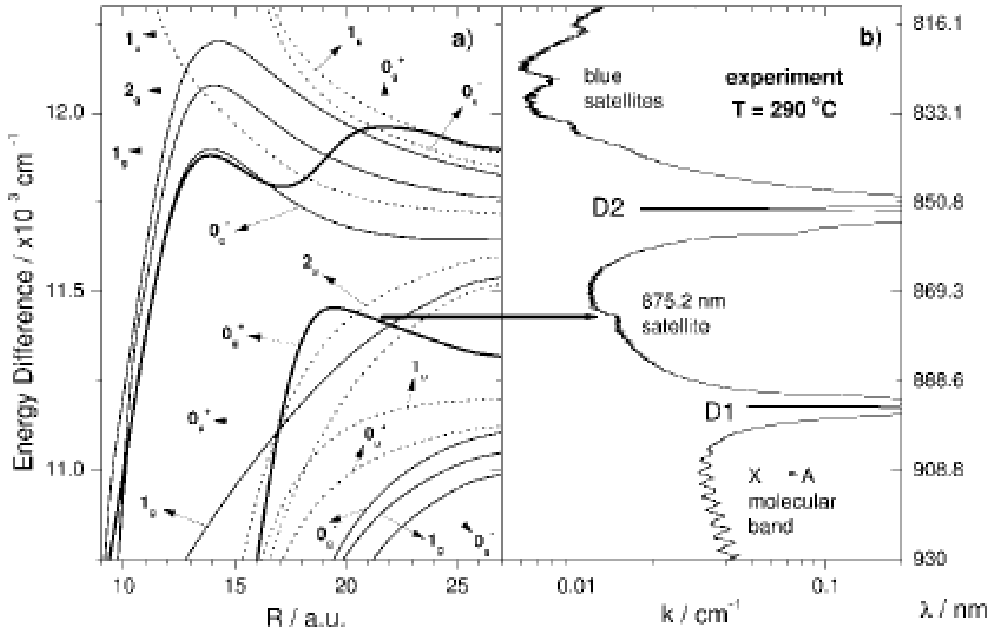
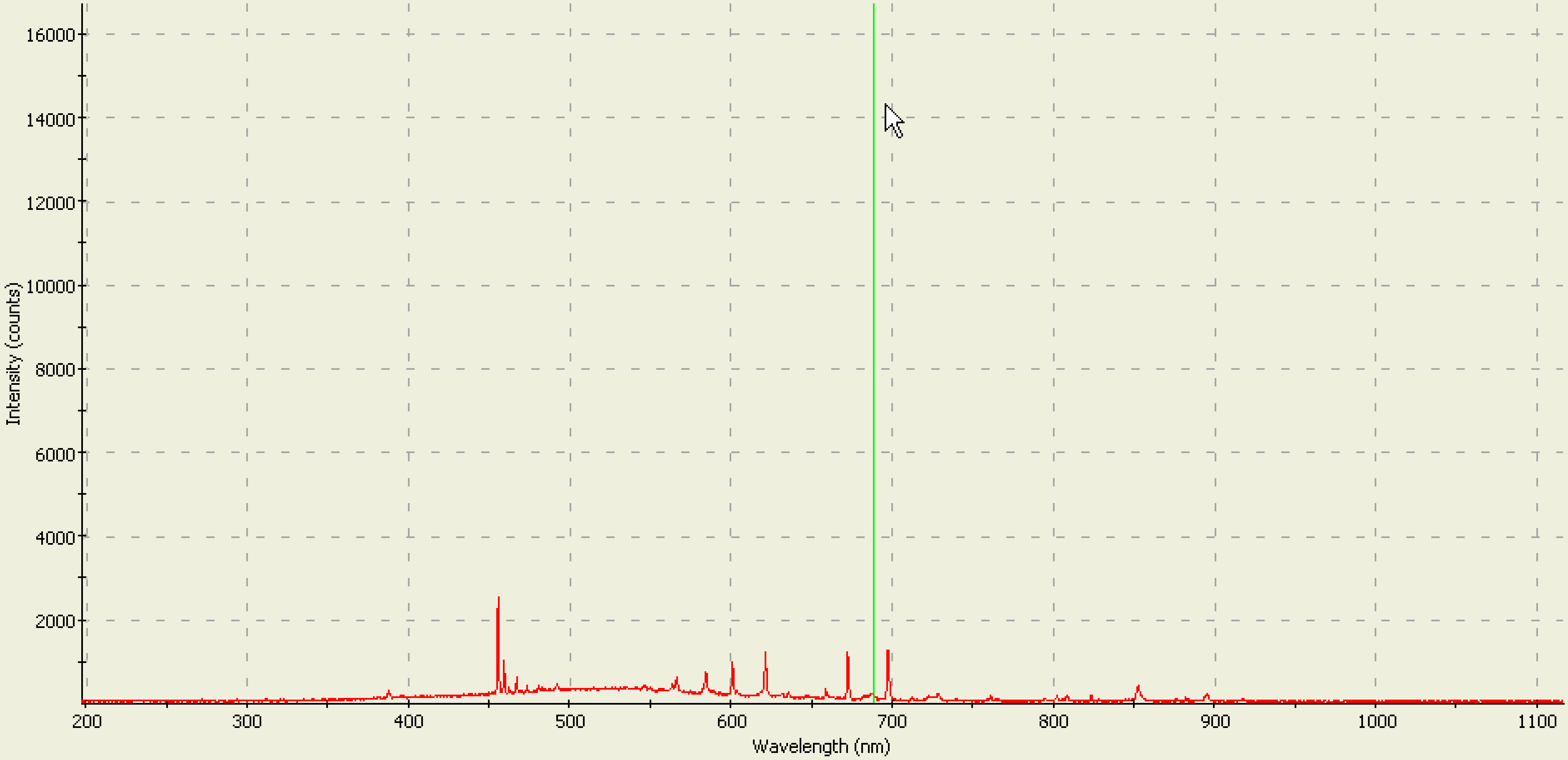
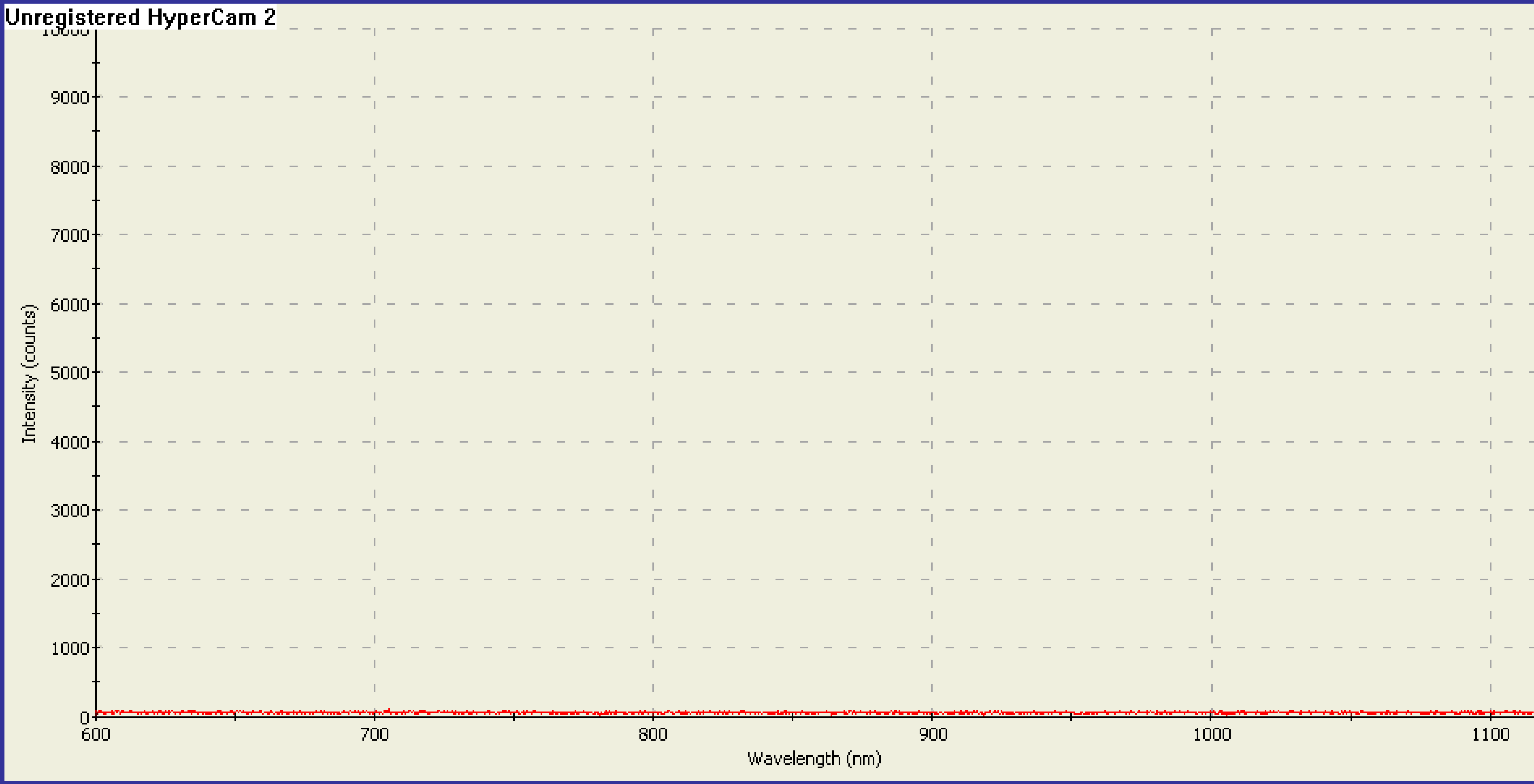


