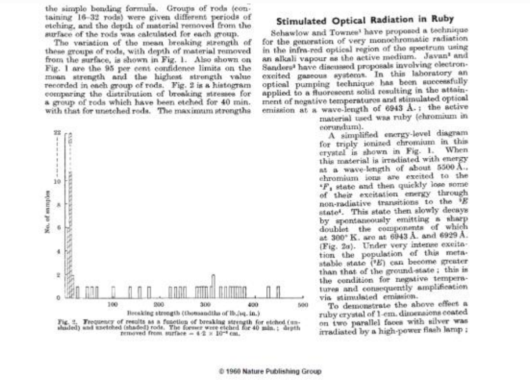
LU ASI zinātniskais seminārs ar vieslektoru

Dag Hanstorp

Trīs desmitgades lāzera spektroskopijas

16th of May 1960



the simple bending formula. Groups of rods (containing 16–32 rods) were given different periods of etching, and the depth of material removed from the surface of the rods was calculated for each group.

The variation of the mean breaking strength of these groups of rods, with depth of material removed from the surface, is shown in Fig. 1. Also shown on Fig. 1 are the 95 per cent confidence limits on the mean strength and the highest strength value recorded in each group of rods. Fig. 2 is a histogram comparing the distribution of breaking stresses for a group of rods which have been etched for 40 min. with that for unetched rods. The maximum strengths

Fig. 2. Frequency of results as a function of breaking strength for etched (unshaded) and unetched (shaded) rods. The former were etched for 40 min.; depth removed from surface = $4\cdot2 \times 10^{-4}$ cm.

Stimulated Optical Radiation in Ruby

Schawlow and Townes[1] have proposed a technique for the generation of very monochromatic radiation in the infra-red optical region of the spectrum using an alkali vapour as the active medium. Javan[2] and Sanders[3] have discussed proposals involving electron-excited gaseous systems. In this laboratory an optical pumping technique has been successfully applied to a fluorescent solid resulting in the attainment of negative temperatures and stimulated optical emission at a wave-length of 6943 Å.; the active material used was ruby (chromium in corundum).

A simplified energy-level diagram for triply ionized chromium in this crystal is shown in Fig. 1. When this material is irradiated with energy at a wave-length of about 5500 Å., chromium ions are excited to the $^4F_2$ state and then quickly lose some of their excitation energy through non-radiative transitions to the ^2E state[4]. This state then slowly decays by spontaneously emitting a sharp doublet the components of which at 300° K. are at 6943 Å. and 6929 Å. (Fig. 2a). Under very intense excitation the population of this metastable state (^2E) can become greater than that of the ground-state; this is the condition for negative temperatures and consequently amplification via stimulated emission.

To demonstrate the above effect a ruby crystal of 1-cm. dimensions coated on two parallel faces with silver was irradiated by a high-power flash lamp;

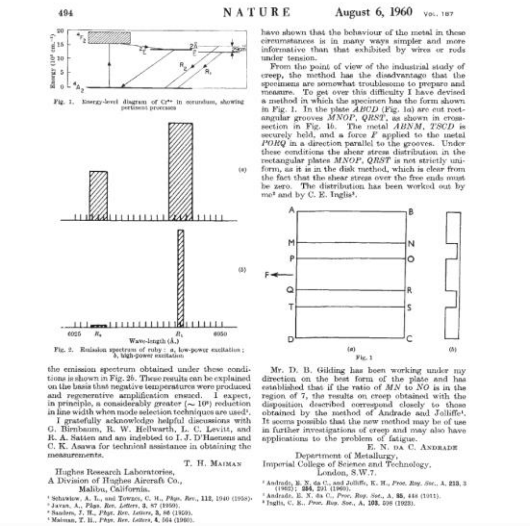


Fig. 1. Energy-level diagram of Cr^{3+} in corundum, showing pertinent processes

Fig. 2. Emission spectrum of ruby: a, low-power excitation; b, high-power excitation

the emission spectrum obtained under these conditions is shown in Fig. 2b. These results can be explained on the basis that negative temperatures were produced and regenerative amplification ensued. I expect, in principle, a considerably greater (~ 10^8) reduction in line width when mode selection techniques are used[1].

I gratefully acknowledge helpful discussions with G. Birnbaum, R. W. Hellwarth, L. C. Levitt, and R. A. Satten and am indebted to I. J. D'Haenens and C. K. Asawa for technical assistance in obtaining the measurements.

T. H. MAIMAN

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[1] Schawlow, A. L., and Townes, C. H., *Phys. Rev.*, **112**, 1940 (1958).
[2] Javan, A., *Phys. Rev. Letters*, **3**, 87 (1959).
[3] Sanders, J. H., *Phys. Rev. Letters*, **3**, 86 (1959).
[4] Maiman, T. H., *Phys. Rev. Letters*, **4**, 564 (1960).

have shown that the behaviour of the metal in these circumstances is in many ways simpler and more informative than that exhibited by wires or rods under tension.

From the point of view of the industrial study of creep, the method has the disadvantage that the specimens are somewhat troublesome to prepare and measure. To get over this difficulty I have devised a method in which the specimen has the form shown in Fig. 1. In the plate *ABCD* (Fig. 1a) are cut rectangular grooves *MNOP*, *QRST*, as shown in cross-section in Fig. 1b. The metal *ABNM*, *TSCD* is securely held, and a force *F* applied to the metal *PORQ* in a direction parallel to the grooves. Under these conditions the shear stress distribution in the rectangular plates *MNOP*, *QRST* is not strictly uniform, as it is in the disk method, which is clear from the fact that the shear stress over the free ends must be zero. The distribution has been worked out by me[2] and by C. E. Inglis[3].

Fig. 1

Mr. D. B. Gilding has been working under my direction on the best form of the plate and has established that if the ratio of *MN* to *NO* is in the region of 7, the results on creep obtained with the disposition described correspond closely to those obtained by the method of Andrade and Jolliffe[1]. It seems possible that the new method may be of use in further investigations of creep and may also have applications to the problem of fatigue.

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Department of Metallurgy,
Imperial College of Science and Technology,
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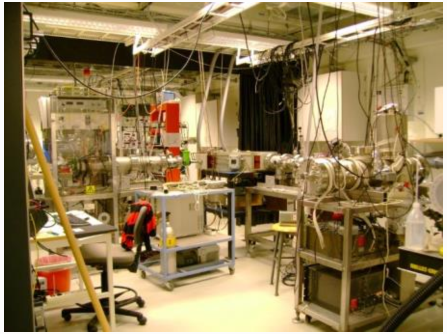
[1] Andrade, E. N. da C., and Jolliffe, K. H., *Proc. Roy. Soc.*, A, **213**, 3 (1952); **254**, 291 (1960).
[2] Andrade, E. N. da C., *Proc. Roy. Soc.*, A, **85**, 448 (1911).
[3] Inglis, C. E., *Proc. Roy. Soc.*, A, **103**, 598 (1923).

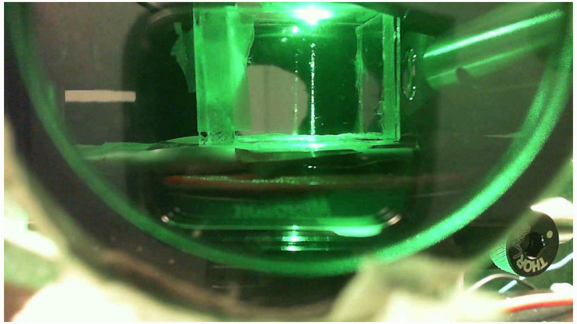
T. H. Maiman Nature **187**, 493–494(1960)

My research interests

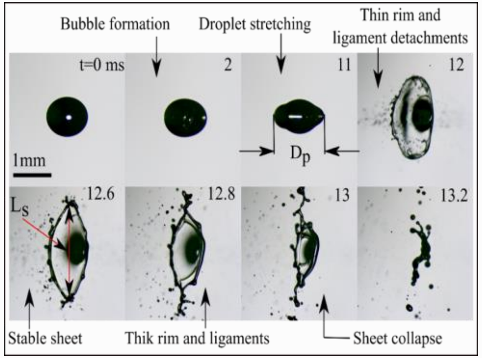
Spectroscopy of negative ions



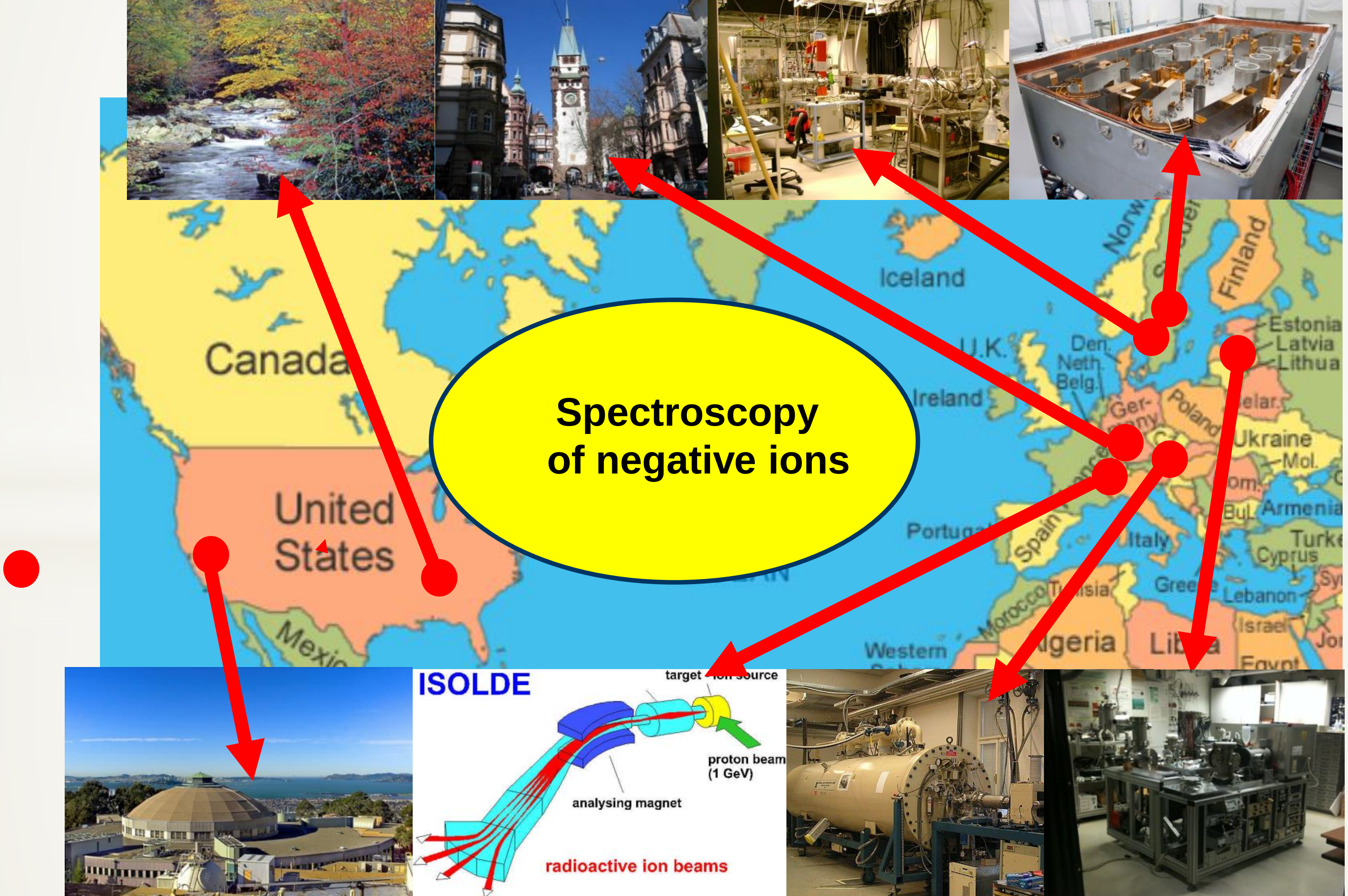
Optical manipulation



Femtosecond spectroscopy



Physics Education Research


Spectroscopy
of negative ions
Canada
United
States
Iceland
U.K.
Ireland
Den.
Neth.
Belg.
Finland
Estonia
Latvia
Poland
Ukraine
Armenia
Italy
Spain
Cyprus
Lebanon
Israel
Western
ISOLDE
target
proton beam
(1 GeV)
analysing magnet
radioactive ion beams

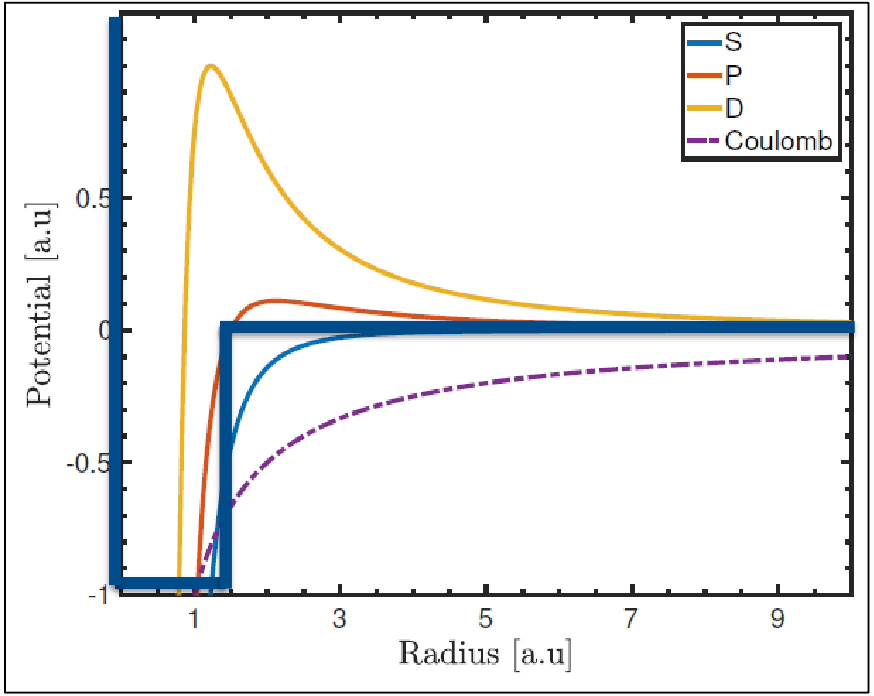
Negative ions

$$H|\Psi\rangle = [\frac{\hbar^2}{2\mu}\Delta + V(r)]|\Psi\rangle = E|\Psi\rangle$$

$$H = H_e + H_{ee} + V(r_i) = -\frac{\hbar^2}{2m_e}\sum_i \Delta_i + \sum_{i,j,i\neq j}\frac{e^2}{4\pi\epsilon_0 r_{ij}} - \frac{Ze^2}{4\pi\epsilon_0 r_i}$$

$$V_C(\boldsymbol{r}) = -\frac{e^2}{4\pi\varepsilon_0 r}$$

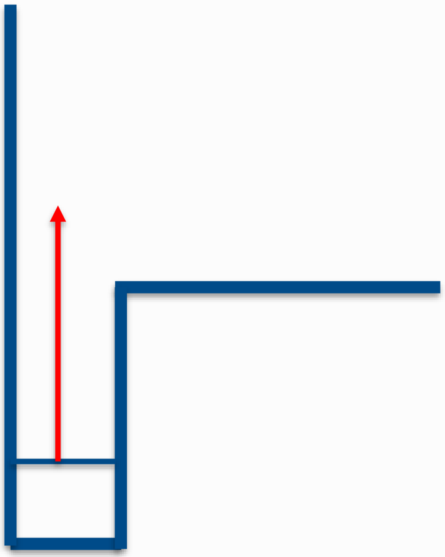
$$V(r) = \frac{l(l+1)}{2r^2} - \frac{\alpha_D}{2r^4}$$

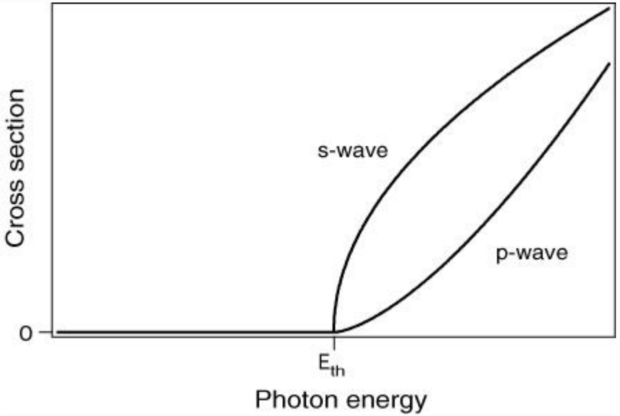


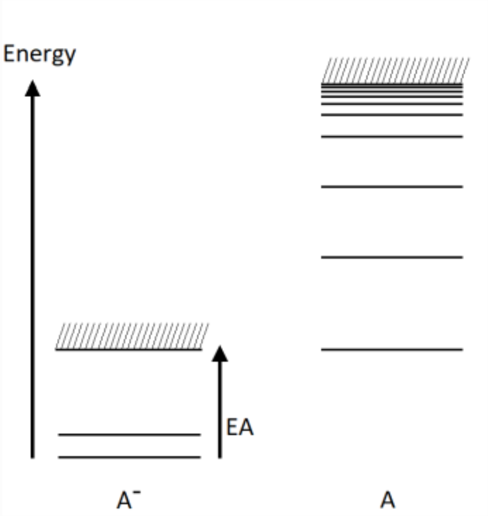
Photdetachment: $hf + A^{-} \rightarrow A + e^{-}$

