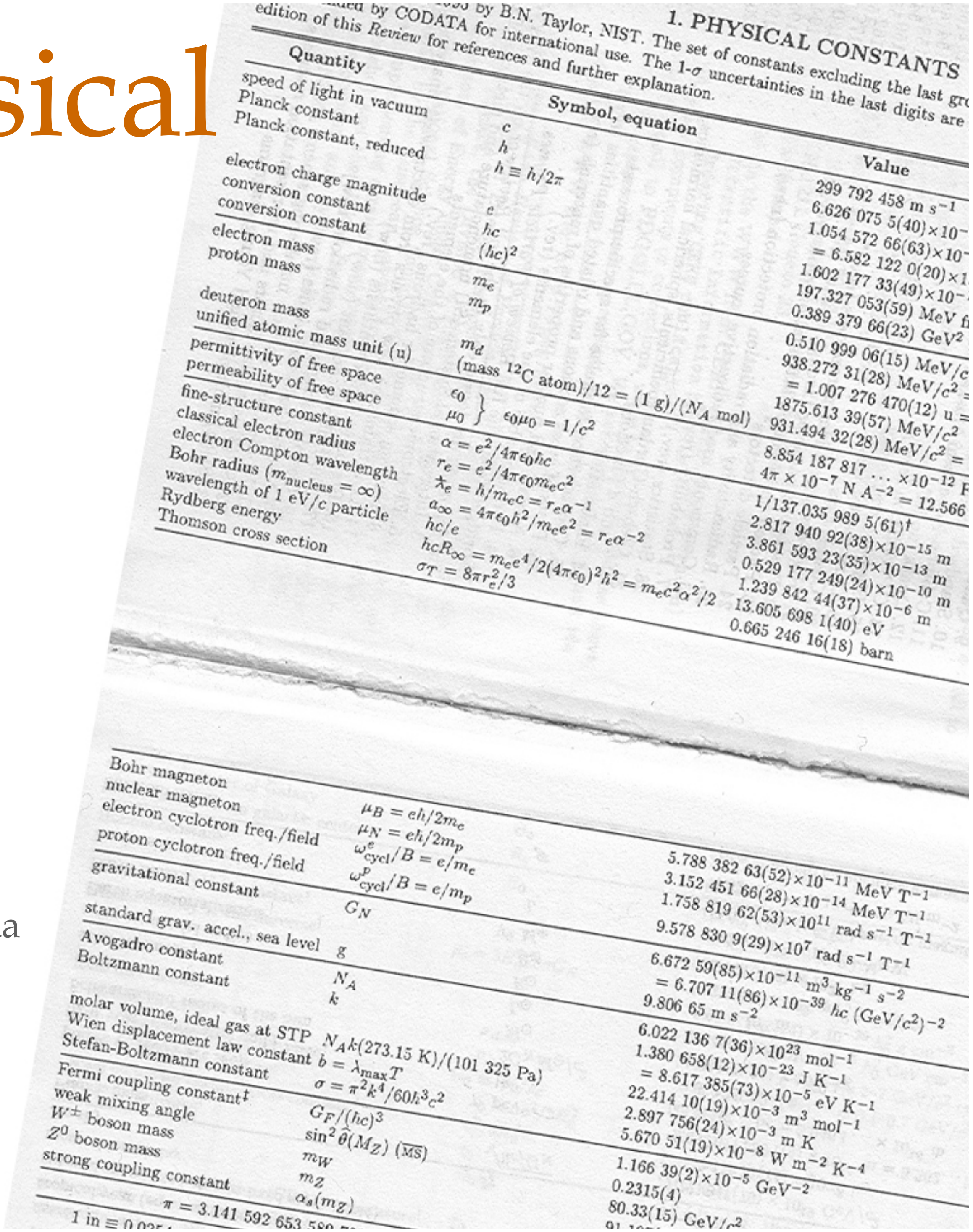
Are the physical constants really constant?

Stanisław Bajtlik

Centrum Astronomiczne im. M. Kopernika

PAN, Warszawa



1. PHYSICAL CONSTANTS

by B.N. Taylor, NIST. The set of constants excluding the last gr
by CODATA for international use. The 1-σ uncertainties in the last digits are
edition of this *Review* for references and further explanation.