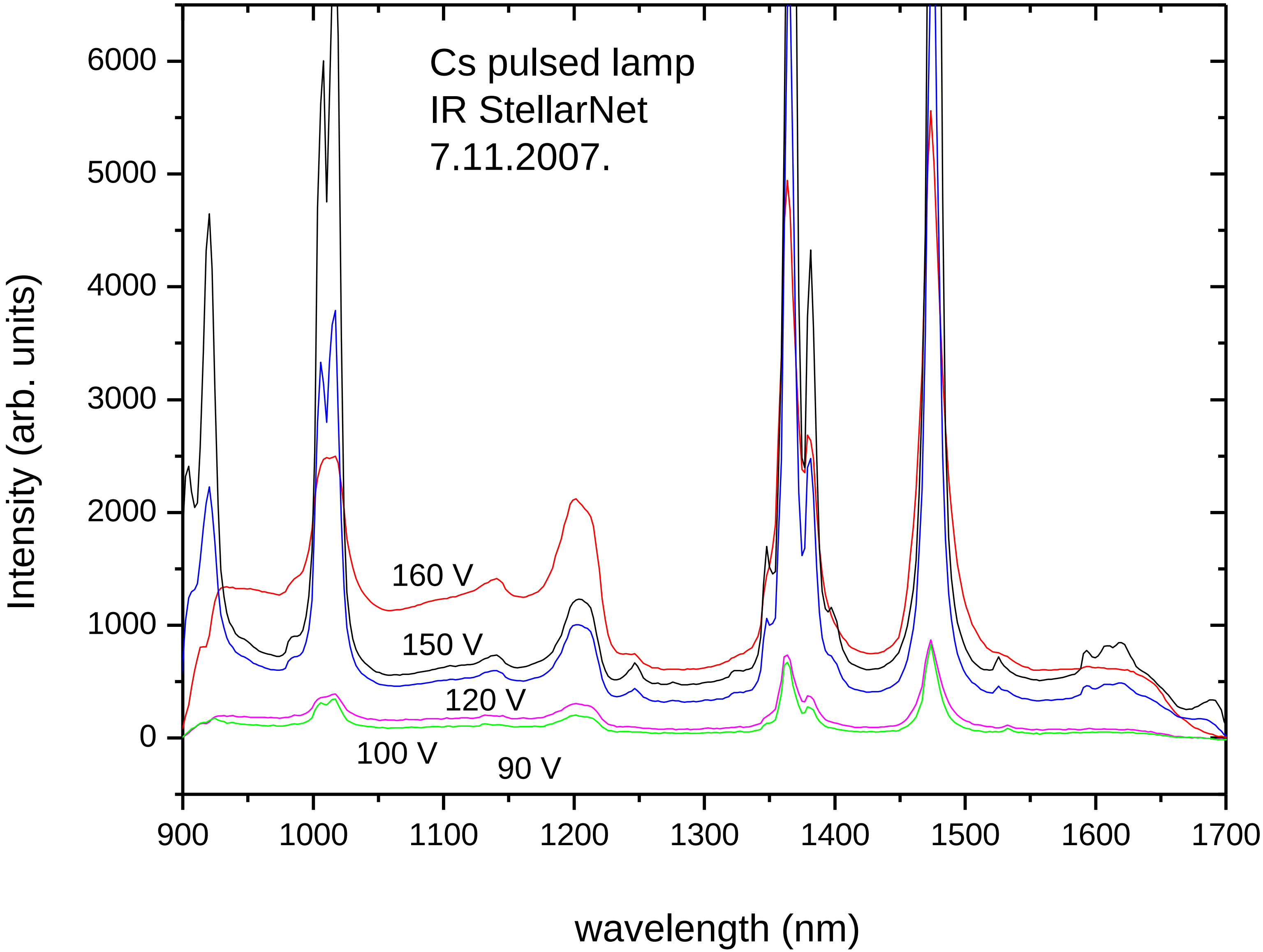
Fig. 3. (a) Cs + Cs difference potentials stemming from the $6\,^2S_{1/2}+6\,^2P_{1/2}$ and $6\,^2S_{1/2}+6\,^2P_{3/2}$ atomic asymptotes at intermediate internuclear distances. Each difference potential is labeled by the upper potential, while the lower potential curve is the Cs_2 $X\,^1\Sigma_g^+(0_g^+)$ state for upper ungerade states (dashed lines), and the lower potential curve is the Cs_2 $a\,^3\Sigma_u^+(0_u^-, 1_u)$ for upper gerade states (solid lines). (b) Measured absorption coefficient of Cs vapor at (T = 290 °C) in the vicinity of the D1 ($6\,^2S_{1/2}+6\,^2P_{1/2}$) and D2 ($6\,^2S_{1/2}+6\,^2P_{3/2}$) line.