Wigner threshold law: $\sigma(E) = (E_{\gamma} - E_{th})^{l+\frac{1}{2}}$

l angular momentum of emitted electron



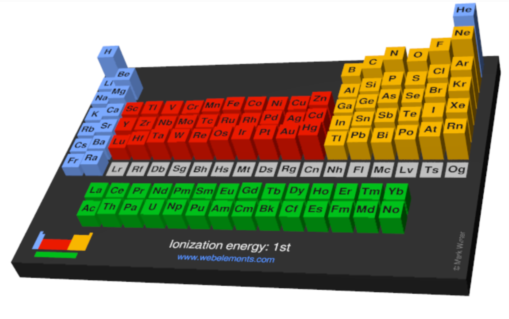


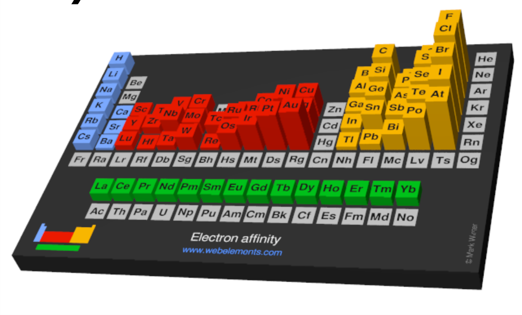


- **Electron affinity (EA)** is the binding energy of the additional electron (in the order of ~1eV)
- **Electron correlation dominated** binding allows probing of theories beyond Hartree-Fock approximation
- **Almost no bound states** with opposite parity existing (except La, Os, Ce, Th and U)

Periodic table of the a) ionization potentials

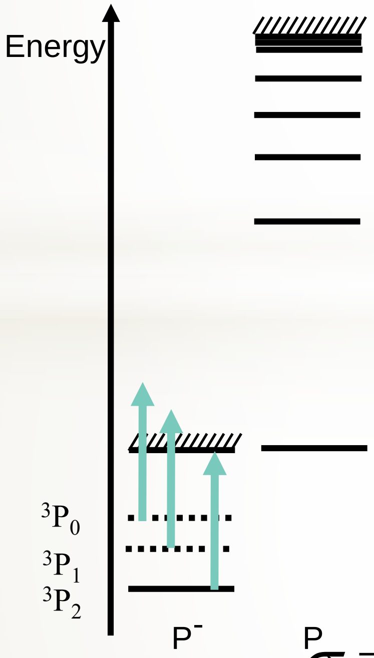
b) electron affinities

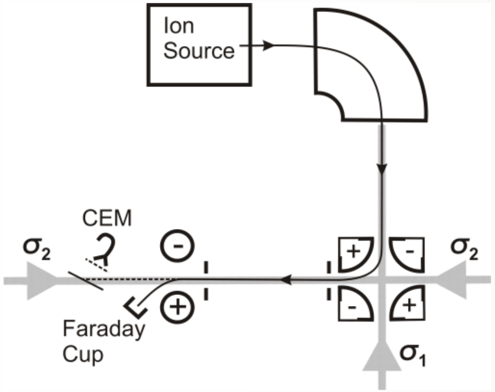


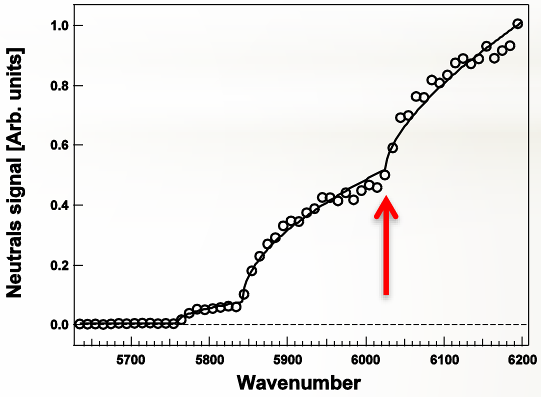


Determination of electron affinities:

$$P^- + h\nu \rightarrow P + e^-$$







$$\sigma = k\,(E-E_{EA})^{l+1/2}$$

EA = 746.68(6) meV

PHYSICAL REVIEW A VOLUME 51, NUMBER 1 JANUARY 1995

Isotope shift in the electron affinity of chlorine

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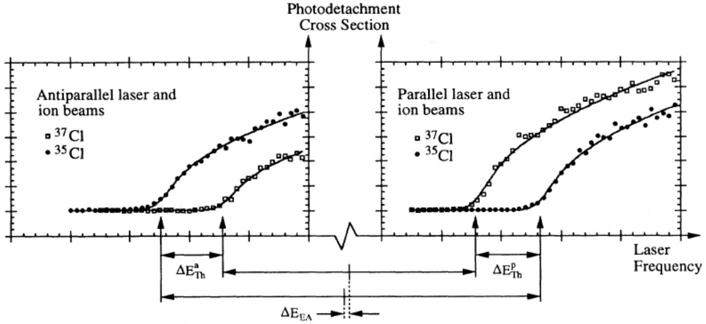
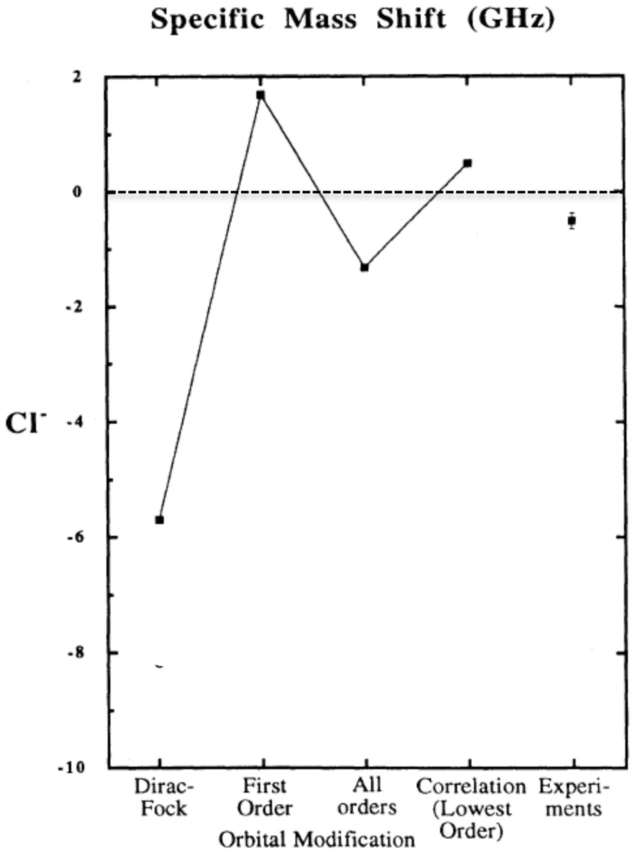
and Göteborg University, S-412 96 Göteborg, Sweden
(Received 14 July 1994)

The specific mass shift in the electron affinity between ^{35}Cl and ^{37}Cl has been determined by tunable-laser photodetachment spectroscopy to be −0.51(14) GHz. The isotope shift was observed as a difference in the onset of the photodetachment process for the two isotopes. In addition, the electron affinity of Cl was found to be 29 138.59(22) cm^{-1}, giving a factor of 2 improvement in the accuracy over earlier measurements. Many-body calculations including lowest-order correlation effects demonstrate the sensitivity of the specific mass shift and show that the inclusion of higher-order correlation effects would be necessary for a quantitative description.

PACS number(s): 35.10.Hn, 32.80.Fb, 31.30.Gs



$$\delta\nu_{SMS} = -0.51(14)\ \text{GHz}$$



Isotope shift on the chlorine electron affinity revisited by an MCHF/CI approach

T Carette[1,2] **and M R Godefroid**[2]

[1] Department of Physics, Stockholm University, AlbaNova University Centre, SE-106 91 Stockholm, Sweden
[2] Chimie quantique et photophysique, CP160/09, Université Libre de Bruxelles, B 1050 Brussels, Belgium

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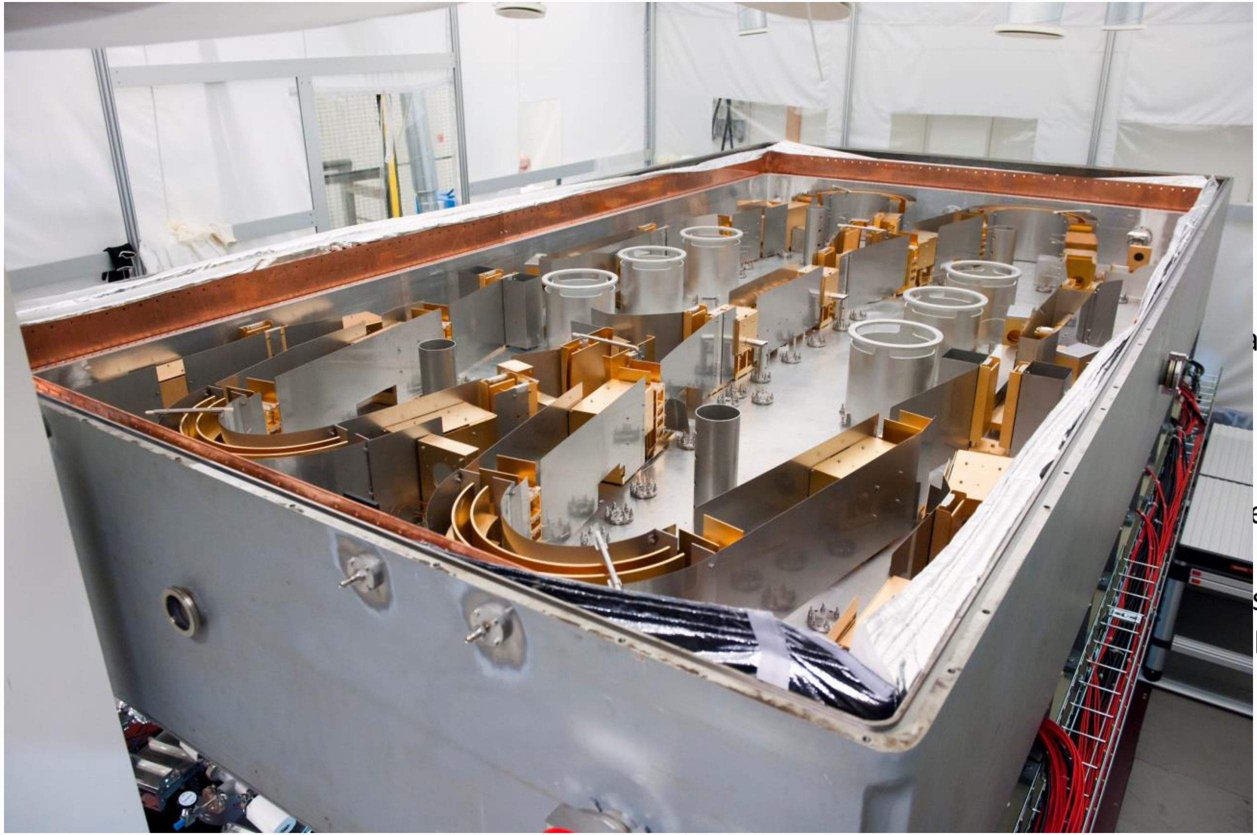
Abstract
Today, the electron affinity is experimentally well known for most of the elements and is a useful guideline for developing *ab initio* computational methods. However, the measurements of isotope shifts on the electron affinity are limited by both resolution and sensitivity. In this context, theory is of great help to further our knowledge and understanding of atomic structures, even though correlation plays a dominant role in negative ions' properties and, particularly, in the calculation of the specific mass shift contribution. This study solves the longstanding discrepancy between calculated and measured specific mass shifts on the electron affinity of chlorine (Berzinsh *et al* 1995 *Phys. Rev.* A **51** 231).

(Some figures may appear in colour only in the online journal)

	SMS	MS	FS	RIS	IS
			This work		
HF	−1.348	−0.607	−0.003(22)	−1.351(22)	−0.610(22)
val. FC−MCHF	−0.674	+0.067	−0.002(20)	−0.676(20)	+0.065(20)
val. MCHF	−0.495	+0.246	−0.003(21)	−0.497(21)	+0.244(21)
final results	−0.535(51)	+0.206(51)	−0.003(22)	−0.538(72)	+0.203(72)
			Berzinsh *et al* [27]		
Exp.				−0.51(14)	+0.22(14)
DF	−1.3	−0.6	+0.014(14)	−1.3	−0.6
MB low corr.	+0.50	+1.24	+0.014(14)	+0.51(2)	+1.26(2)

DESIREE – Double Electrostatic Ion Ring Experiment

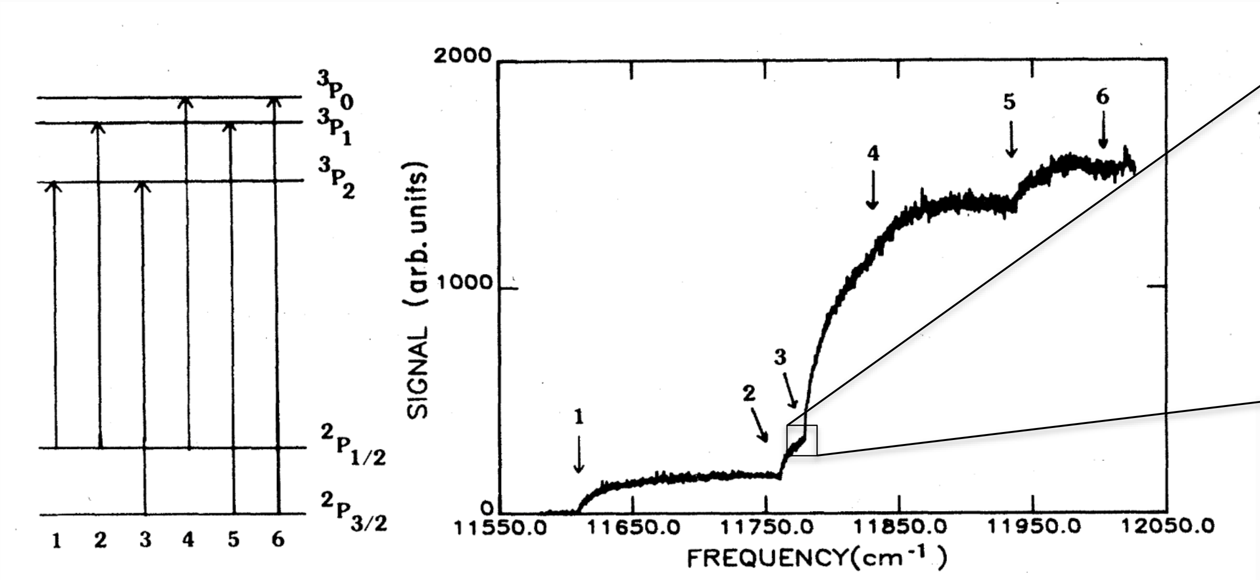


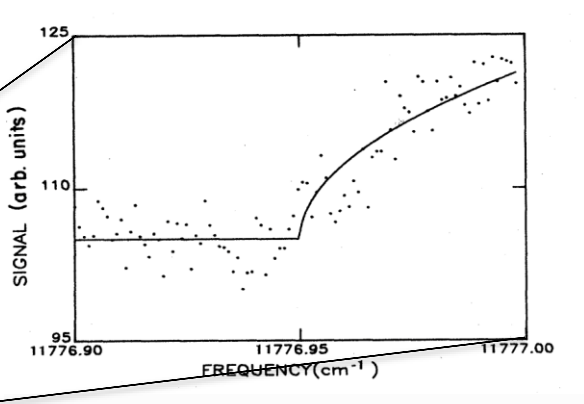
amu

eV

s
RO

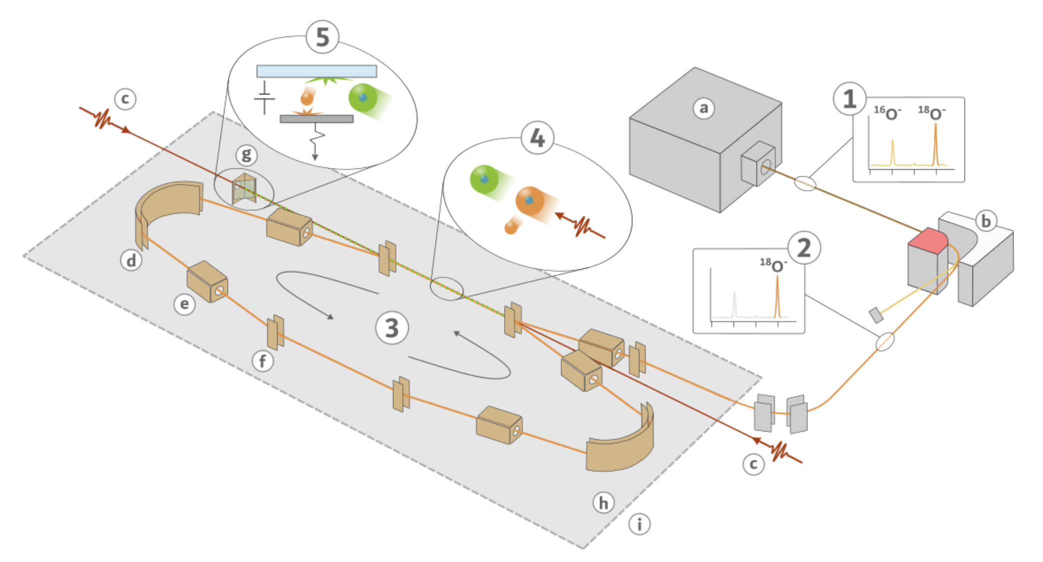
A Precision measurement of the EA of O^-



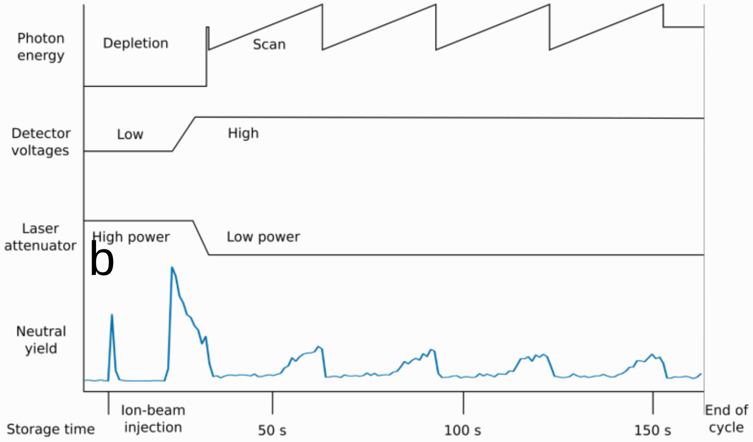


S/B= 15/100=1/7

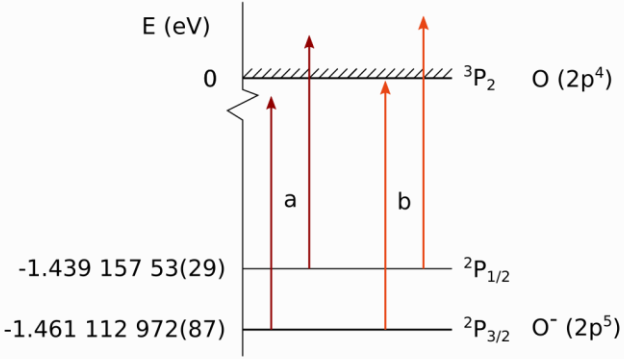
Neumark, D. M., et al. Physical Review A 32.3 (1985): 1890