Quantity	Symbol, equation	Value
speed of light in vacuum	c	299 792 458 m s^{-1}
Planck constant	h	6.626 075 5(40)$\times 10^{-}$
Planck constant, reduced	$\hbar \equiv h/2\pi$	1.054 572 66(63)$\times 10^{-}$ = 6.582 122 0(20)$\times 1$
electron charge magnitude	e	1.602 177 33(49)$\times 10^{-}$
conversion constant	$\hbar c$	197.327 053(59) MeV f
conversion constant	$(\hbar c)^2$	0.389 379 66(23) GeV^2
electron mass	m_e	0.510 999 06(15) MeV/c
proton mass	m_p	938.272 31(28) MeV/c^2 = = 1.007 276 470(12) u =
deuteron mass	m_d	1875.613 39(57) MeV/c^2
unified atomic mass unit (u)	(mass ^{12}C atom)/12 = (1 g)/(N_A mol)	931.494 32(28) MeV/c^2 =
permittivity of free space	ϵ_0	8.854 187 817 ... $\times 10^{-12}$ F
permeability of free space	μ_0 $\Big\}$ $\epsilon_0 \mu_0 = 1/c^2$	$4\pi \times 10^{-7}$ N A^{-2} = 12.566
fine-structure constant	$\alpha = e^2/4\pi\epsilon_0 \hbar c$	1/137.035 989 5(61)†
classical electron radius	$r_e = e^2/4\pi\epsilon_0 m_e c^2$	2.817 940 92(38)$\times 10^{-15}$ m
electron Compton wavelength	$\lambda\!\!\!^{-}_e = \hbar/m_e c = r_e \alpha^{-1}$	3.861 593 23(35)$\times 10^{-13}$ m
Bohr radius ($m_{\text{nucleus}} = \infty$)	$a_\infty = 4\pi\epsilon_0 \hbar^2/m_e e^2 = r_e \alpha^{-2}$	0.529 177 249(24)$\times 10^{-10}$ m
wavelength of 1 eV/c particle	hc/e	1.239 842 44(37)$\times 10^{-6}$ m
Rydberg energy	$hcR_\infty = m_e e^4/2(4\pi\epsilon_0)^2 \hbar^2 = m_e c^2 \alpha^2/2$	13.605 698 1(40) eV
Thomson cross section	$\sigma_T = 8\pi r_e^2/3$	0.665 246 16(18) barn
Bohr magneton	$\mu_B = e\hbar/2m_e$	5.788 382 63(52)$\times 10^{-11}$ MeV T^{-1}
nuclear magneton	$\mu_N = e\hbar/2m_p$	3.152 451 66(28)$\times 10^{-14}$ MeV T^{-1}
electron cyclotron freq./field	$\omega^e_{\text{cycl}}/B = e/m_e$	1.758 819 62(53)$\times 10^{11}$ rad s^{-1} T^{-1}
proton cyclotron freq./field	$\omega^p_{\text{cycl}}/B = e/m_p$	9.578 830 9(29)$\times 10^{7}$ rad s^{-1} T^{-1}
gravitational constant	G_N	6.672 59(85)$\times 10^{-11}$ m^3 kg^{-1} s^{-2} = 6.707 11(86)$\times 10^{-39}$ $\hbar c$ $(GeV/c^2)^{-2}$
standard grav. accel., sea level	g	9.806 65 m s^{-2}
Avogadro constant	N_A	6.022 136 7(36)$\times 10^{23}$ mol^{-1}
Boltzmann constant	k	1.380 658(12)$\times 10^{-23}$ J K^{-1} = 8.617 385(73)$\times 10^{-5}$ eV K^{-1}
molar volume, ideal gas at STP	$N_A k$(273.15 K)/(101 325 Pa)	22.414 10(19)$\times 10^{-3}$ m^3 mol^{-1}
Wien displacement law constant	$b = \lambda_{\max} T$	2.897 756(24)$\times 10^{-3}$ m K
Stefan-Boltzmann constant	$\sigma = \pi^2 k^4/60\hbar^3 c^2$	5.670 51(19)$\times 10^{-8}$ W m^{-2} K^{-4}
Fermi coupling constant‡	$G_F/(\hbar c)^3$	1.166 39(2)$\times 10^{-5}$ GeV^{-2}
weak mixing angle	$\sin^2 \hat{\theta}(M_Z)$ ($\overline{MS}$)	0.2315(4)
$W^\pm$ boson mass	m_W	80.33(15) GeV/c^2
Z^0 boson mass	m_Z	91.1
strong coupling constant	$\alpha_s(m_Z)$	

π = 3.141 592 653 589

1 in ≡ 0.025

What are the physical constants and how meny are there ?

Units of meassure vs. Fundamental constants

$\hbar = c = G = 1$ why not?