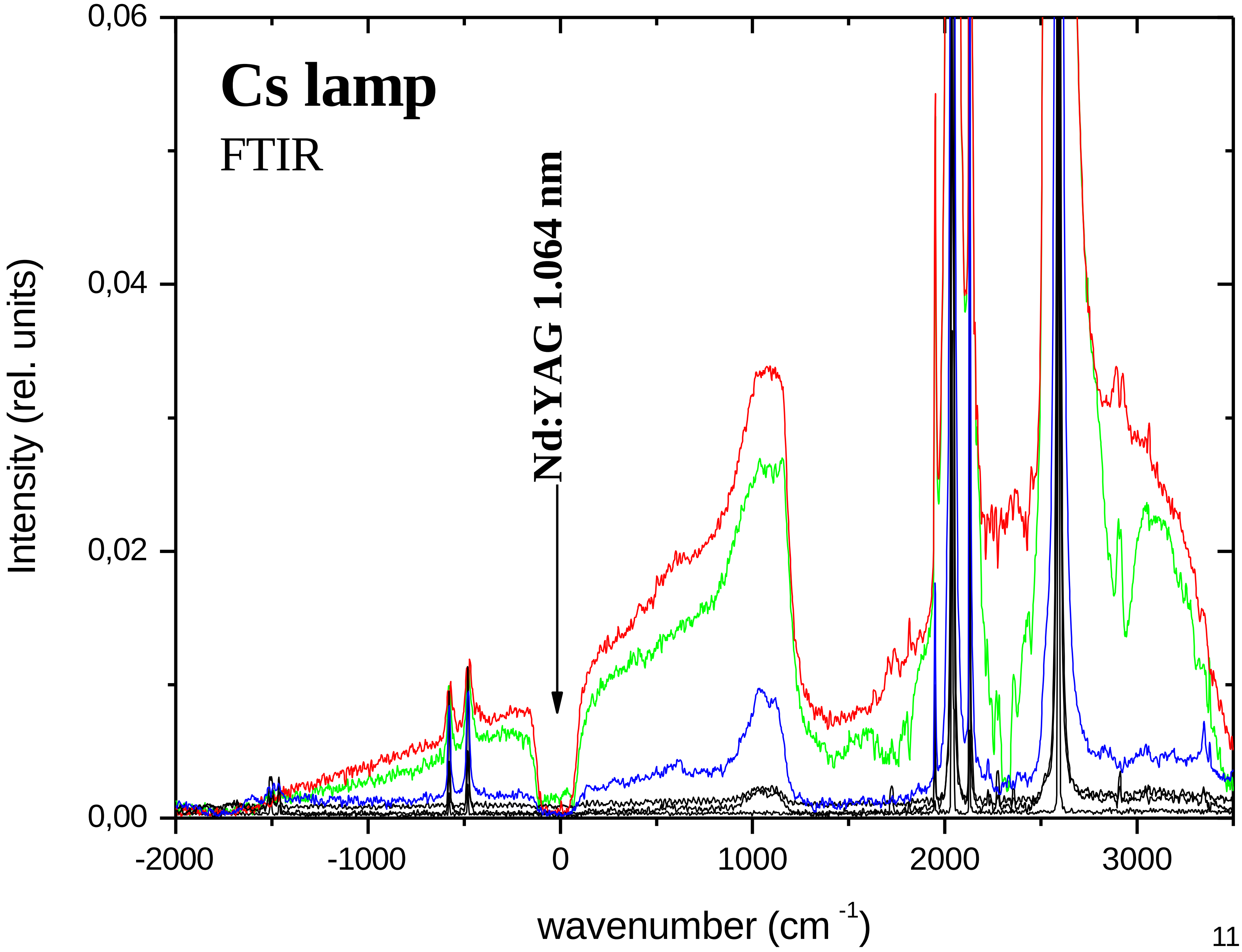
D. Veza, R. Beuc, S. Milosevic and G. Pichler, **Cusp satellite bands in the spectrum of Cs2 molecule**, *European Physical Journal D* 2 (1998) No. 1, 45-52 (Eur. Phys. J. D).

R. Beuc, H. Skenderovic, T. Ban, D. Veza, G. Pichler, and W. Meyer
Cesium satellite band at 875.2 nm stemming from the Cs_2 0^+_g (6p $^2P_{1/2}$ + 6s $^2S_{1/2}$) state,
Eur. Phys. J. D **15**, 209-214 (2001).