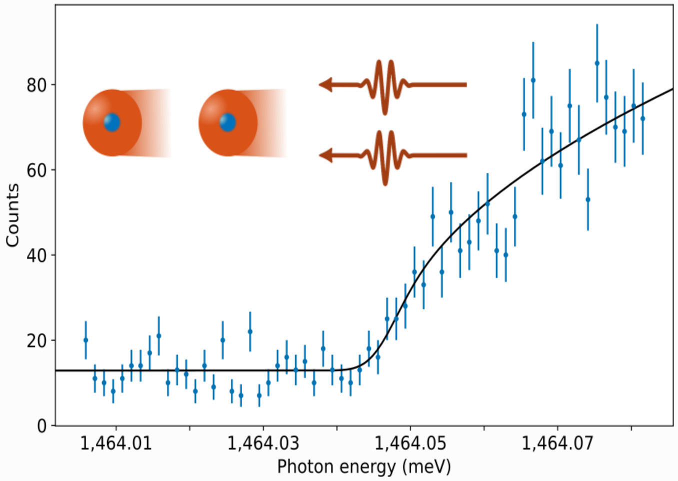
5
4
1
2
3
a
b
c
d
e
f
g
h
i
$^{16}O^-$
$^{18}O^-$
$^{18}O^-$

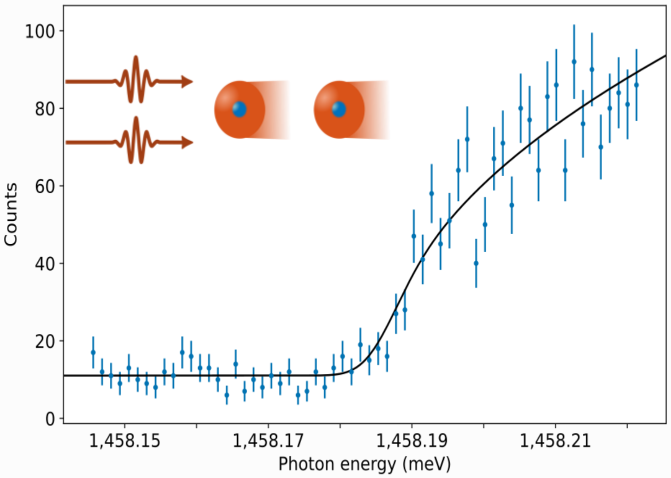


Photon energy
Depletion
Scan
Detector voltages
Low
High
Laser attenuator
High power
Low power
b
Neutral yield
Storage time
Ion-beam injection
50 s
100 s
150 s
End of cycle



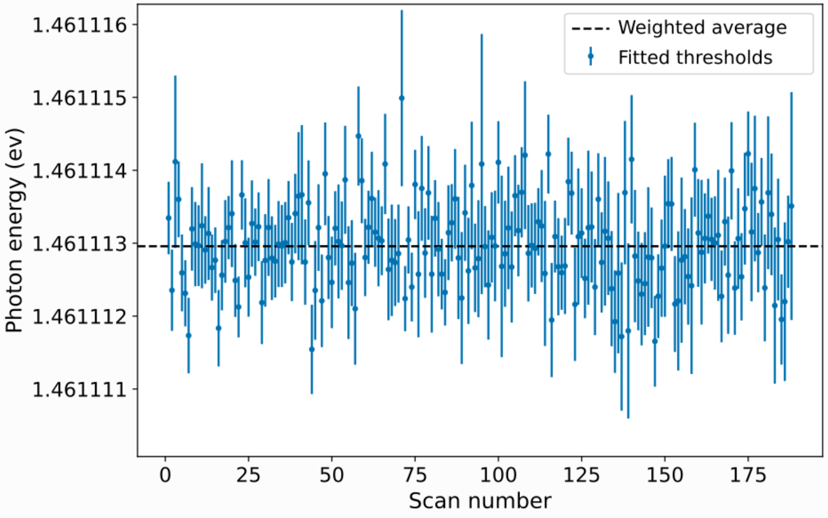
E (eV)
0
$^3P_2$
O ($2p^4$)
a
b
-1.439 157 53(29)
$^2P_{1/2}$
-1.461 112 972(87)
$^2P_{3/2}$
O^- ($2p^5$)

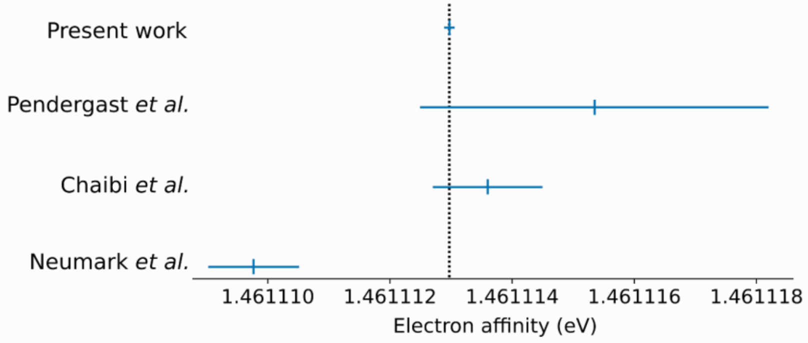




S/B= 80/15= 5/1→ 35 times improvement

$$\sqrt{E_{EA}^{p}E_{EA}^{a}} = \sqrt{\frac{1+v/c}{\sqrt{1-v^2/c^2}}E_{EA}\frac{1-v/c}{\sqrt{1-v^2/c^2}}E_{EA}} = \sqrt{E_{EA}E_{EA}} = E_{EA}$$





Final result: E_{EA} = 1.461 112 972 (87) eV

- 10-fold precision improvement
- Theoretical results vary between ~1.45-1.47 eV

$^{18-16}$O isotope shift

- Previous IS experimental value: -9.2(2.2) µeV

C. Blondel, Physical Review A 64, 052504 (2001).

Previous Theoretical value: -7.104 µeV

Godefroid and C. F. Fischer, Phys. Rev. A 60, R2637 (1999).

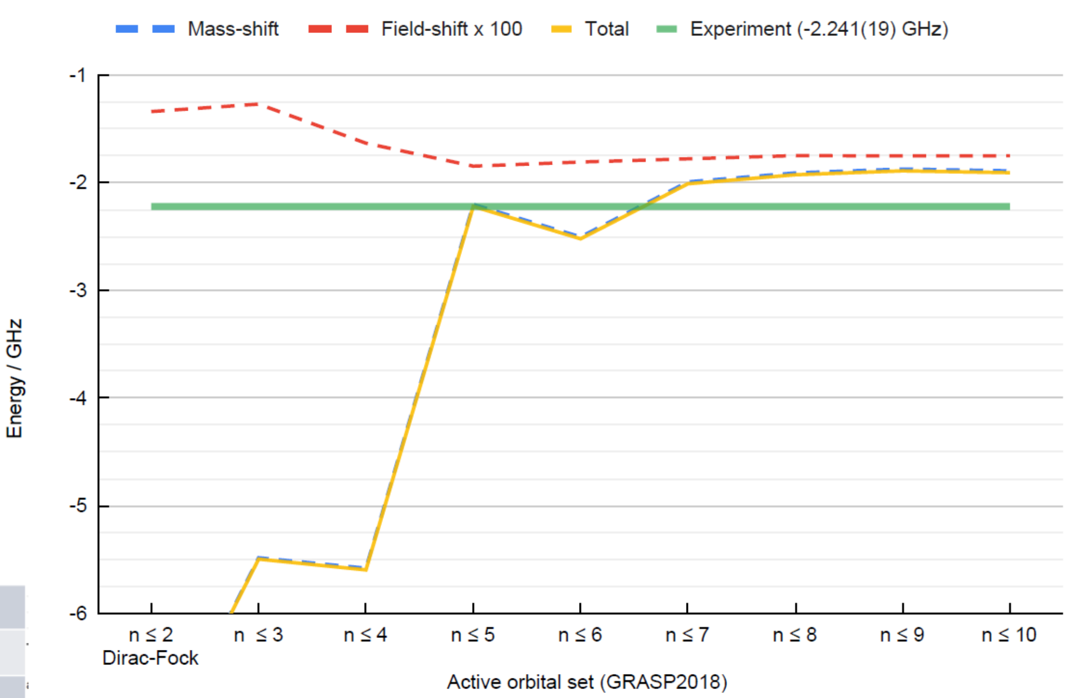
$$E_{EA}(^{16}O) = 1.461\,112\,972\,(87)\ \text{eV}$$

$$E_{EA}(^{18}O) = 1.461\,103\,706\,(67)\ \text{eV}$$

$$IS = -0.000\,009\,267(11)\ \text{eV}$$

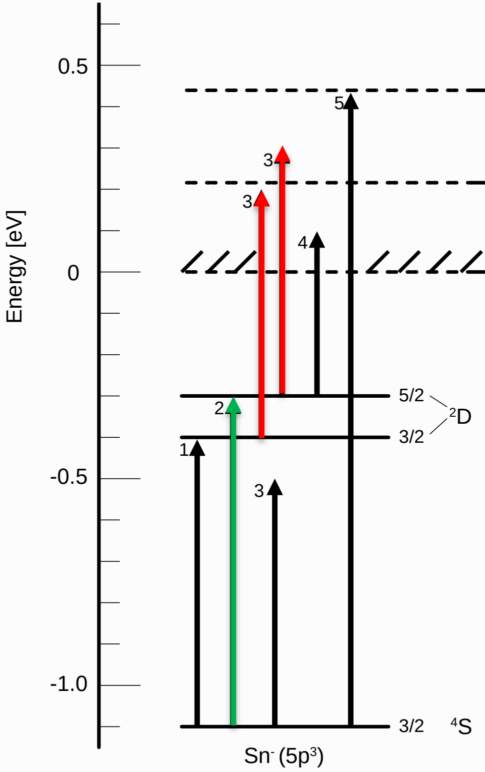
Theory by Jon Grumer

- - **Atomic structure:** MCDHF + RCI using latest dev. version of GRASP*, correlation model inspired by Godefroid and Froese Fischer***
- - **total IS on EA** = -7.9 μeV
  Mass shift dominates completely
  tricky to converge due to counteracting normal and specific mass shifts
-

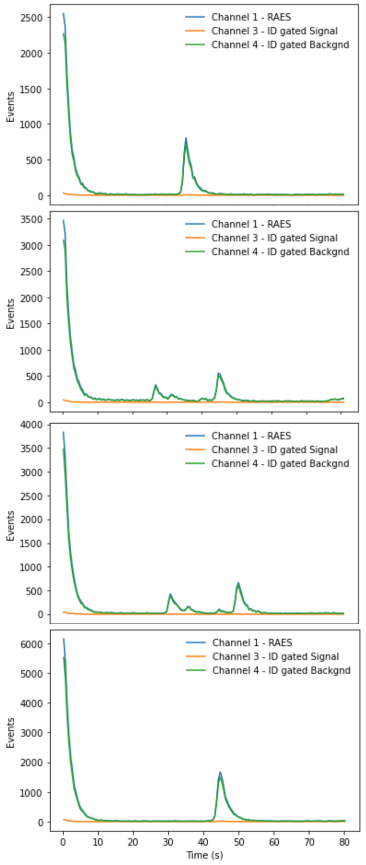


		year	IS (μeV)
Blondel	Exp.	2001	9.2 (2.2)
Godefroid	Theory	1999	7.104
Kristiansson	Exp.	2022	9.267(11)
Grumer	Theory	2023	7.90

$$Sn^- + h\nu \rightarrow Sn + e^-$$



1 1735 nm, 0.7 eV
2 1535 nm, 0.8 eV
3 1115 nm < x < 2040 nm, 1.1 eV > x > 0.6 eV
4 3118 nm < x < 4070 nm, 0.4 eV > x > 0.3 eV
5 806 nm, 1.5 eV



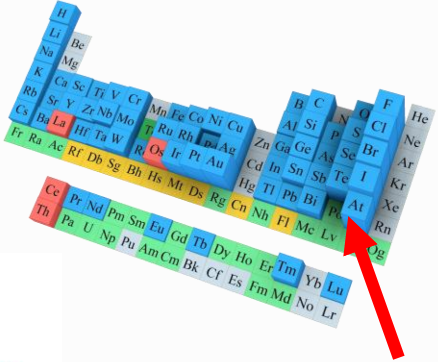
116

117

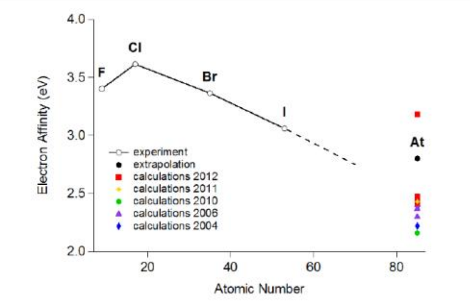
119

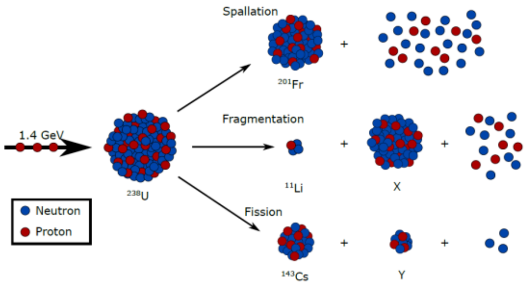
120

The electron affinity of Astatine

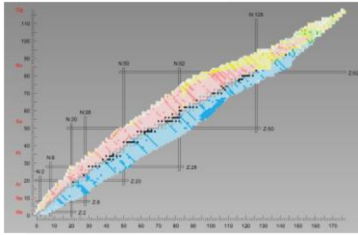


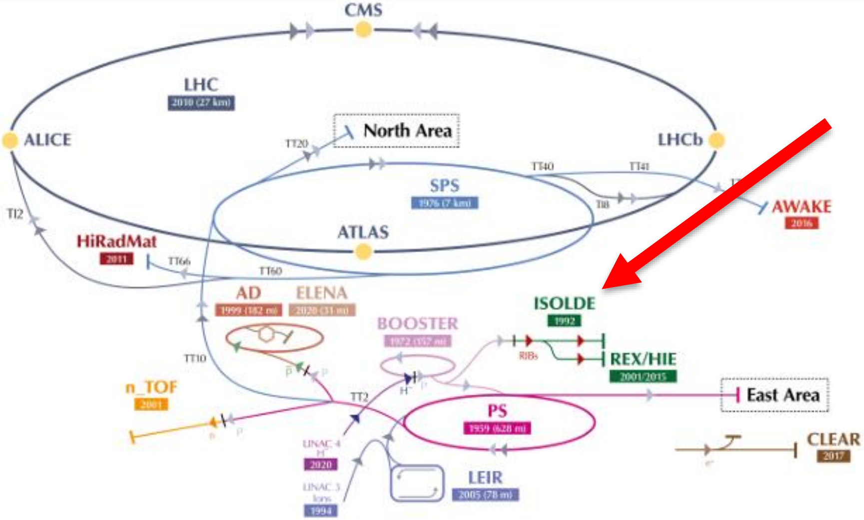
- Least abundant element on earth
- 70 mg in the crust of the earth
  (1 atom per 100 kg mass)
- Decays through α-decay
- Small knowledge about its
  chemical and physical properties
- Used in cancer treatment
  Targeted Alfa Therapy (TAT)
  (suitable lifetime and energy,
  non-toxic, non-radioactive daughters)



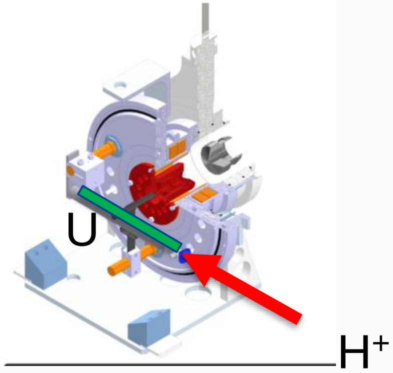


Spallation
201Fr
1.4 GeV
238U
Fragmentation
11Li
X
Fission
143Cs
Y
Neutron
Proton





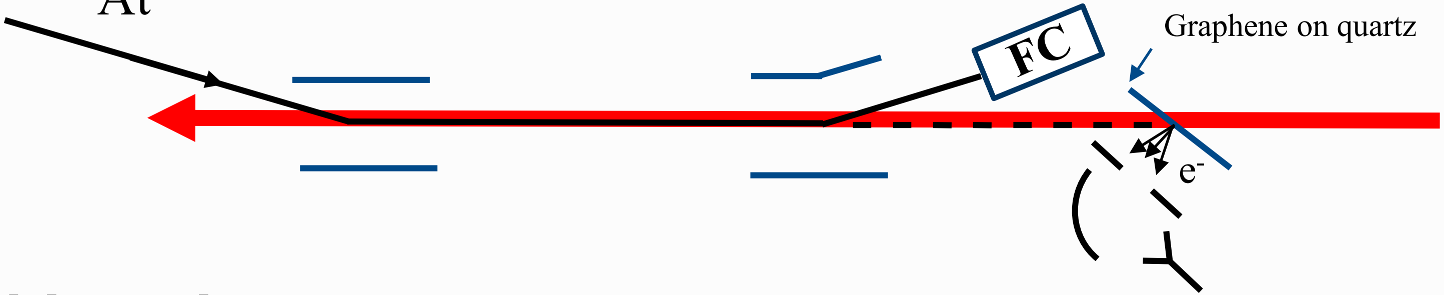
CMS
LHC
2010 (27 km)
ALICE
North Area
LHCb
TT20
TT40
TT41
SPS
1976 (7 km)
AWAKE
2016
TI2
HiRadMat
2011
ATLAS
TT66
TT60
AD
1999 (182 m)
ELENA
2020 (31 m)
ISOLDE
1992
BOOSTER
1972 (157 m)
RIBs
REX/HIE
2001/2015
TT10
n_TOF
2001
TT2
East Area
PS
1959 (628 m)
LINAC 4
2020
CLEAR
2017
LINAC 3
Ions
1994
LEIR
2005 (78 m)