Planck length $\approx 2 \times 10^{-35}$ m

Planck time $\approx 5 \times 10^{-45}$ s

Planck mass $\approx 2 \times 10^{-8}$ kg

GR and quantum mechanics do not contain dimensionless constants – speed of light, gravitational constant and Planck constant are sufficient to establisch units of mass, time and length

How many fundamental constants are there?

Mass: 6 quarks (mass/M_P)

3 leptons

3 neutrinos

1 Higssa particle

2 W+Z bozons

----

6 + 3 + 1 + 2 = 15

Coupling constants:

elektroweak

strong

= 2

W with quarks interactions

Kobayashi-Masakawy matrix

4 independent constants

= 4

Neutrinos

3 additional parameters for neutrino oscillations

= 3

Cosmological constant Λ

= 1

Parity breaking paremeter Θ

= 1

Total: 23 fundamental constants

but

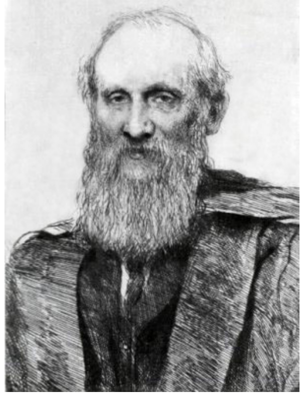
What with (for instance) photon mass = 0

number of spatial dimenssions = 3 (?)

index in the inverse square Newton or Coulomb laws (= 2)?

Or with Lorentz signature?

Are the physical constants really constant?

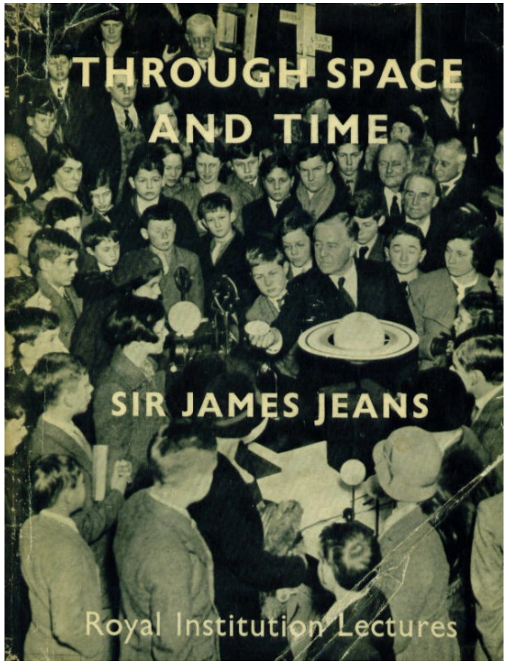


1874 - William Thomson (Kelvin)

suggested viariations of the speed of light

(by 8 km/s/My)

1927-1932 - a series of papers on decreasing value of the speed of light



1931 – 1935 – cosmological arguments for decreasing value of c

1931 – James Hopwood Jeans proposed changes in the sizes

of atoms as an explanation of redshift

1935 – 1938 – papers on the secular variations of the Planck

constant (Chalmers, Nernst, Sambursky)

Paul Adrien Maurice Dirac:

Large dimensionless numbers coincidence hypothesis

Forces:

Proton-electron Coulomb interaction

-- ==

Proton-electron Newton interaction

$$= \frac{4\pi\epsilon_0 G m_{pr} m_e}{e^2} \approx \mathbf{4.4 \times 10^{40}}$$

Lengths:

radius of the Universe 10^{26} m

-- = ---------------- ≈ $\mathbf{3 \text{ x } 10^{40}}$

Classical adius of the electron $3 \text{ x } 10^{-15}$ m

Times:

$$\frac{\text{Age of the Universe}}{\text{Light crossing of elementary particle}} = \frac{6 \text{ x } 10^{17}\text{ s}}{10^{-23}\text{ s}} = \mathbf{6 \text{ x } 10^{40}}$$

Number of particles in the Universe: $\approx 10^{80}$

Dirac’s hypothesis:

$$G \propto t^{-1}$$

Falsified by the results of observations in the Solar System

Fine structure constant α

$$\alpha = \frac{e^2}{\hbar c \, 4\pi\epsilon_0} = 7.2973525376(50) \times 10^{-3} = \frac{1}{137.035999679(94)}$$

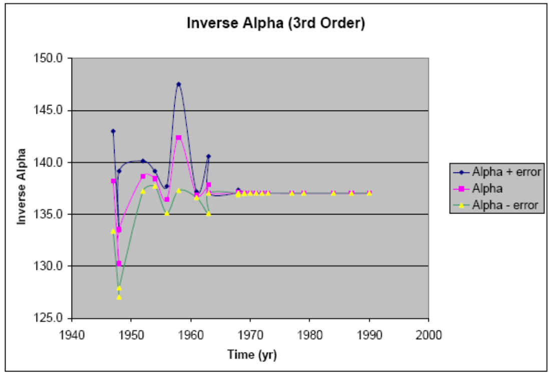
fine-structure constant is a fundamental physical constant, namely the coupling constant characterizing the strength of the electromagnetic interaction. Being a dimensionless quantity, it has constant numerical value in all systems of units. Arnold Sommerfeld introduced the fine-structure constant in 1916.