16000
14000
12000
10000
8000
6000
4000
2000
Intensity (counts)
200
300
400
500
600
700
800
900
1000
1100
Wavelength (nm)


Unregistered HyperCam 2
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Intensity (counts)
600
700
800
900
1000
1100
Wavelength (nm)


Cs pulsed lamp
IR StellarNet
7.11.2007.
160 V
150 V
120 V
100 V
90 V
Intensity (arb. units)
wavelength (nm)
0
1000
2000
3000
4000
5000
6000
900
1000
1100
1200
1300
1400
1500
1600
1700



Cs lamp
FTIR
Nd:YAG 1.064 nm
Intensity (rel. units)
0,06
0,04
0,02
0,00
-2000
-1000
0
1000
2000
3000
wavenumber (cm -1)

Absorption spectroscopy of the rubidium dimer in an overheated vapor: An accurate check of molecular structure and dynamics, *Absorption spectroscopy of the rubidium dimer in an overheated vapor: An accurate check of molecular structure and dynamics, C. Vadla et al. PRA* **75**, 032512 2007

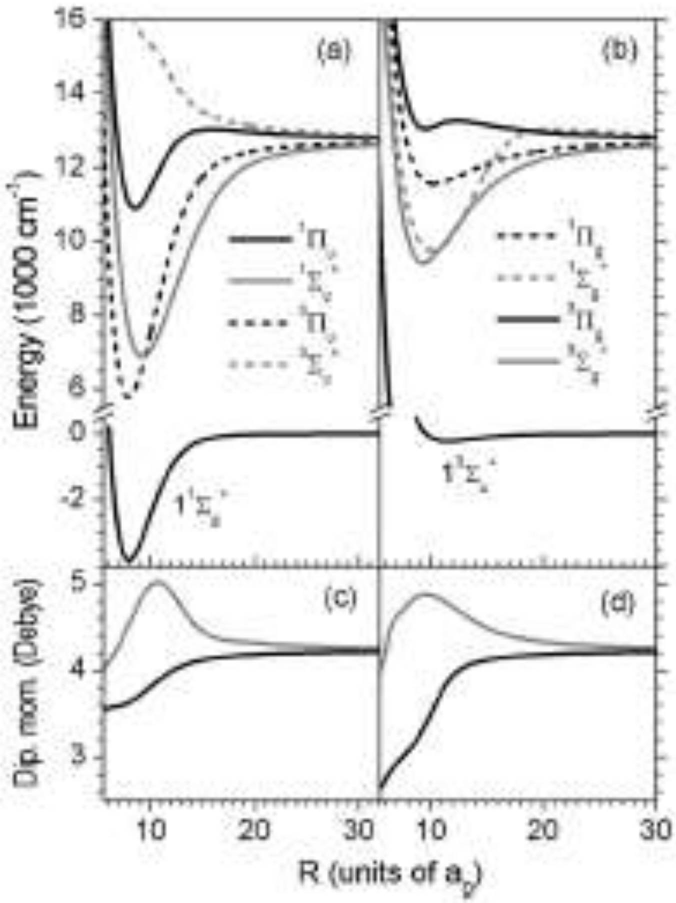


FIG. 1. Hund's case-(a) potentials and transition dipole moments relevant to the transitions between the Rb(5S)+Rb(5S) and Rb(5S)+Rb(5P) manifolds. (a) Lower $1^1\Sigma_g^+$ and upper *ungerade* potentials. (b) Lower $1^3\Sigma_u^+$ and upper *gerade* potentials. (c) $1^1\Sigma_g^+ - 1^1\Sigma_u^+$ (gray) and $1^1\Sigma_g^+ - 1^1\Pi_u$ (black) transition dipole moments. (d) $1^3\Sigma_u^+ - 1^3\Sigma_g^+$ (gray) and $1^3\Sigma_u^+ - 1^3\Pi_g$ (black) transition dipole moments. At the scale of the figure, experimental and theoretical potentials are almost identical.