U
H+

GANDALPH

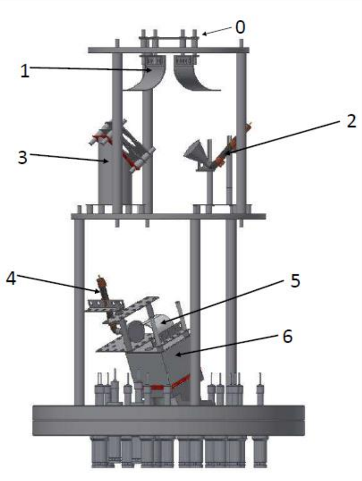
Gothenburg **AN**ion **D**etector for **A**ffinity measurements by **L**aser **PH**otodetachment



For each laserpuls:

Signal:
0.01 atom

Background:
10^{14} photons

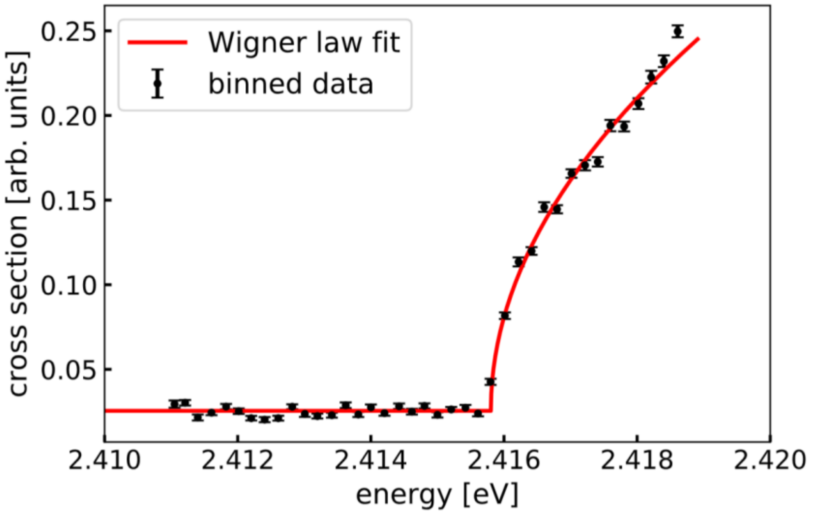


Drawing: Annie Ringvall-Moberg

RESUTLS

Experiment: EA= 2.415 78 (5) eV
Theory EA = 2.414 (16) eV

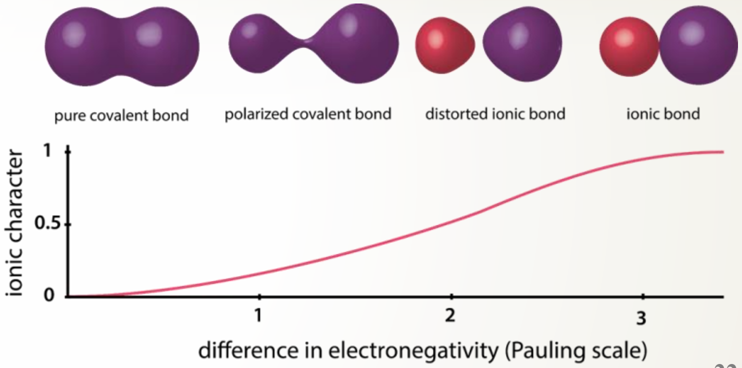
By Anastasia Anastasia Borschevsky and co-workers: DIRAC15 program package using the single reference coupled-cluster approach in the framework of the Dirac- Coulomb Hamiltonian (DC-CCSD(T))



Rothe et al. Nat. Commun. 4, 1835 (2013).
IP(At) = 9.317 51(8) eV

→

Electronegativity = (IP + EA)/2 = 5.866 65 eV

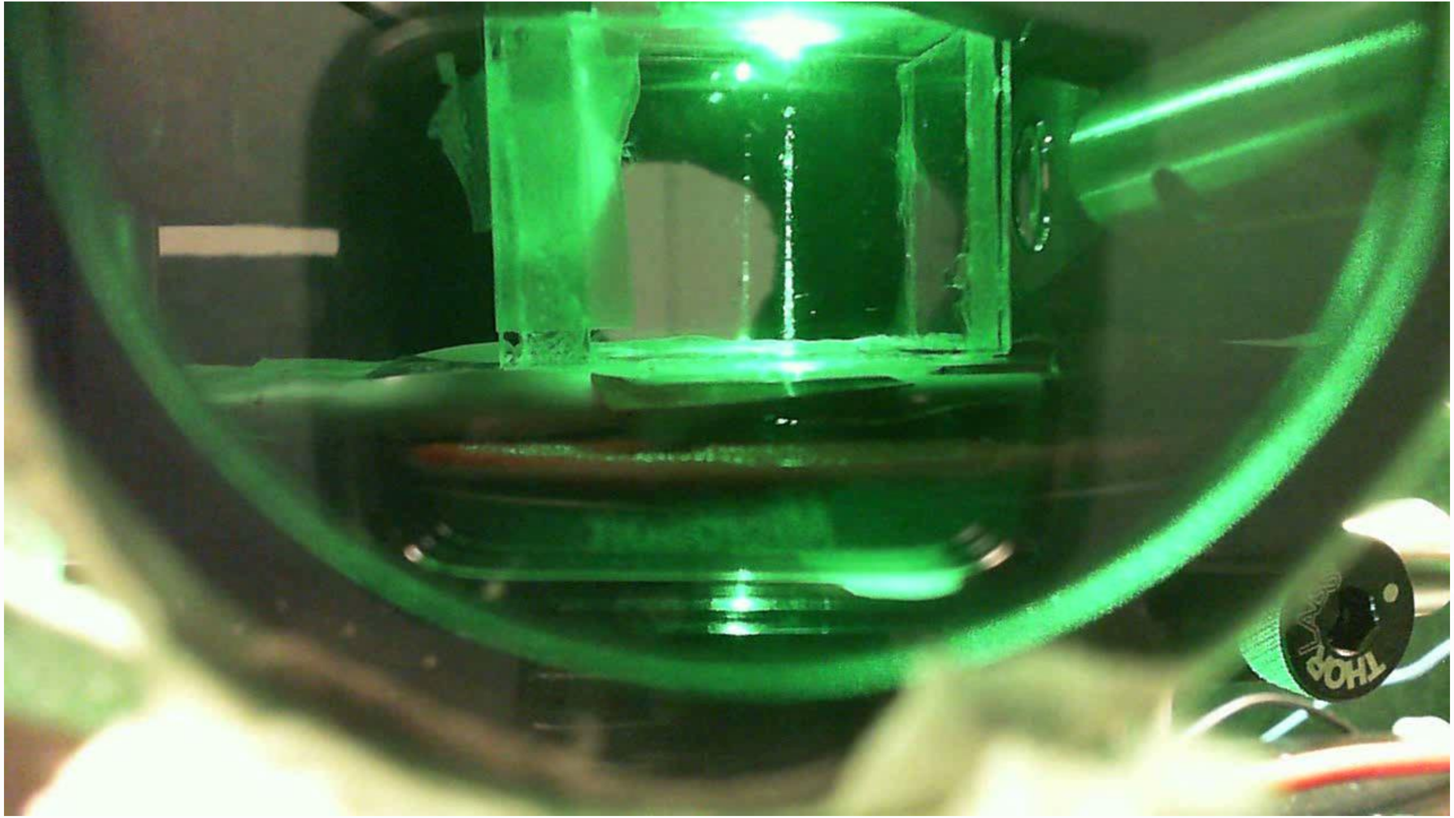


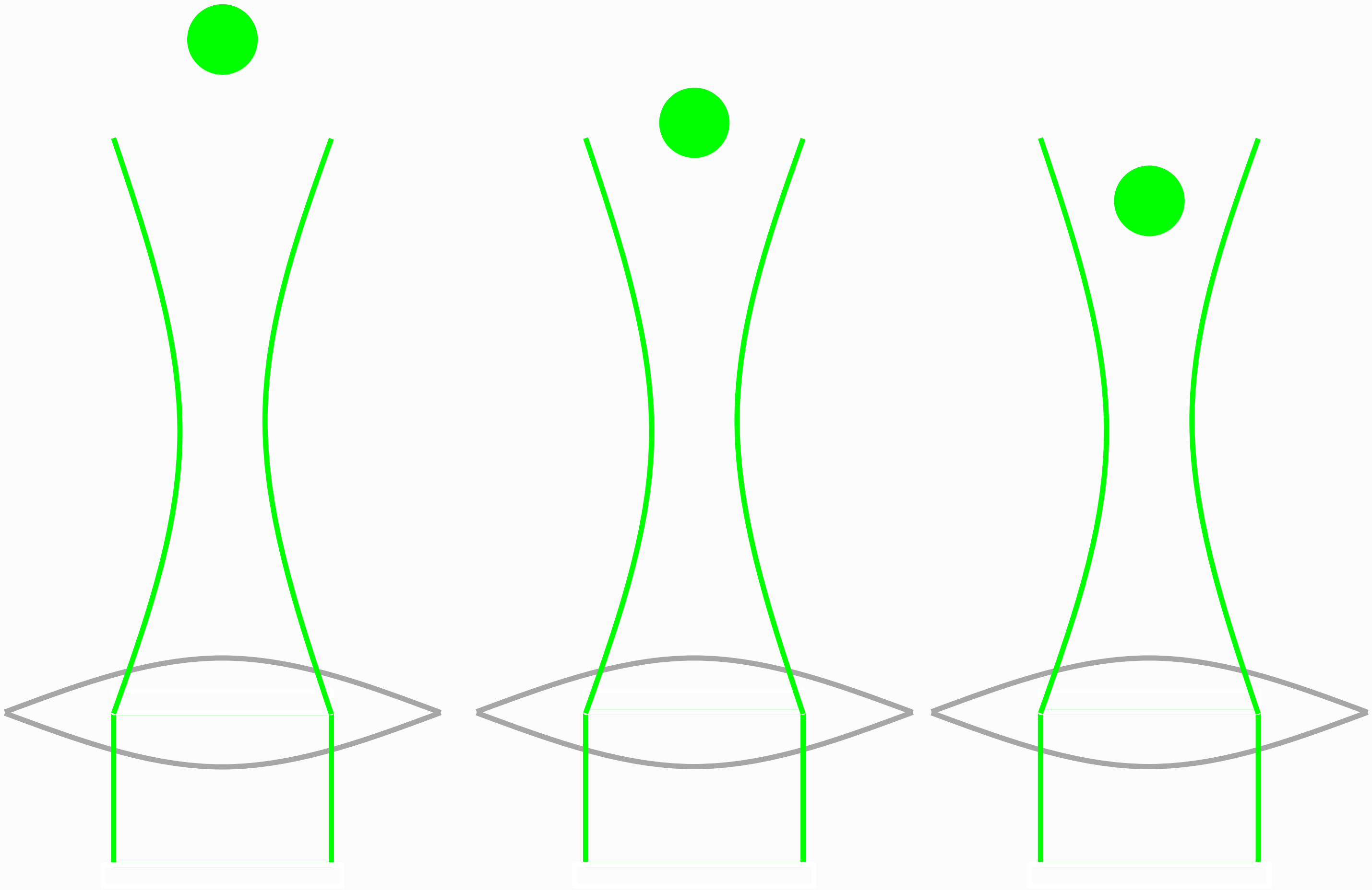
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

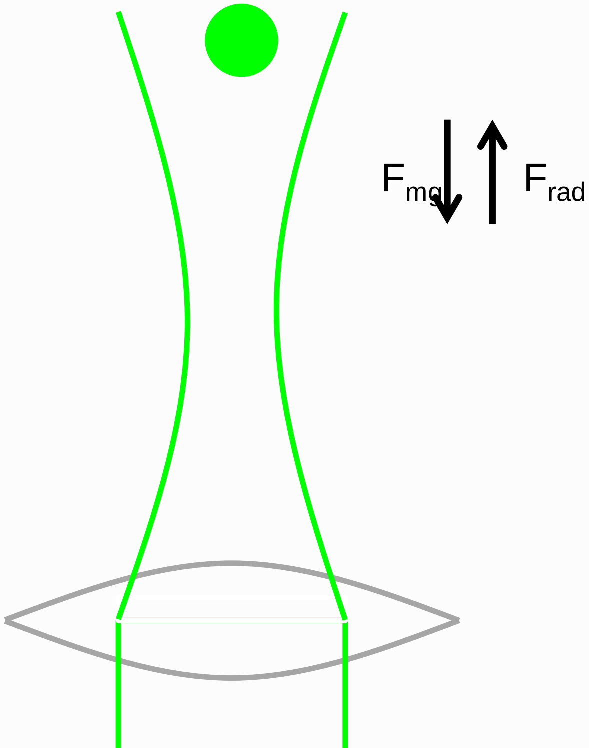
Measurement of shifts in the electron affinities of chlorine isotopes

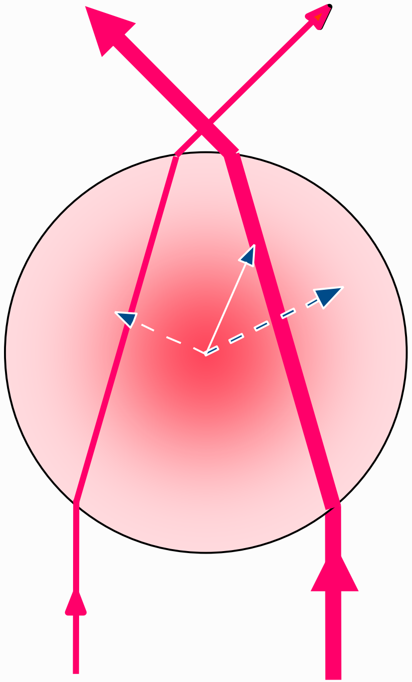
Dag Hanstorp[1], Jakob Welander[1], David Leimbach[1], Annie Ringvall-Moberg[1,2], Michel Godefroid[3], Per Jönsson[4], Jörgen Ekman[4], Tomas Brage[5], Klaus Wendt[6], Reinhard Heinke[6], Oliver Forstner[7], Yuan Liu[8], Ronald Garcia Ruiz[9], Shane Wilkins[9], Adam Vernon[9], Cory Binnersley[9], Kieran Flanagan[9], Gerda Neyens[10], Agi Koszorus[10], Kara Lynch[2], Sebastian Rothe[2], Tim Giles[2], Katerina Chrysalidis[2,6], Pierre Larmonier[2], Valentin Fedosseev[2] and Bruce Marsh[2].



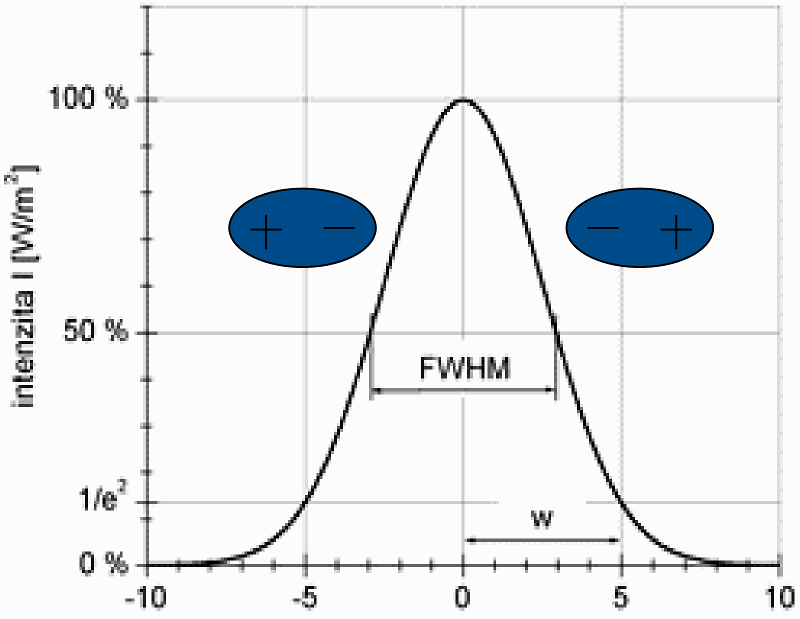


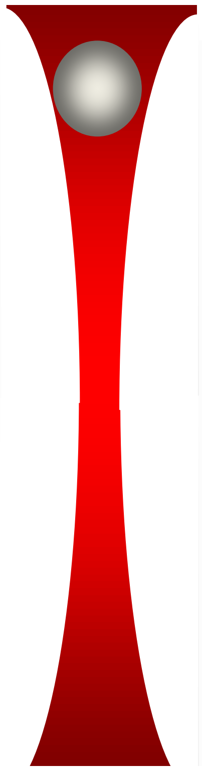
OPTICAL LEVITATION





Trapping in Wave optic





Optical levitation

Volume 24, Number 4 PHYSICAL REVIEW LETTERS 26 January 1970

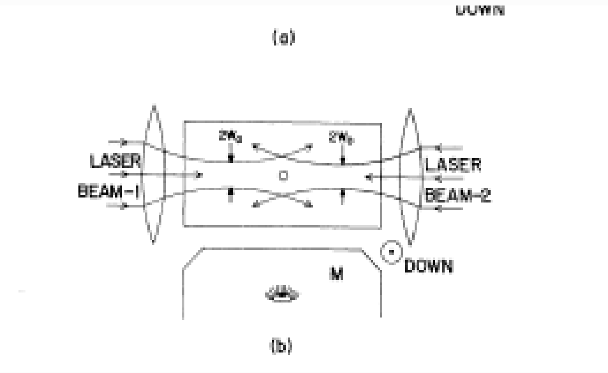
ACCELERATION AND TRAPPING OF PARTICLES BY RADIATION PRESSURE

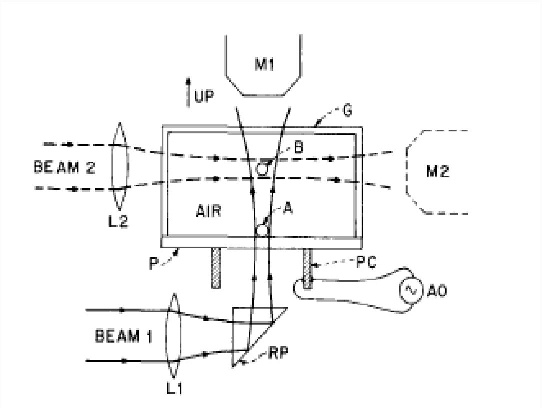
A. Ashkin
Bell Telephone Laboratories, Holmdel, New Jersey 07733
(Received 3 December 1969)