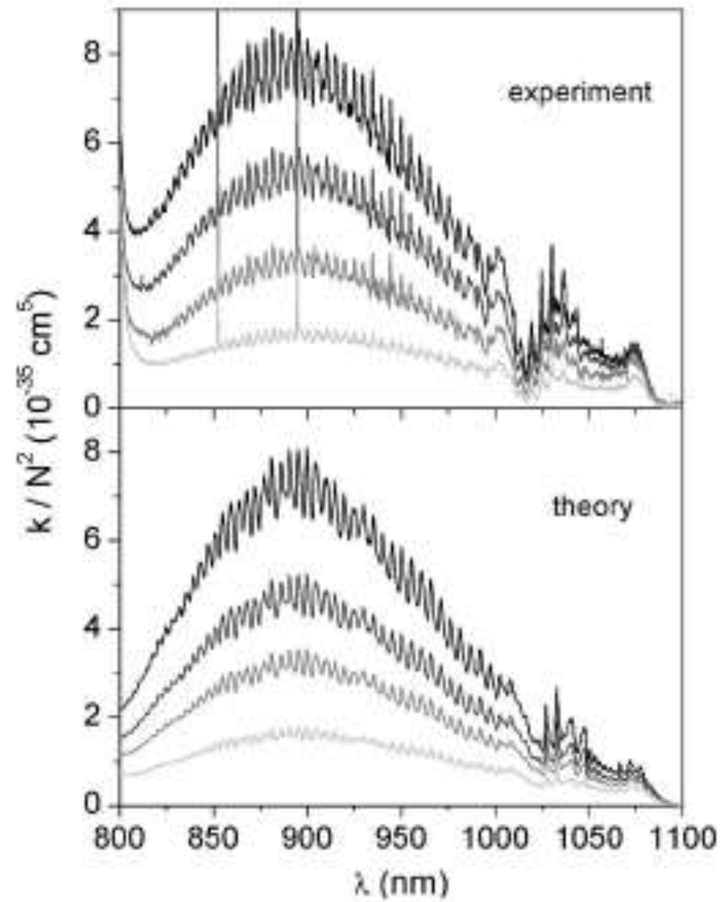
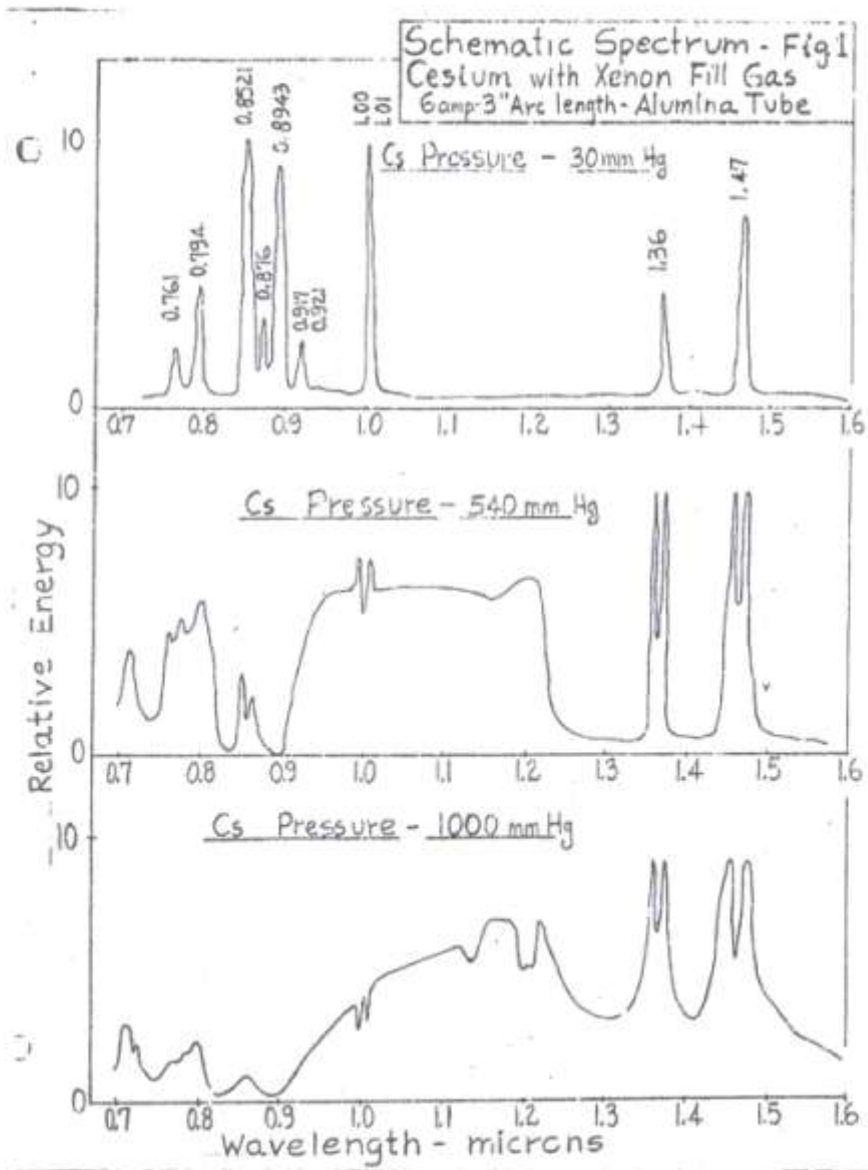
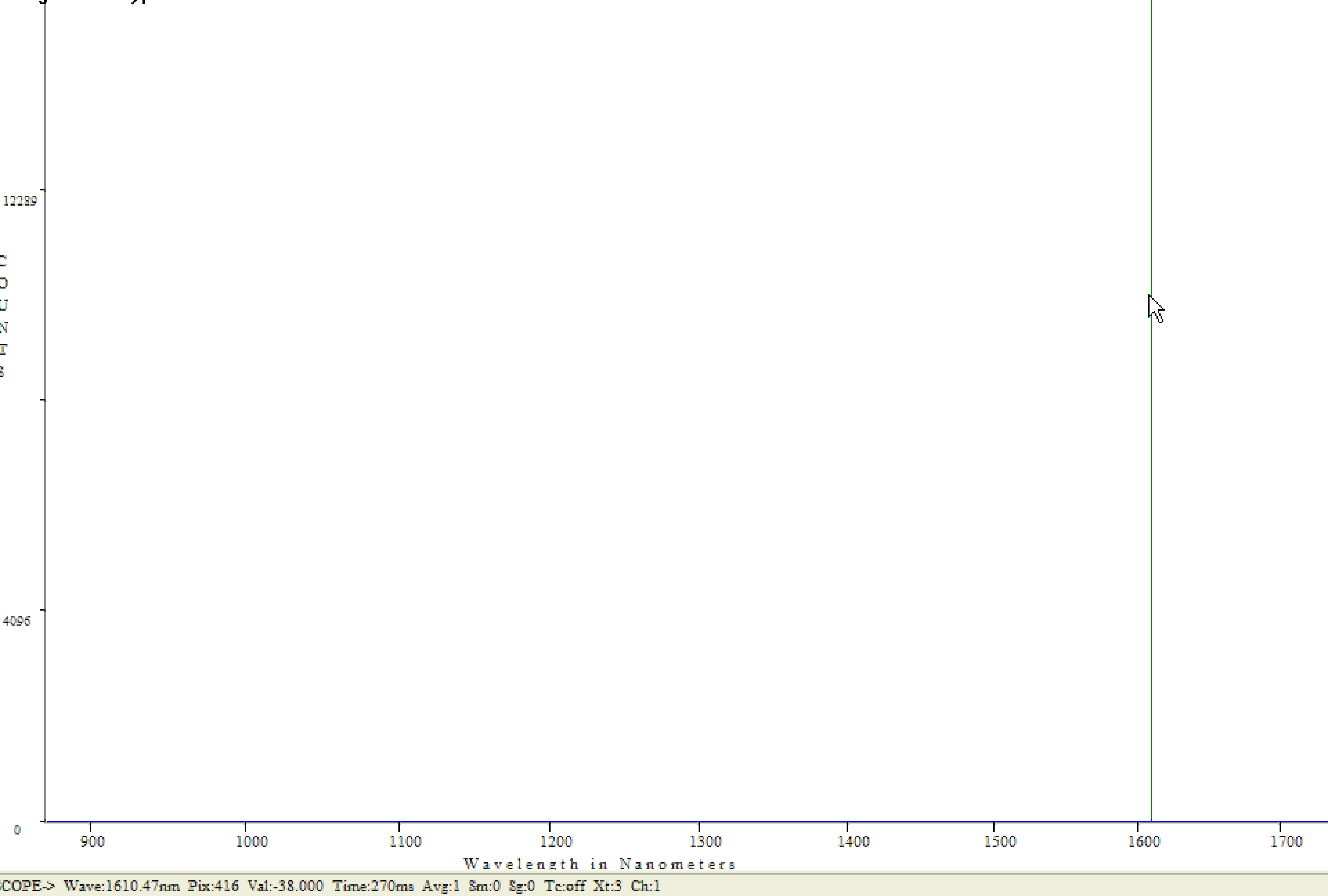
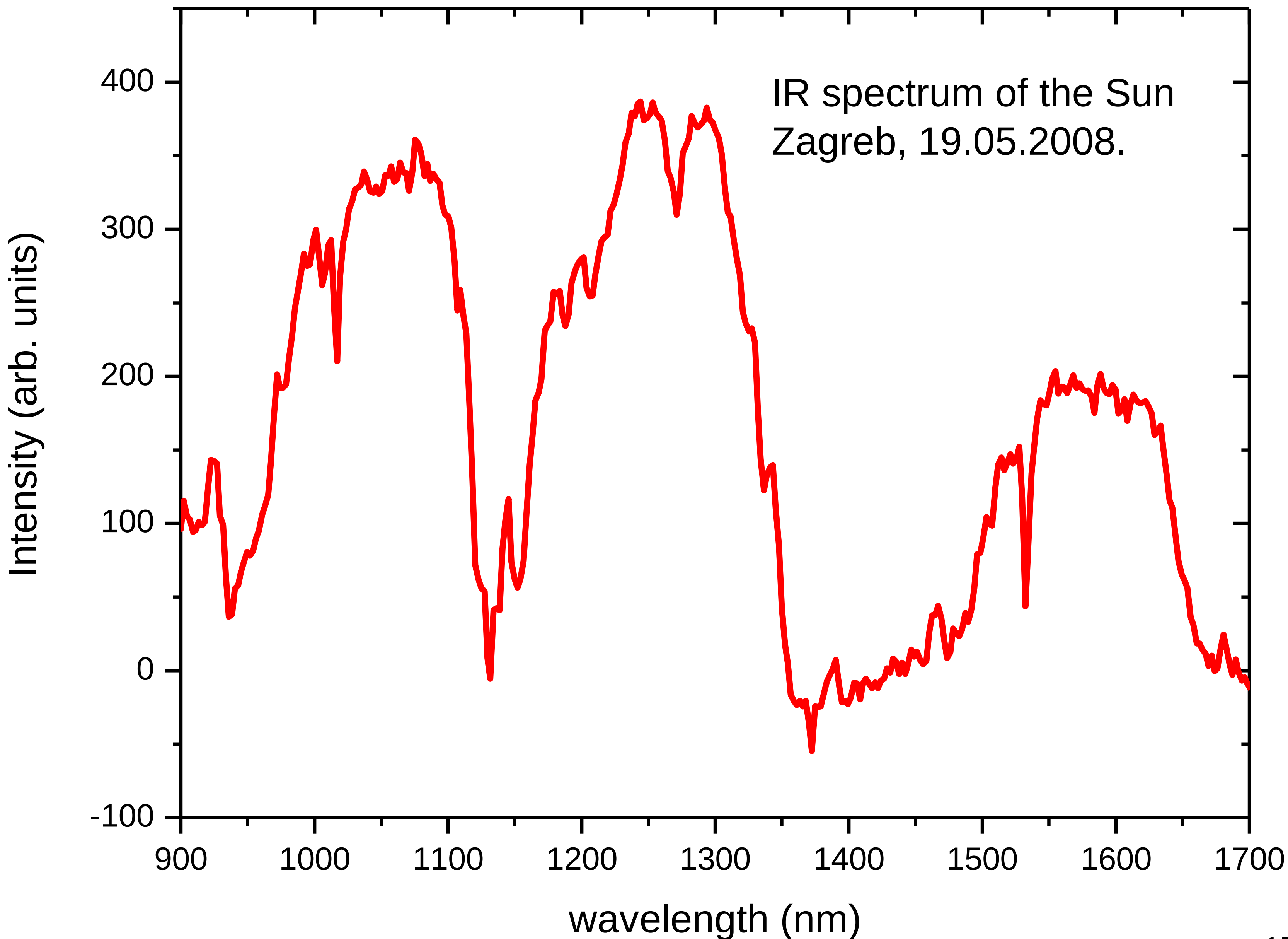


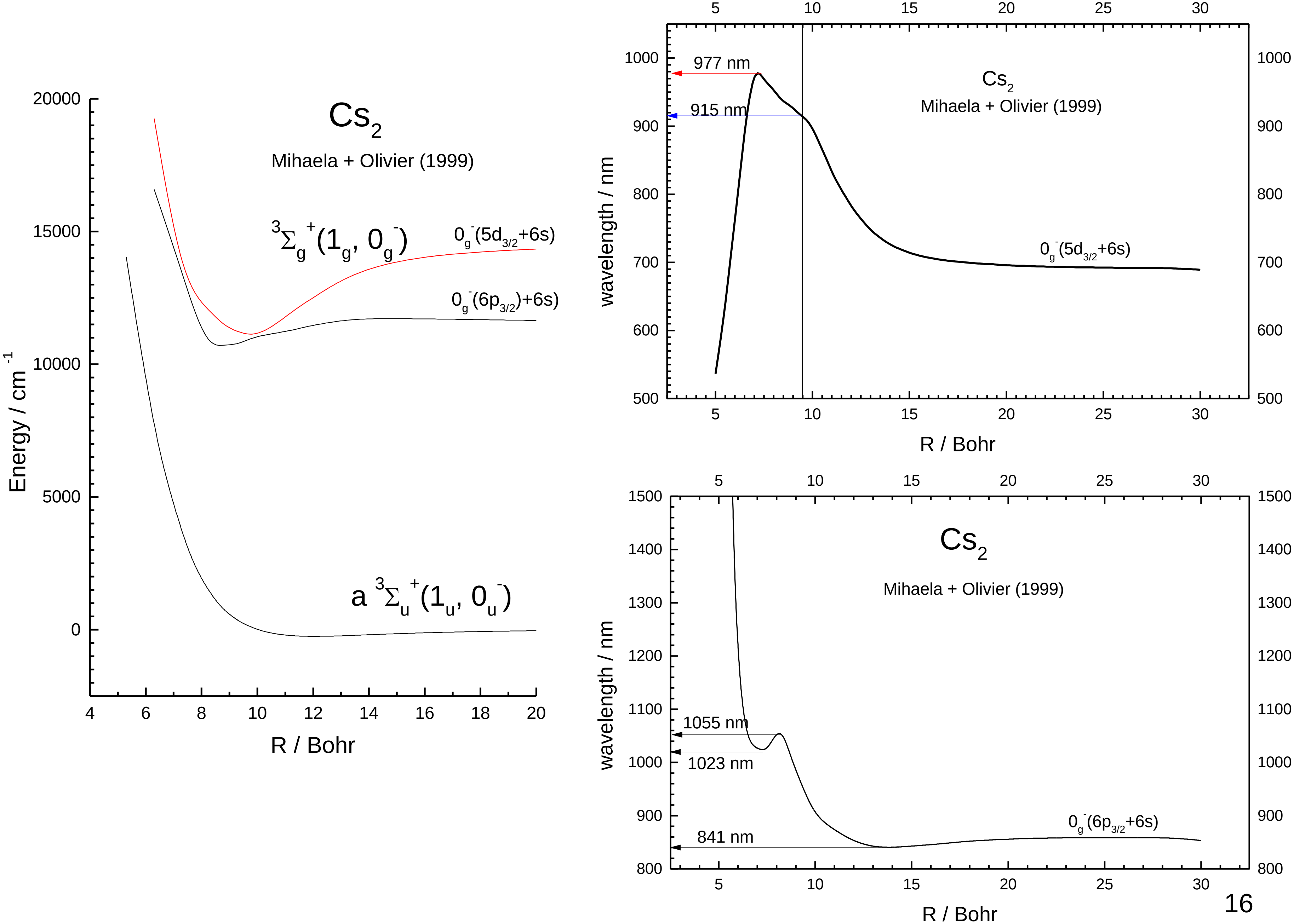
FIG. 12. The comparison of simulated and measured reduced absorption coefficients in the Rb_2 *X*-*A* band for four different temperatures given in Fig. 5. Quantum mechanical simulations were performed with *R*-dependent spin-orbit coupling and taking into account the weighted sum of different isotopomer contributions.