APPLIED PHYSICS LETTERS VOLUME 19, NUMBER 8 15 OCTOBER 1971

Optical Levitation by Radiation Pressure

A. Ashkin and J. M. Dziedzic
Bell Telephone Laboratories, Holmdel, New Jersey 07733
(Received 14 June 1971; in final form 13 August 1971)





OPTICAL MANIPULATION - ARTHUR ASHKIN

- 1970 – Optical levitation

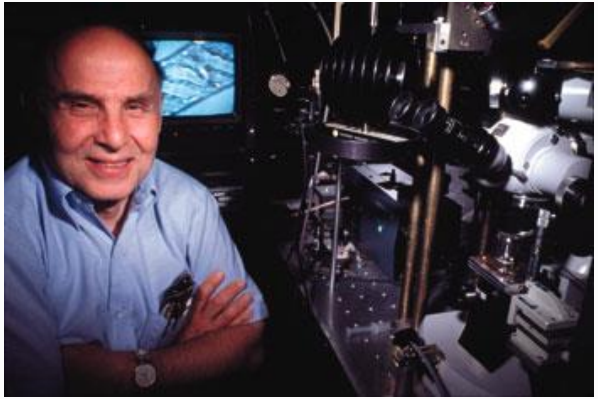
  Ashkin&J.M.Dziedzic, App.Phys.Lett.**19**,283(1971)

- 1986 – The optical tweezers -trapped living

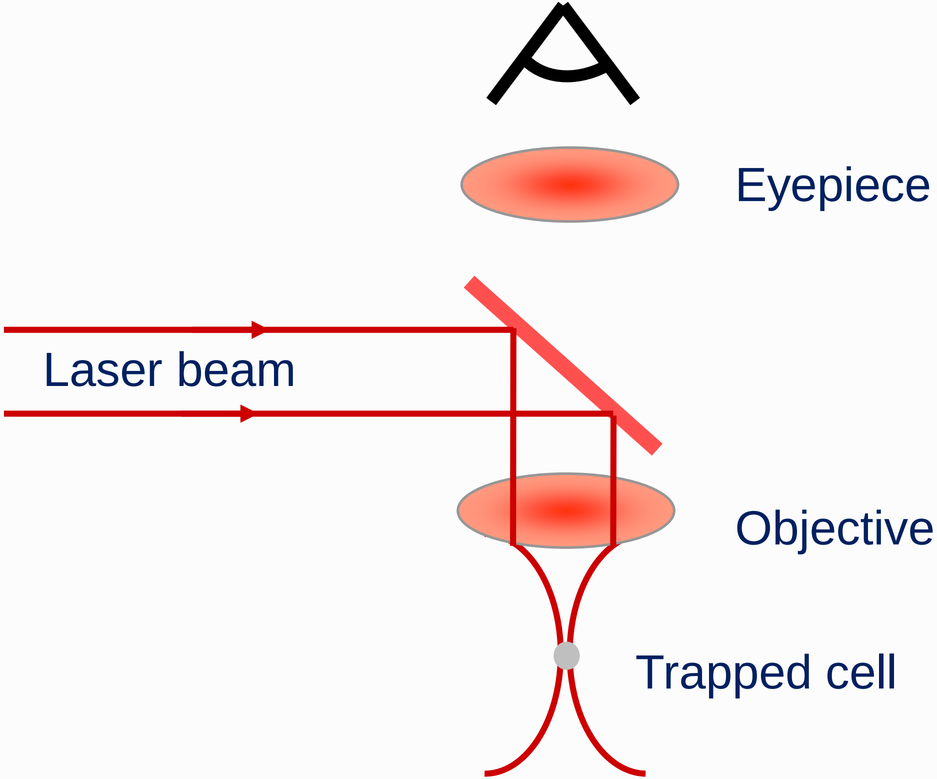
  A. Ashkin et al., Optics Letters. **11**, 288 (1986)

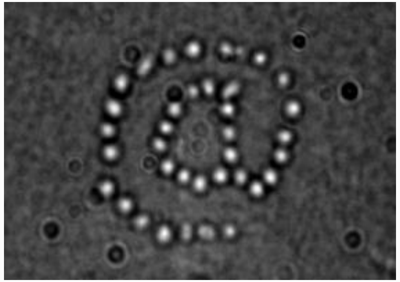
- Nobel prize in physics 2018

“for the optical tweezers and their application to biological systems.”

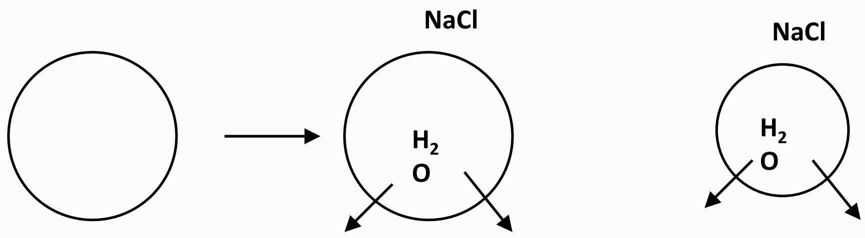


The optical tweezers





Salt stress of a single yeast cell



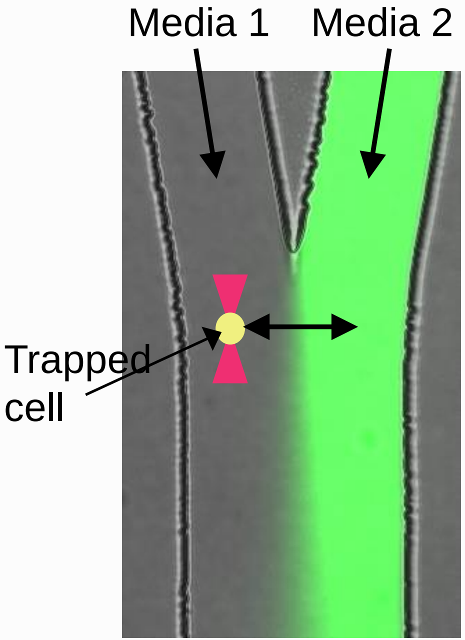
Normal cell

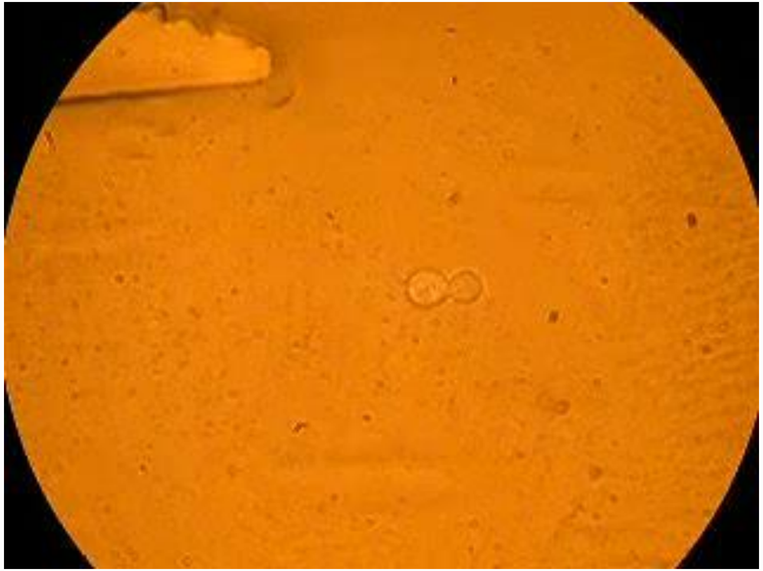
Osmotic shock

Volume decrease

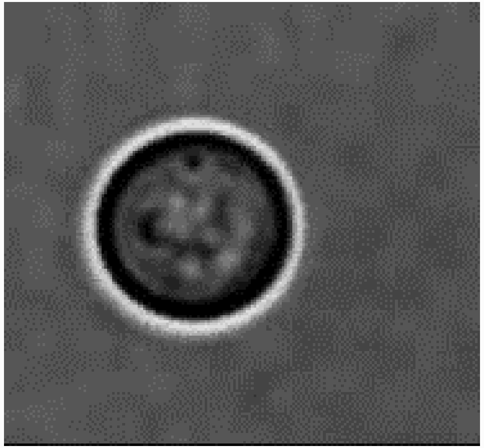
Glycerol production starts

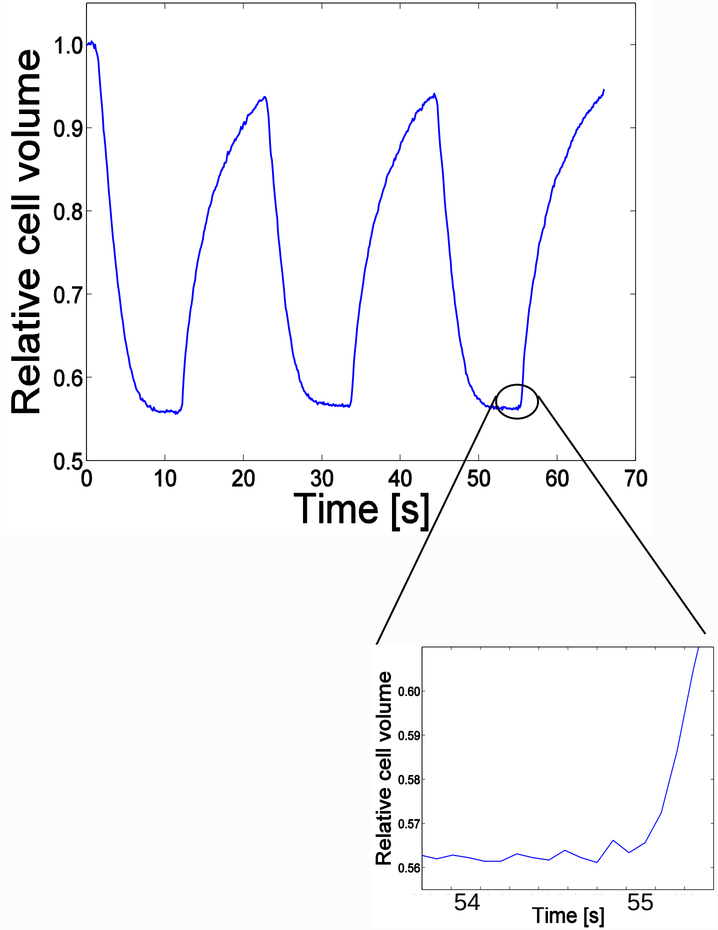
Salt stress of a single yeast cell





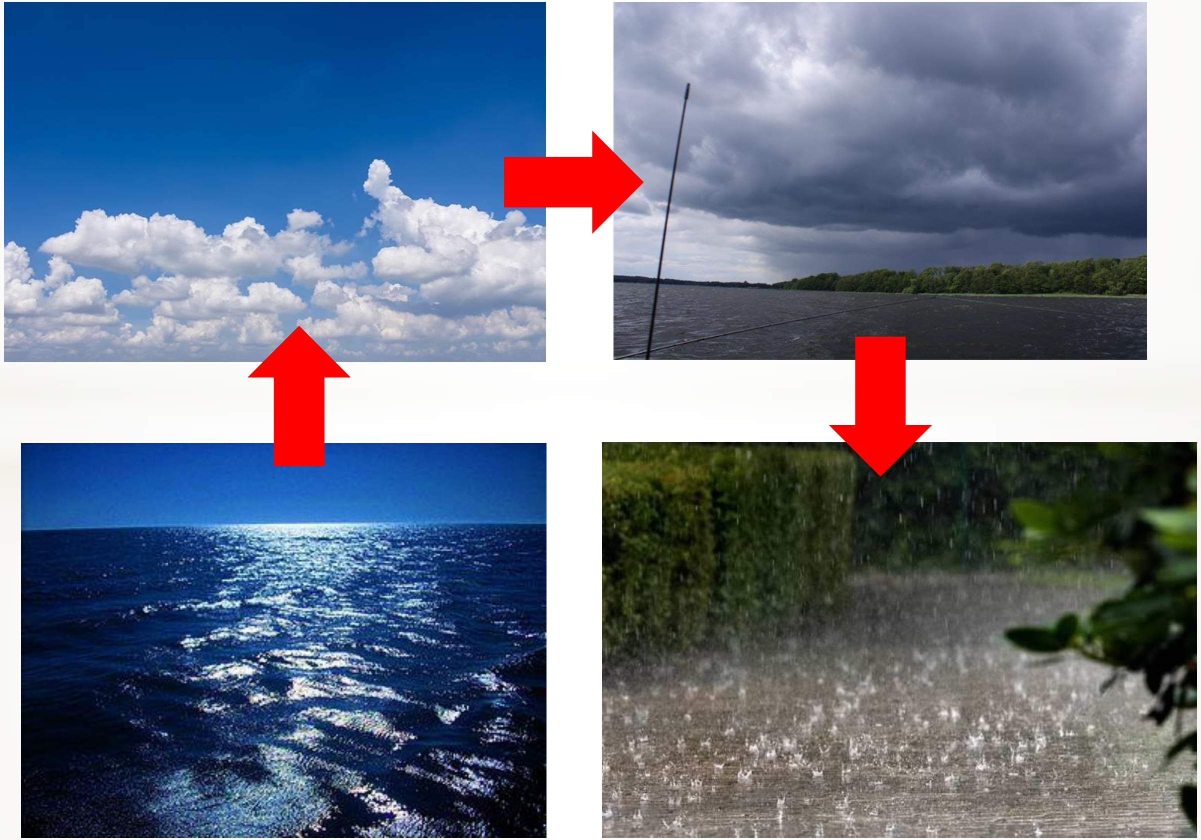
In cooperation with group of Stefan Hohmann
At Cell and Molecular Biology, Göteborg University



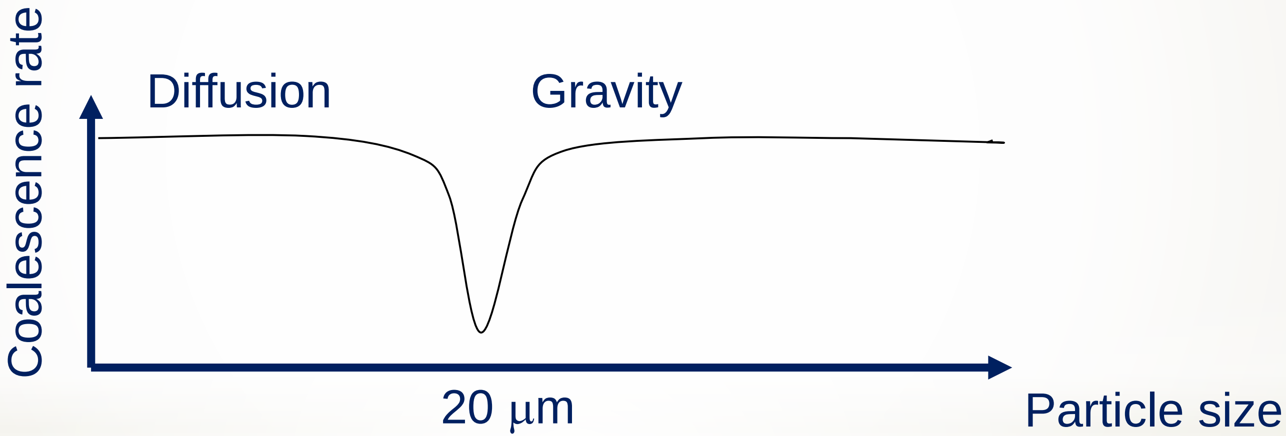


Relative cell volume
1.0
0.9
0.8
0.7
0.6
0.5
0
10
20
30
40
50
60
70
Time [s]
Relative cell volume
0.60
0.59
0.58
0.57
0.56
54
55
Time [s]

How are raindrops created?

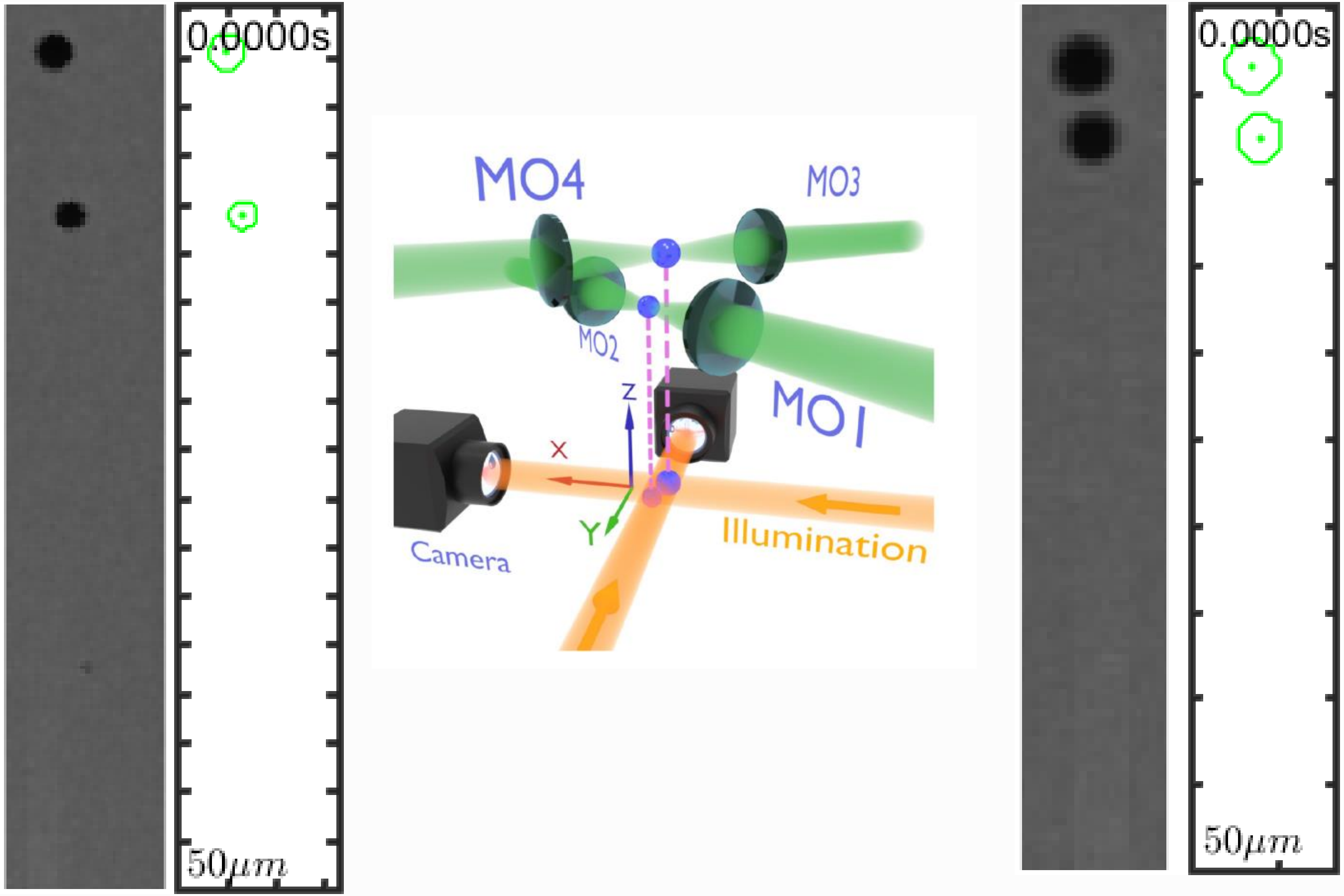


The bottleneck problem:

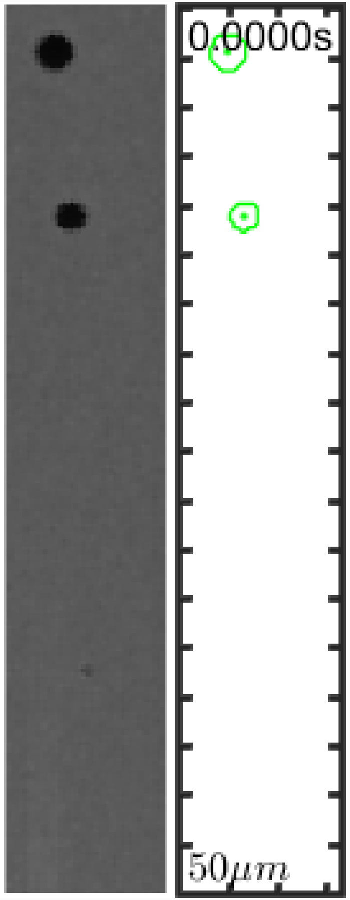


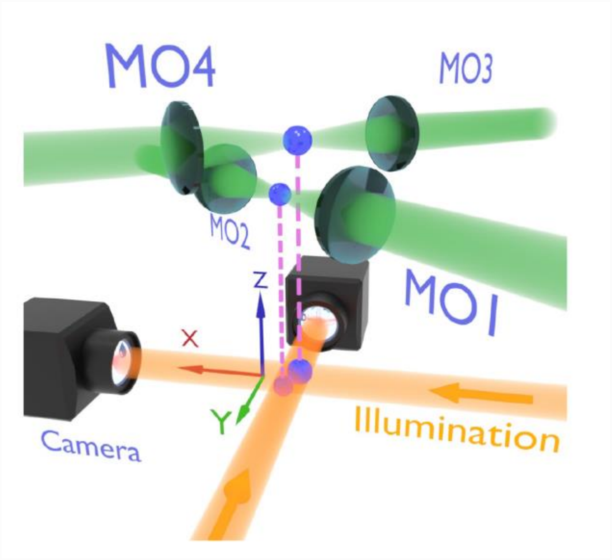
A similar problems occurs in planet formation

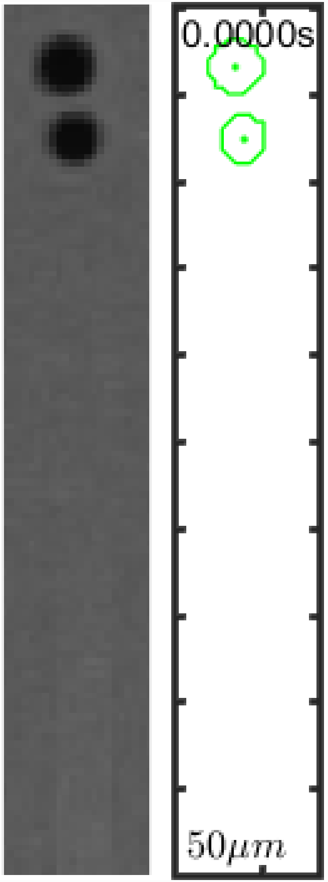
Research project ” Bottlenecks for particle growth in turbulent aerosols" from the Knut and Alice Wallenberg Foundation, coordinated by Bernhard Mehlig



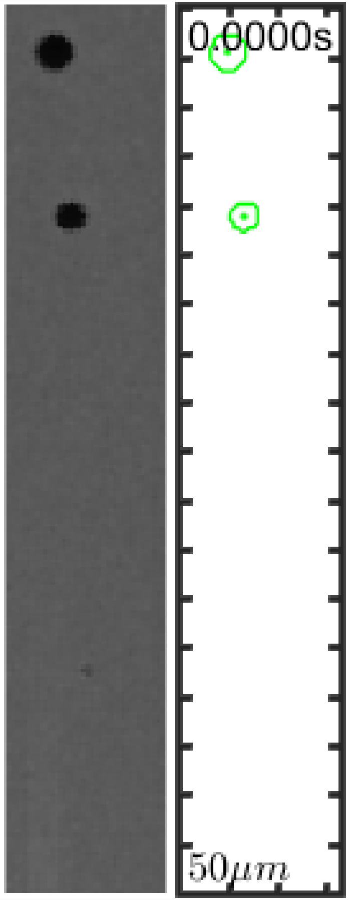
Ivanov et al. Optics express **25** (2017) 1391

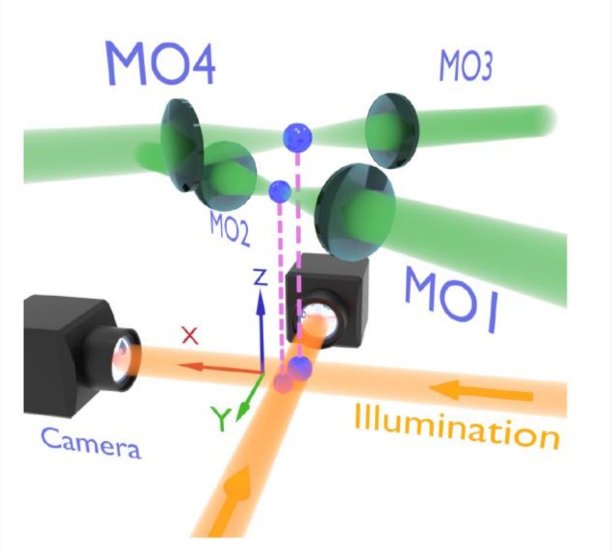


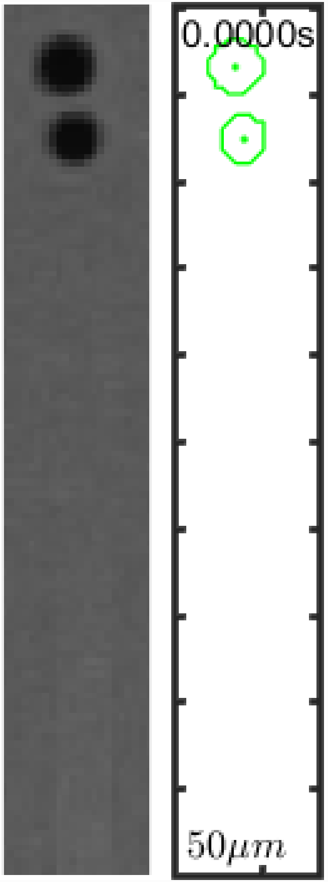




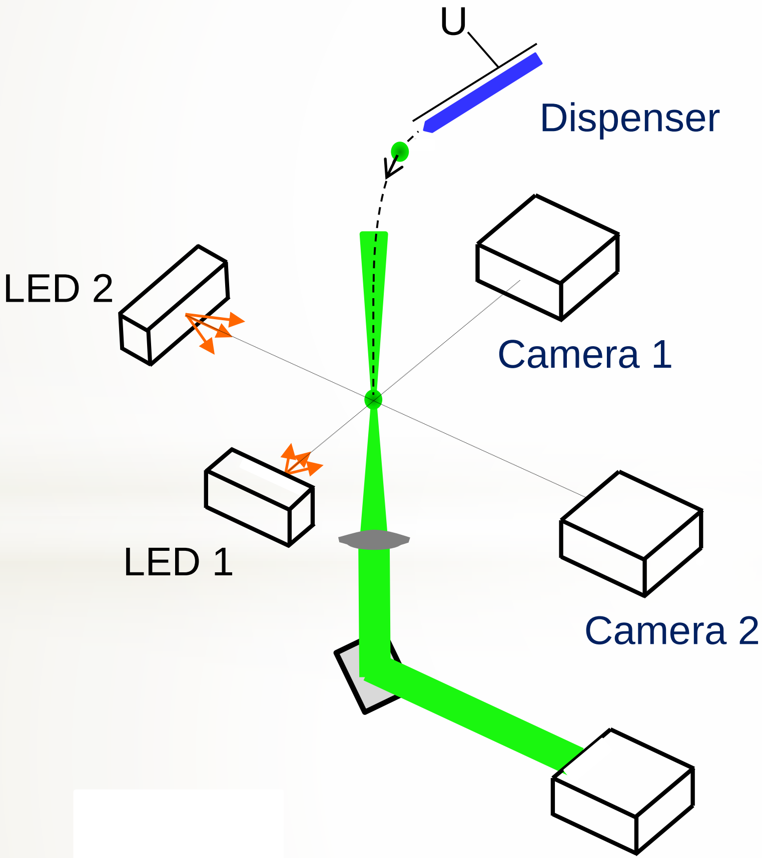
Ivanov et al. Optics express **25** (2017) 1391

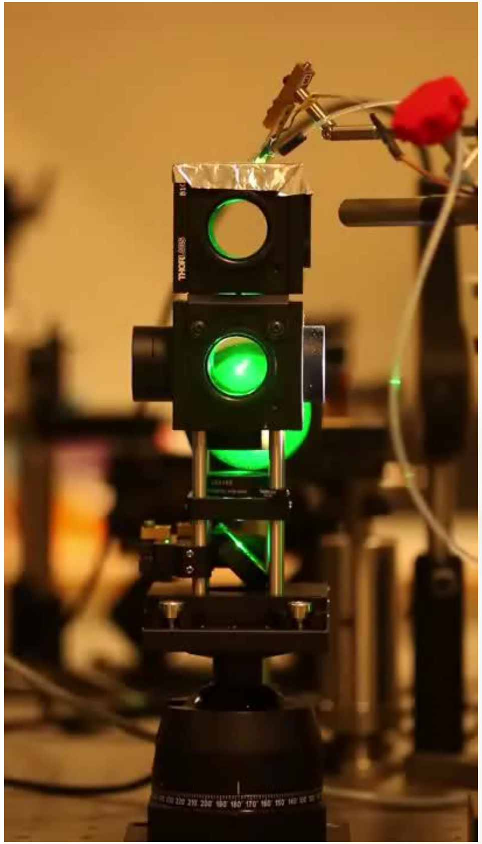


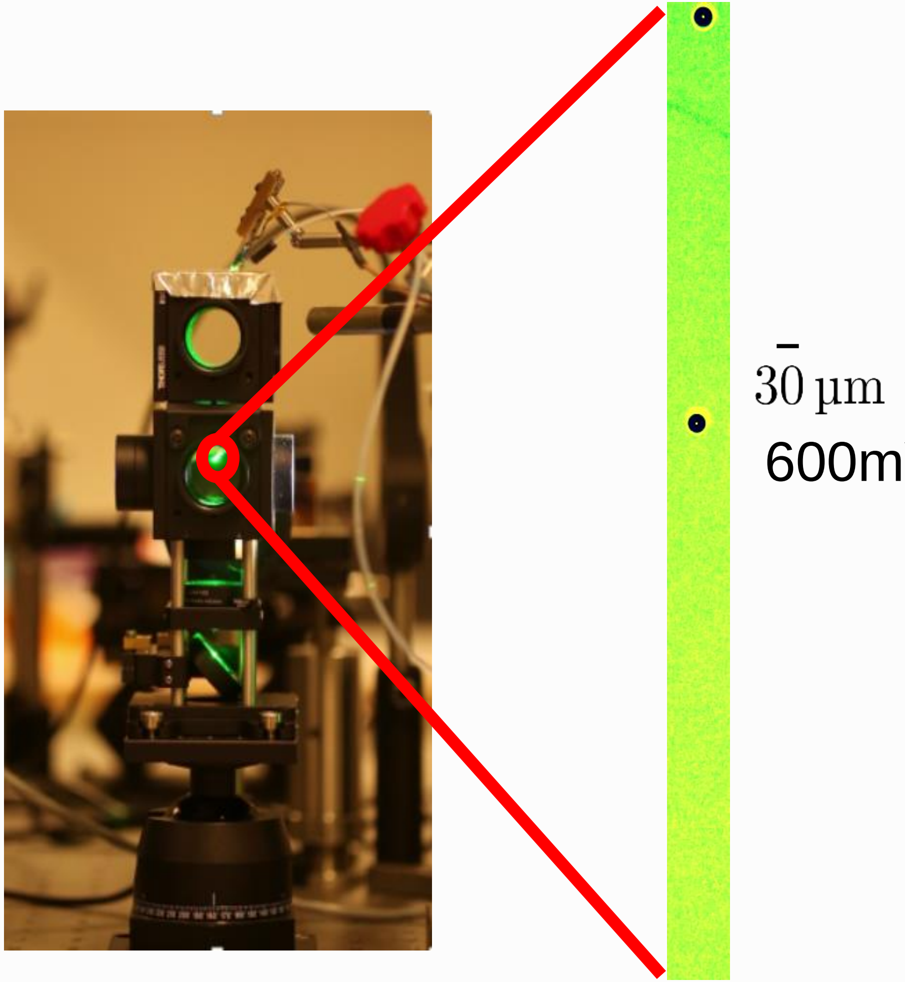




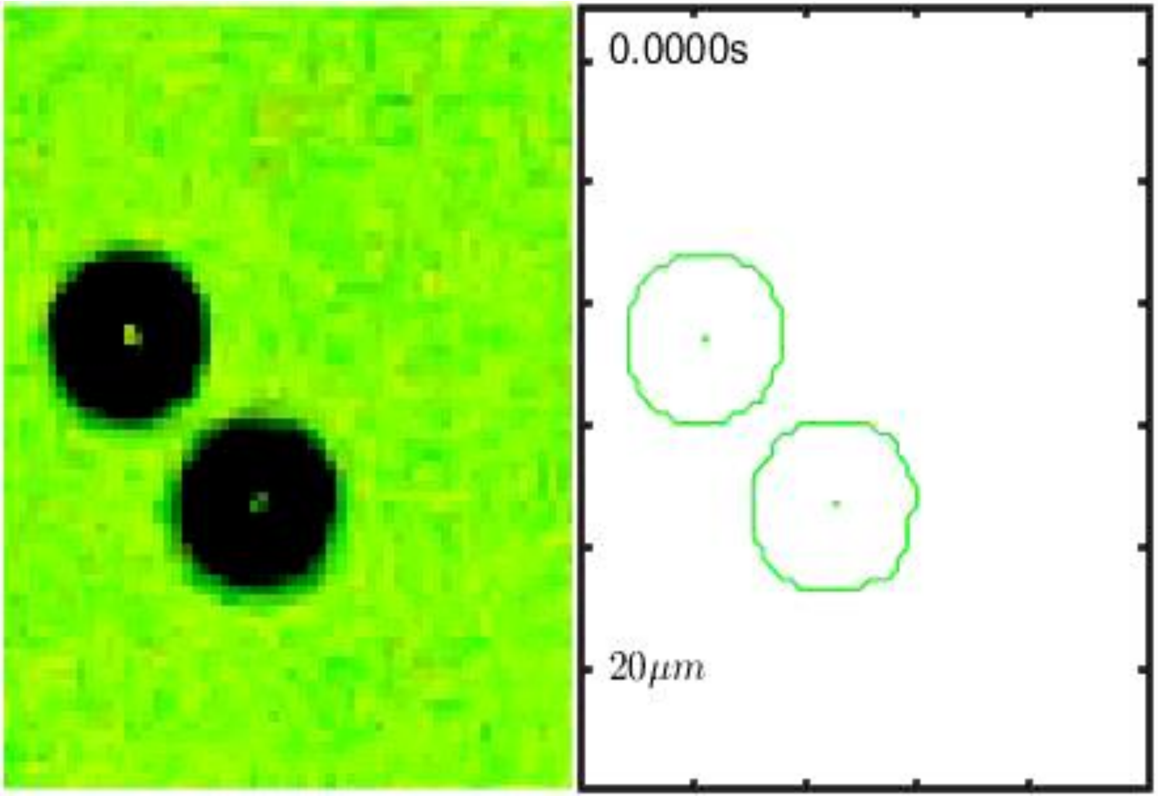
Ivanov et al. Optics express **25** (2017) 1391