Schematic Spectrum - Fig 1
Cesium with Xenon Fill Gas
6amp-3" Arc length - Alumina Tube
Cs Pressure - 30 mm Hg
Cs Pressure - 540 mm Hg
Cs Pressure - 1000 mm Hg
Relative Energy
Wavelength - microns
0.761
0.794
0.8521
0.876
0.8943
0.917
0.921
1.00
1.01
1.36
1.47


12289
C
O
U
N
T
S
4096
0
900
1000
1100
1200
1300
1400
1500
1600
1700
Wavelength in Nanometers
COPE-> Wave:1610.47nm Pix:416 Val:-38.000 Time:270ms Avg:1 Sm:0 Sg:0 Tc:off Xt:3 Ch:1



IR spectrum of the Sun
Zagreb, 19.05.2008.
Intensity (arb. units)
400
300
200
100
0
-100
900
1000
1100
1200
1300
1400
1500
1600
1700
wavelength (nm)


Cs2
Mihaela + Olivier (1999)
3Σg+(1g, 0g-)
0g-(5d3/2+6s)
0g-(6p3/2)+6s)
a 3Σu+(1u, 0u-)
Energy / cm-1
R / Bohr
977 nm
915 nm
wavelength / nm
1055 nm
1023 nm
841 nm
0g-(6p3/2+6s)

VOLUME 80, NUMBER 20 PHYSICAL REVIEW LETTERS 18 MAY 1998

Formation of Cold Cs_2 Molecules through Photoassociation

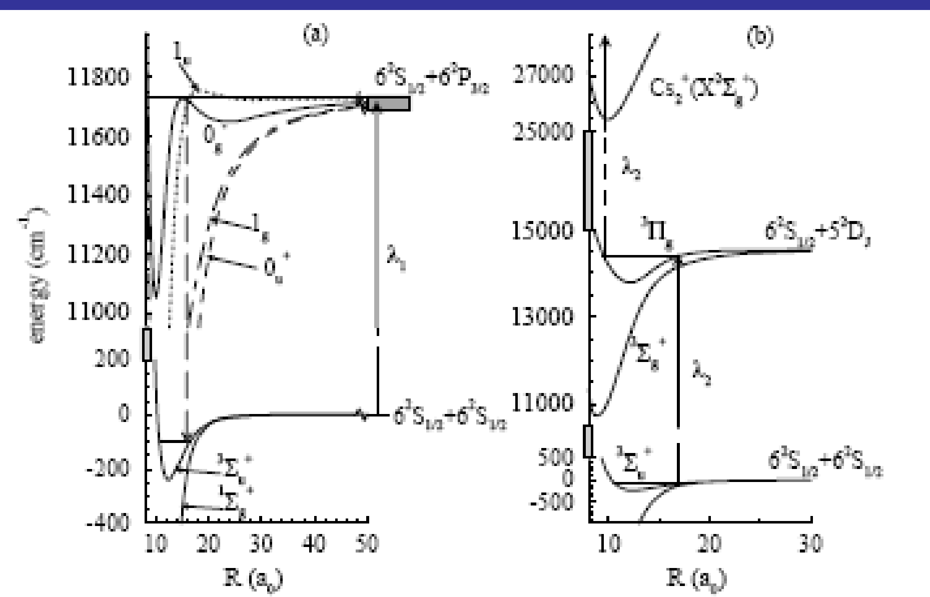
A. Fioretti, D. Comparat, A. Crubellier, O. Dulieu, F. Masnou-Seeuws, and P. Pillet

Laboratoire Aimé Cotton, CNRS II, Bâtiment 505, Campus d'Orsay, 91405 Orsay Cedex, France*

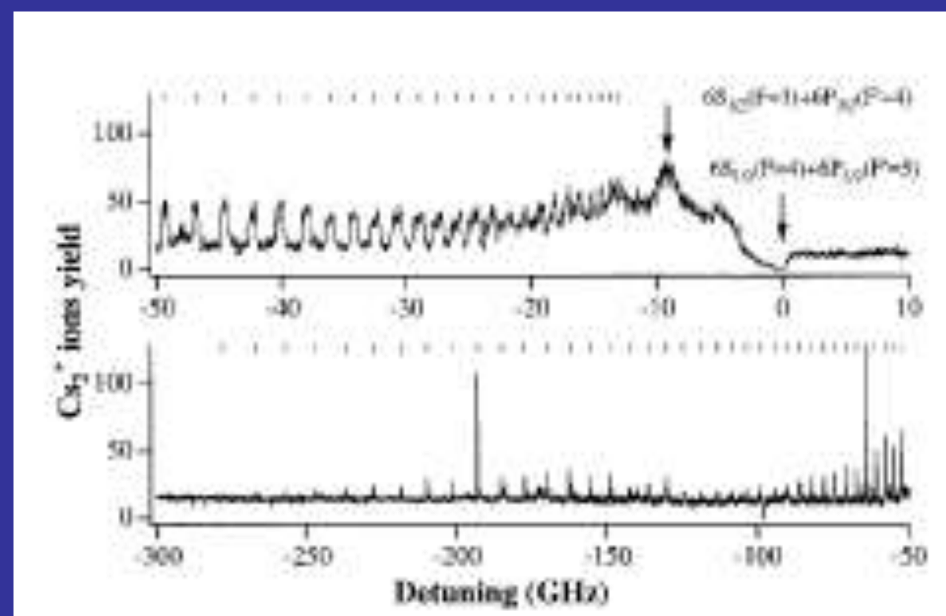
(Received 10 November 1997)

We have performed photoassociative spectroscopy of cold Cs atoms in a vapor-cell magneto-optical trap, within 10 cm^{-1} below the dissociation limit $6s\,^2S_{1/2} + 6p\,^2P_{3/2}$. Our detection method is based on pulsed-laser photoionization of Cs_2 molecules, selectively detected through a time-of-flight mass spectrometer. Temporal and spatial analysis of Cs_2^+ ions show for the first time the formation of translationally cold Cs_2 triplet ground state molecules, at a temperature $T \sim 300\ \mu K$.

[S0031-9007(98)06137-7]



Giant resonances

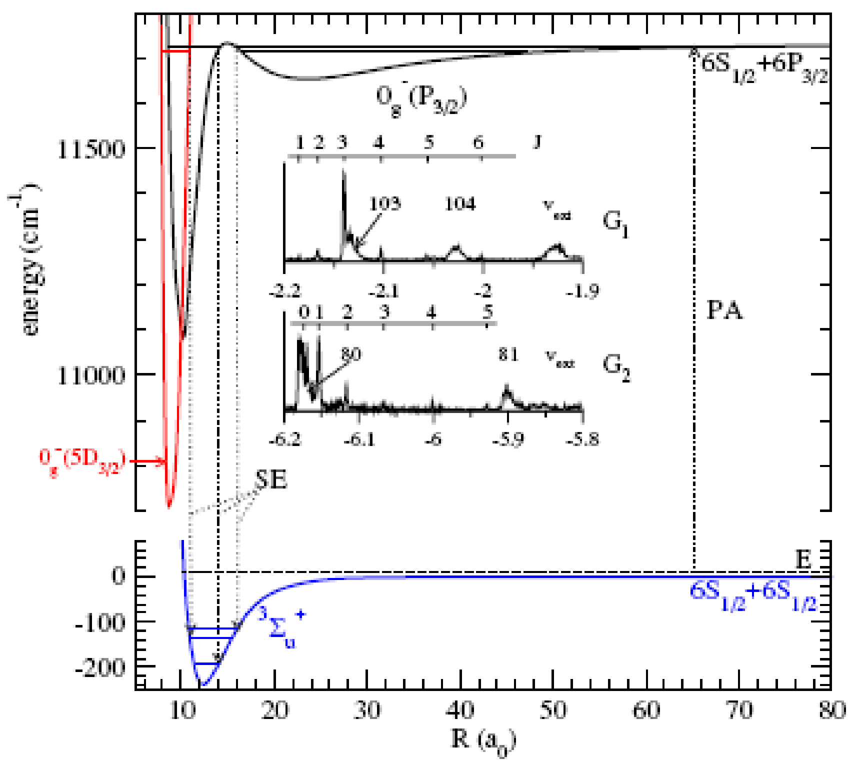


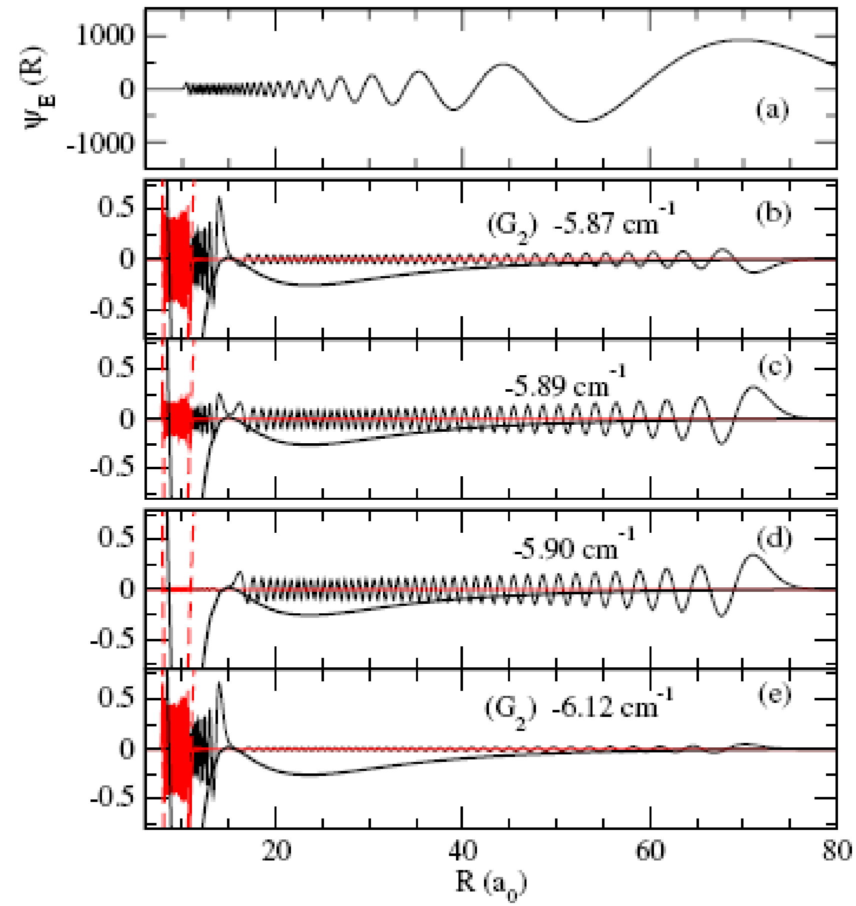
INSTITUTE OF PHYSICS PUBLISHING JOURNAL OF PHYSICS B: ATOMIC, MOLECULAR AND OPTICAL PHYSICS

J. Phys. B: At. Mol. Opt. Phys. 39 (2006) S945–S956 doi:10.1088/0953-4075/39/19/S09

Efficient formation of strongly bound ultracold caesium molecules by photoassociation with tunnelling

Mihaela Vatasescu[1], Claude M Dion[2] and Olivier Dulieu[3]





Conclusions

G. Pichler, V. Živčec, R. Beuc, Ž. Mrzljak, T. Ban,
H. Skenderović, K. Günther and J. Liu,
UV, Visible and IR Spectrum of the Cs High Pressure Lamp
Physica Scripta, **T105** (2003) 98-100.

Basic AMO Science

Cs high pressure discharge presents an excellent source to study rich atomic and molecular phenomena

New Technology

Digital spectrometers offer rapid overview of the whole UV, visible, and near infrared spectrum at different conditions.

Applications

Improvement of the Cs white light source is possible through the understanding of the basic atomic, molecular, optical and plasma physics.

Thank you!

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FEMTO

Supported by the Ministry of Science of the Republic of Croatia and the Alexander von Humbolt Stiftung, Germany