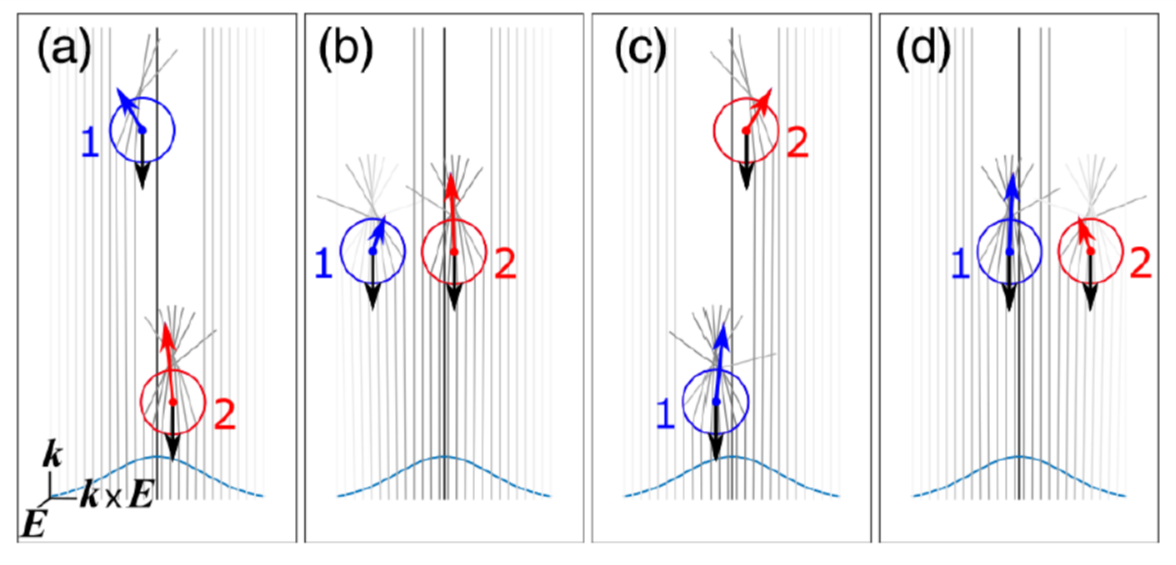

U
Dispenser
LED 2
Camera 1
LED 1
Camera 2





600mW laser


0.0000s
20μm


(a)
1
2
k
k×E
E
(b)
1
2
(c)
2
1
(d)
1
2

NUMERICAL MODEL

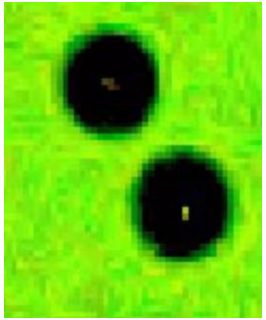
- Gravitation
- Hydrodynamic forces (Stoke)
- Coulumb forces
- Optical forces
  - Ray optics regime
  - Fresnels law´s
  - Momentum of photon

$$m\frac{\mathrm{d}\boldsymbol{v}^{(i)}}{\mathrm{d}t} = \boldsymbol{F}_G^{(i)} + \boldsymbol{F}_H^{(i)} + \boldsymbol{F}_Q^{(i)} + \boldsymbol{F}_O^{(i)} \, , \; (i = 1, 2) \, .$$

$$\boldsymbol{F}_G^{(i)} = -\frac{1}{6}\pi \, \rho \, g \, D^3 \, \hat{\boldsymbol{k}} \, ,$$

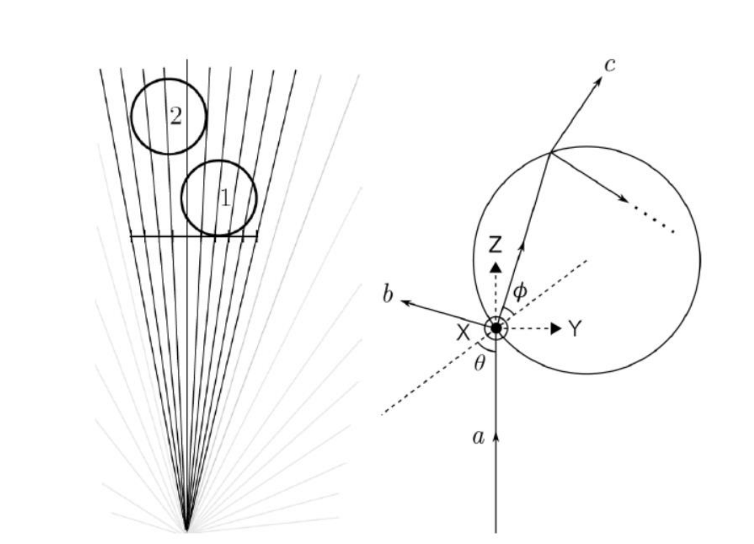
$$\boldsymbol{F}_H^{(i)} = 3\pi\eta D\left[-\boldsymbol{v}^{(i)} + \sum_{j\neq i}^{2} \frac{3D}{8r_{ij}}\left(\boldsymbol{I} + \frac{\boldsymbol{r}_{ij}\boldsymbol{r}_{ij}}{r_{ij}^2}\right)\cdot \boldsymbol{v}^{(j)}\right]$$

$$\boldsymbol{F}_Q^{(i)} = \sum_{j\neq i}^{2} \frac{F_Q \, \boldsymbol{r}_{ij}}{r_{ij}}\left[\frac{D^2}{r_{ij}^2}\right] .$$

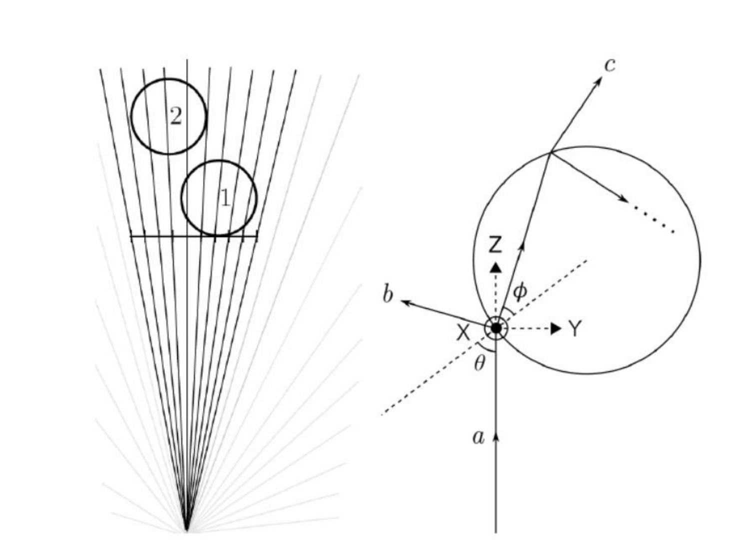


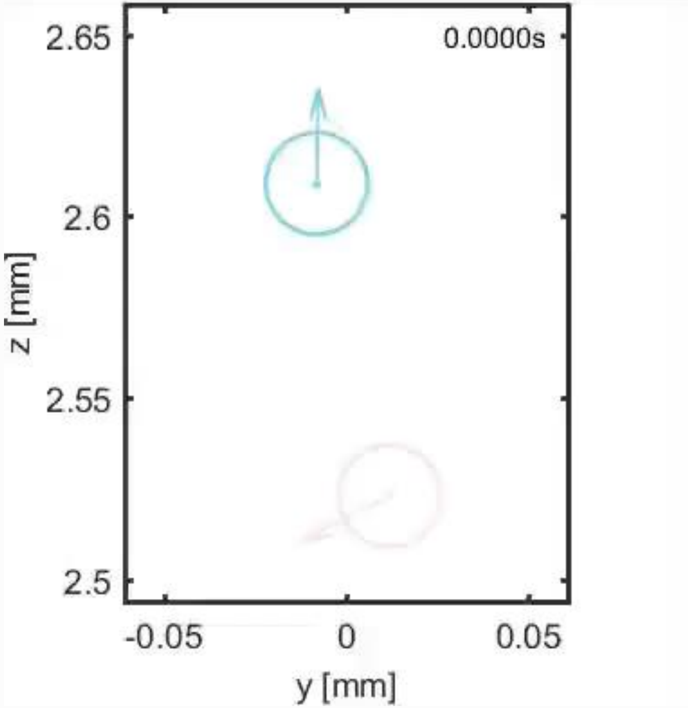
Forces	Expression	Magnitude (N)
Optical	$F_O = qPD^2/(cw^2)$	3.3×10^{-10}
Gravity	$F_G = \pi\rho g D^3/6$	1.4×10^{-10}
Hydrodynamic	$F_H = 9\pi\eta D v_T/8$	5.3×10^{-11}
Electrostatic	$F_Q = Q^2/(4\pi\epsilon D^2)$	2.9×10^{-11}

NUMERICAL MODEL



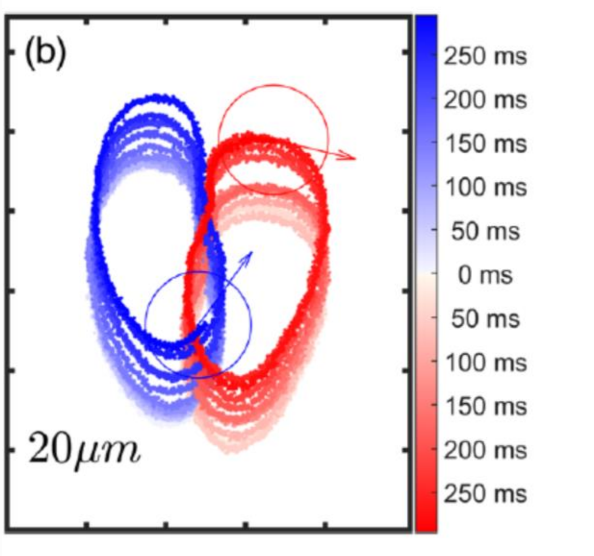
NUMERICAL MODEL

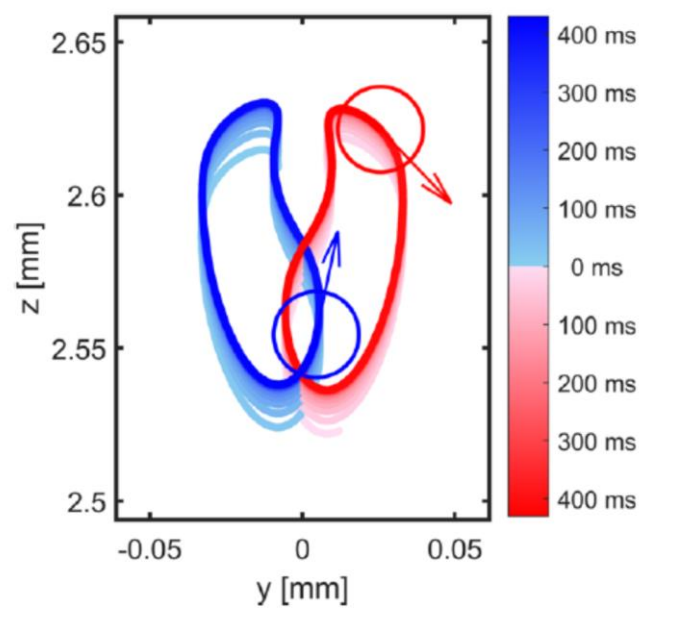




EXPERIMENT

MODEL





PHYSICAL REVIEW LETTERS **122,** 043902 (2019)

Editors' Suggestion | Featured in Physics

Juggling with Light

Albert J. Bae[*]
Max Planck Institute for Dynamics and Self-Organization, 37077 Goettingen, Germany

Dag Hanstorp and Kelken Chang[†]
Department of Physics, University of Gothenburg, 412 96 Gothenburg, Sweden

(Received 11 October 2018; published 1 February 2019)

PHYSICAL REVIEW LETTERS **122**, 043902 (2019)

Editors' Suggestion Featured in Physics

Juggling with Light

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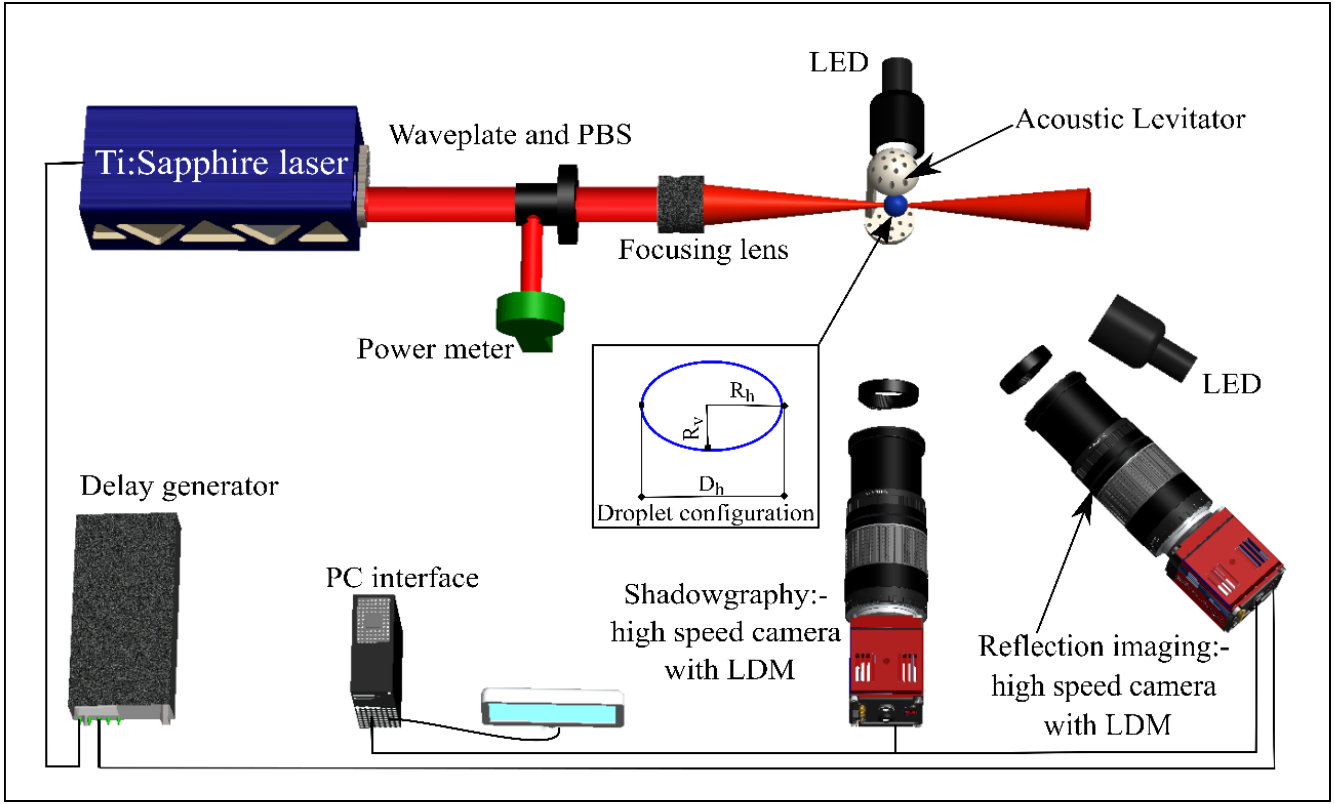
(Received 11 October 2018; published 1 February 2019)

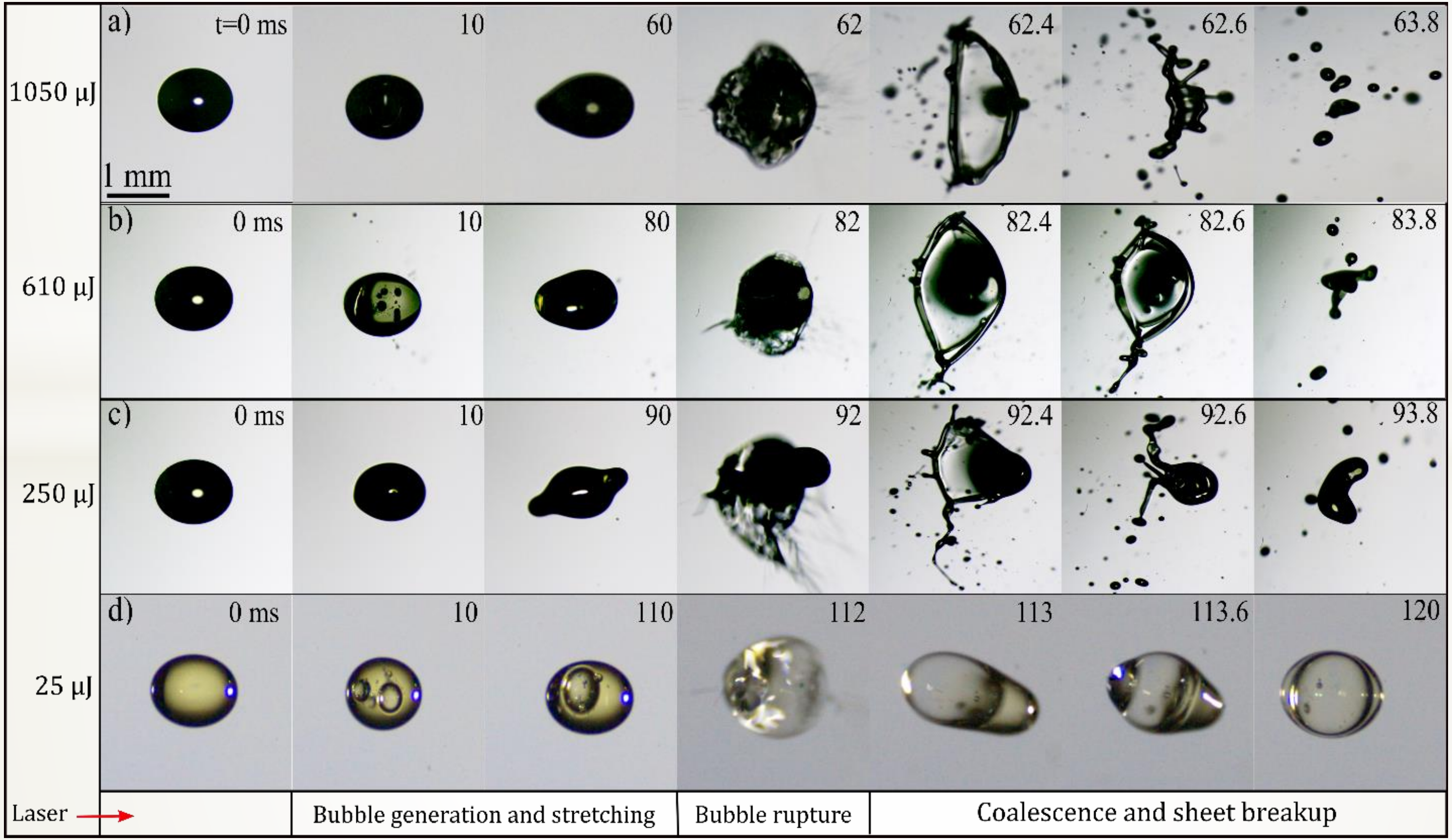
Bubble dynamics and atomization of acoustically levitated biofuel droplets using femtosecond laser pulses

Vishal S. Jagadale[1], Devendra Deshmukh[1], Dag Hanstorp[2,] * & Yogeshwar Nath Mishra[1,2,3]



Bubble dynamics and atomization of acoustically levitated biofuel droplets using femtosecond laser pulses

Vishal S. Jagadale[1], Devendra Deshmukh[1], Dag Hanstorp[2,] * & Yogeshwar Nath Mishra[1,2,3]



Femtosecond laser bone sectioning

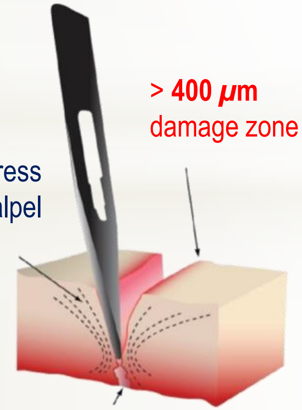
Master project, Department of Physics

Sahlgrenska hospital + GU physics

UNIVERSITY OF GOTHENBURG

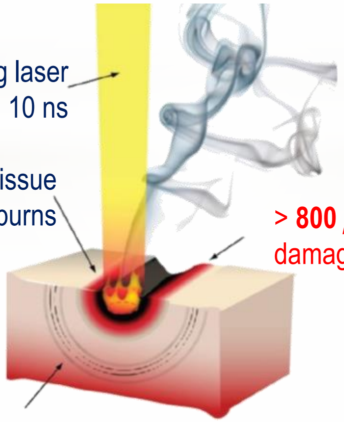
Motivation: Sectioning of bones in osteology to access the bone marrow. This is of great interest in medcial researcher e.g. in investigations of leukemia for an anlysis of cells in the bone marrow using optical methods.

Today: a) Surgical Scalpel

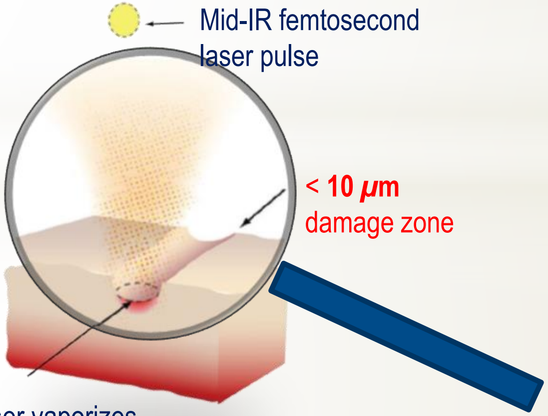


☼ Almost impossible for fresh bones (living cells cannot be preserved)

b) Conventional Medical Laser



Solution: Femtosecond laser sectioning



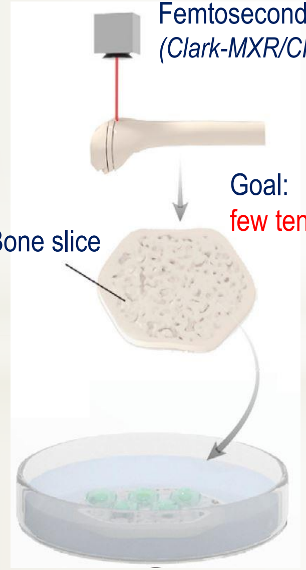
Femtosecond laser bone sectioning

Master project, Department of Physics

Sahlgrenska hospital + GU physics

UNIVERSITY OF GOTHENBURG

Concept:

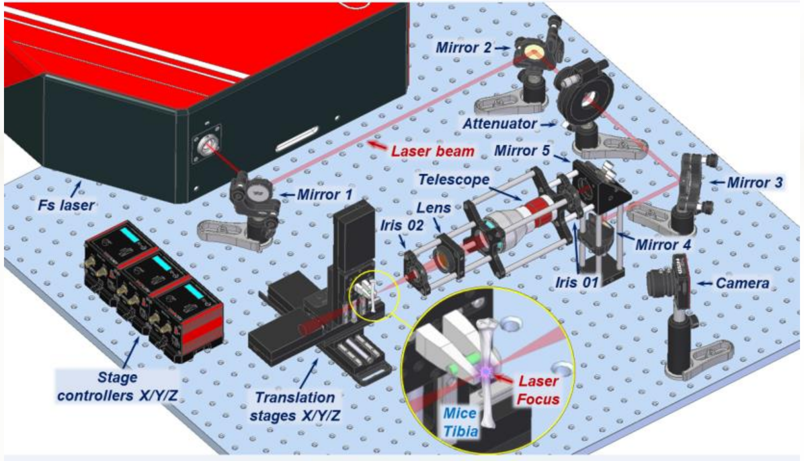


Project goal: Build a femtosecond laser bone sectioning platform at Laserlab Göteborg

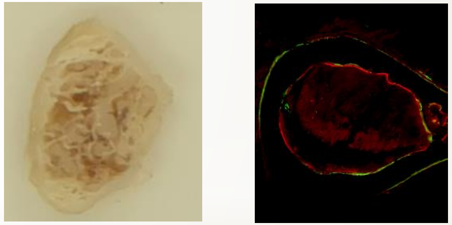
that can produce

A) Smooth surfaces

B) Thin slices (tens of micrometers, i.e. a fraction of the thickness of a human hair)



Preliminary results: Mice bone microtome sections with trabecular bones



300 µm slice
PFA-fixed tibia

100 µm slice
Pre-stained bone

Number of students:

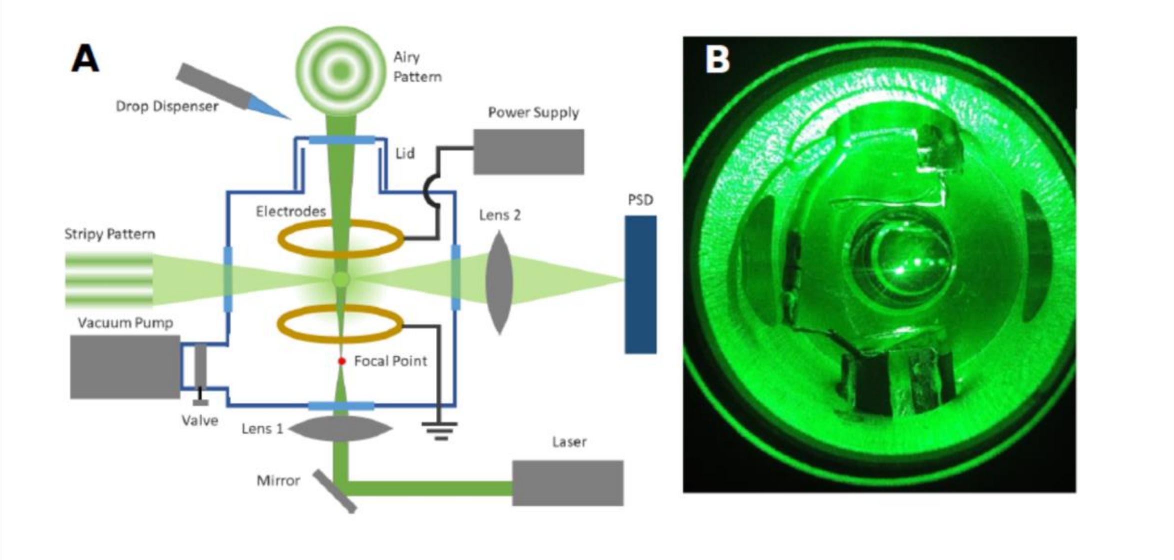
- One in physics
- Two in physics
- One in physics and one in medicine

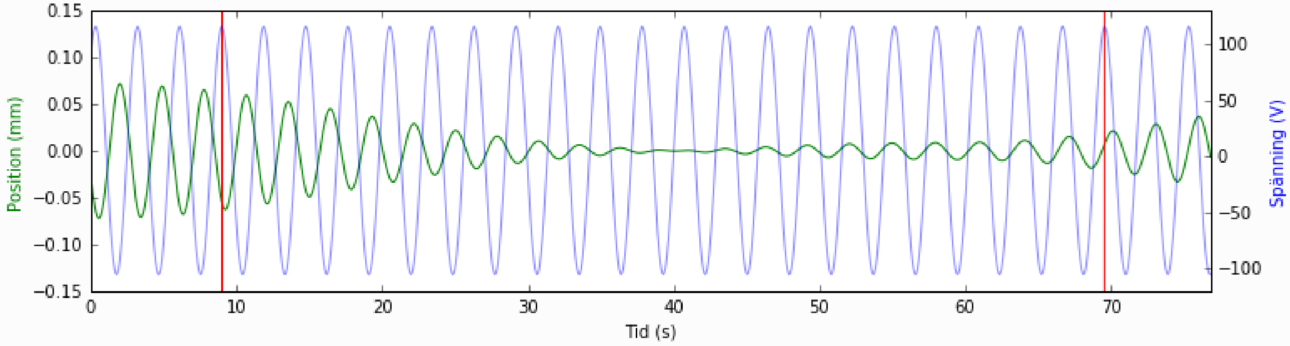
Prior knowledge:

- Optics
- Mechanics
- Electronics/computer control/programming
- Physics
- or Medicine

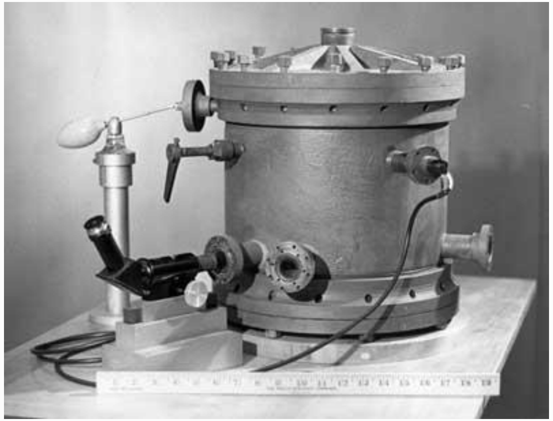
Contacts:

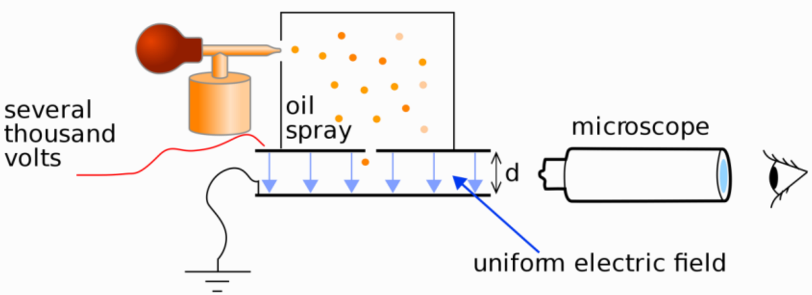
Prof. Dag Hanstorp (dag.hanstorp@gu.se)
Dr. Di Lu (di.lu@physics.gu.se)


A
Airy
Pattern
Drop Dispenser
Power Supply
Lid
PSD
Electrodes
Lens 2
Stripy Pattern
Vacuum Pump
Focal Point
Valve
Lens 1
Laser
Mirror
B


Position (mm)
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
Spänning (V)
100
50
0
−50
−100
0
10
20
30
40
50
60
70
Tid (s)

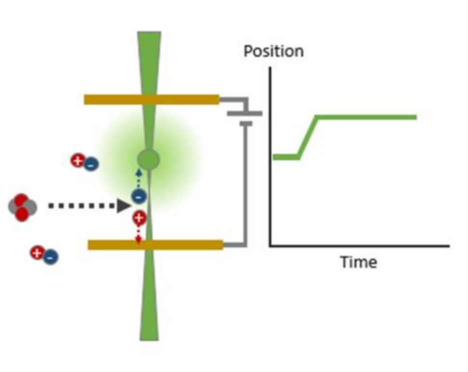
Millikan’s experiment





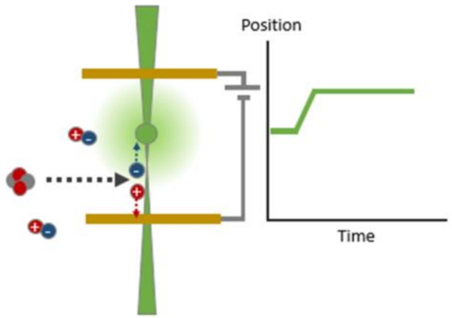
On the Elementary Electric charge and the Avogadro

Electrons Gained
+30e
+25e
+20e
+15e
+10e
+5e
+1e
16
15
14
13



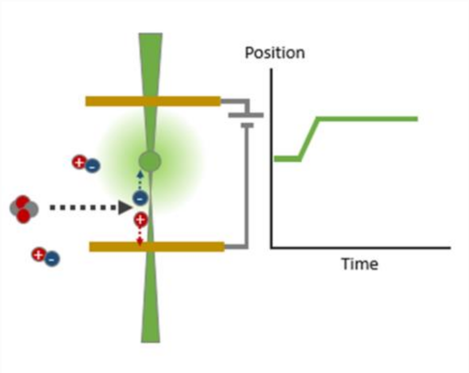
Position
Time

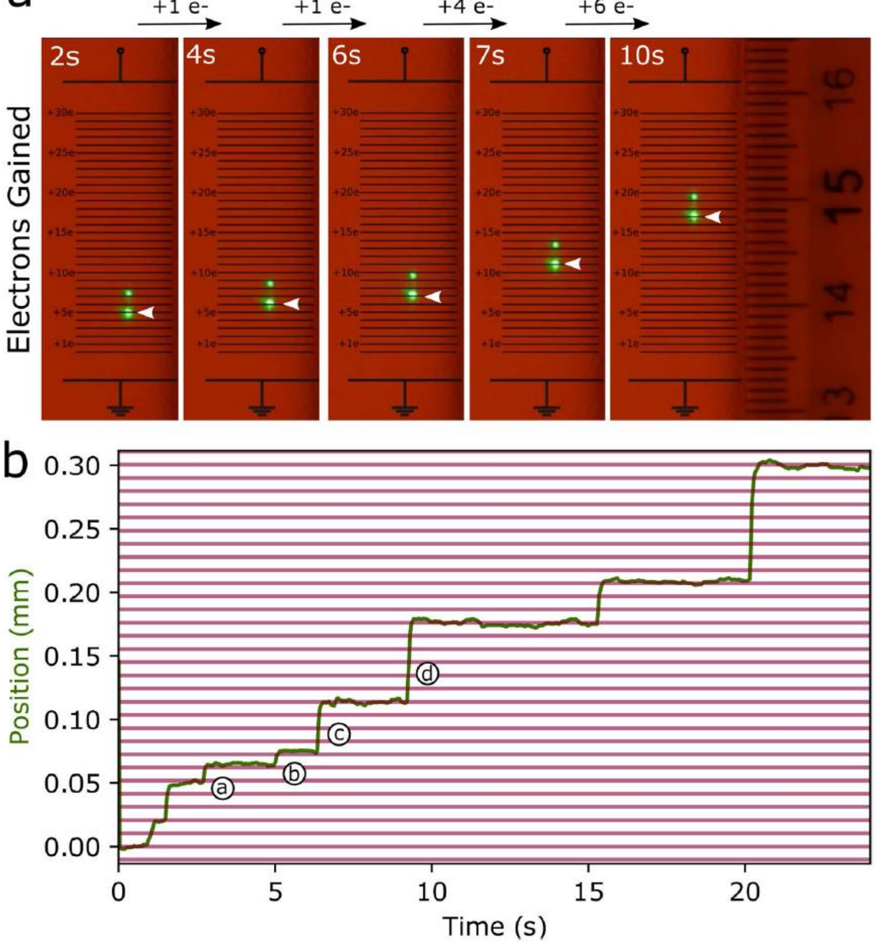
+30e
+25e
+20e
Electrons Gained
+15e
+10e
+5e
+1e
16
15
14
13



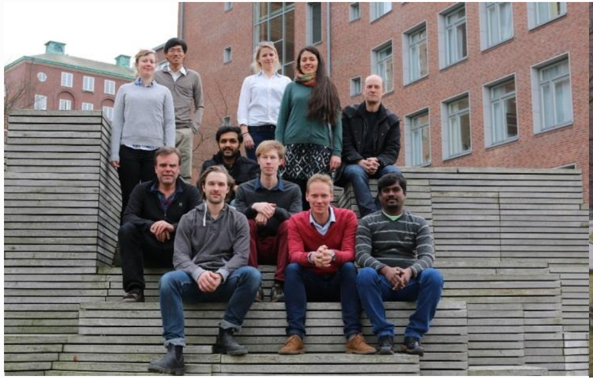
Position
Time


Electrons Gained
+30e
+25e
+20e
+15e
+10e
+5e
+1e
16
15
14
13


Position
Time


+1 e-
+1 e-
+4 e-
+6 e-
2s
4s
6s
7s
10s
Electrons Gained
+30e
+25e
+20e
+15e
+10e
+5e
+1e
b
Position (mm)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
a
b
c
d
0
5
10
15
20
Time (s)

ACKNOWLEDGEMENT



Vetenskapsrådet

SI. Svenska institutet.

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Paldies parjūsu uzmanību!

Conclusion and outlook

High resolution EA measurements	→ Beamtime approved at DESIREE for Si^- in September (Julia Karls)
Isotope shifts	→ Beamtime approved at CERN for studies of a IS in the chain ^{38}Cl- ^{43}Cl
Lifetimes studies	→ Beamtimes at DESIREE approved for studies of Th- and Sn^-
EA of Radioactive elements	→ Beamtime for Po^- approved at CERN

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High-precision electron affinity of oxygen

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The electron affinity of astatine

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Thank you!