Sommerfeld developed Bohr’s theory by introducting elliptical orbits and relativistic corrections

$\alpha = v_l/c$, where v_l – electron velocity on the first Bohr’s orbit, c – speed of light

Numerical speculations α = 1/137 (Arnold)

Dziś $\Delta\alpha/\alpha < 10^{-9}$



Alpha data from QED since 1950

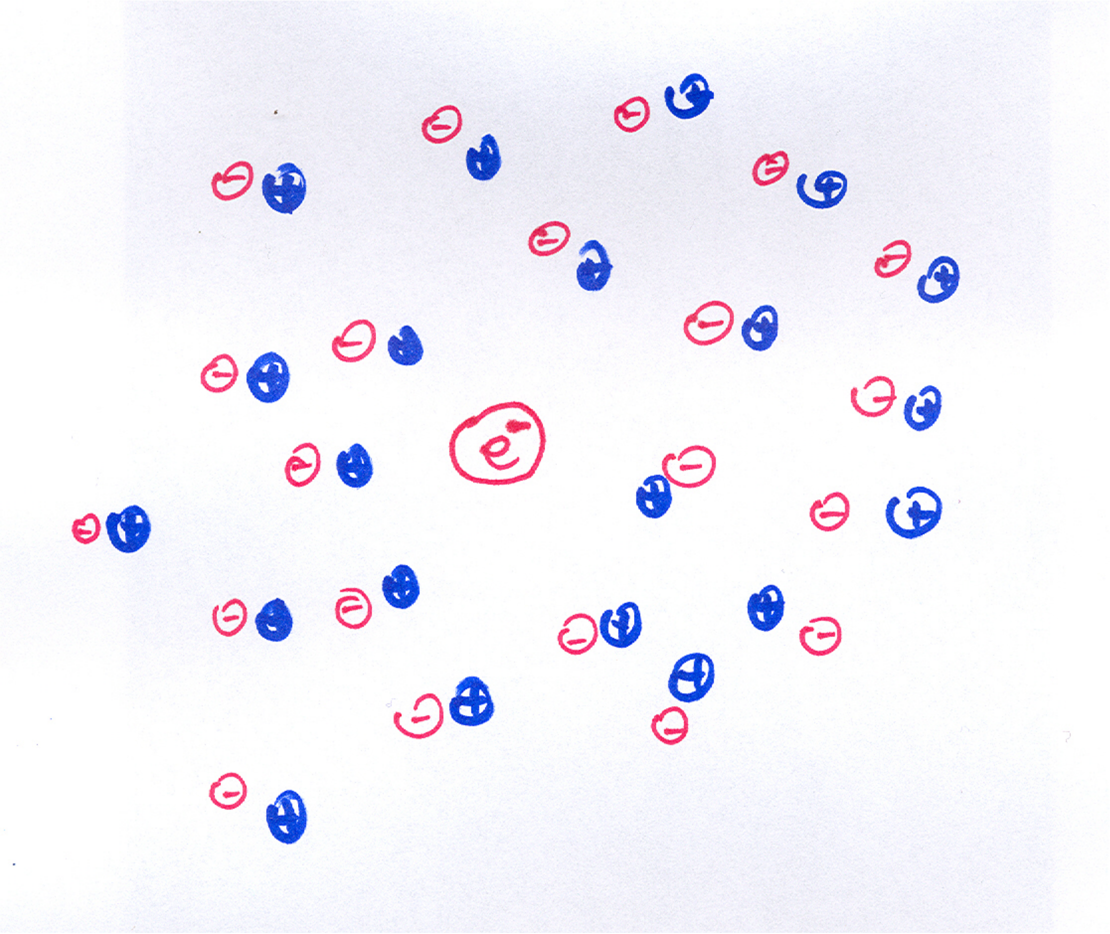
α today

α= square of the effective charge, screened by the polarized vacum, observed from infinity

α - value depends on energy

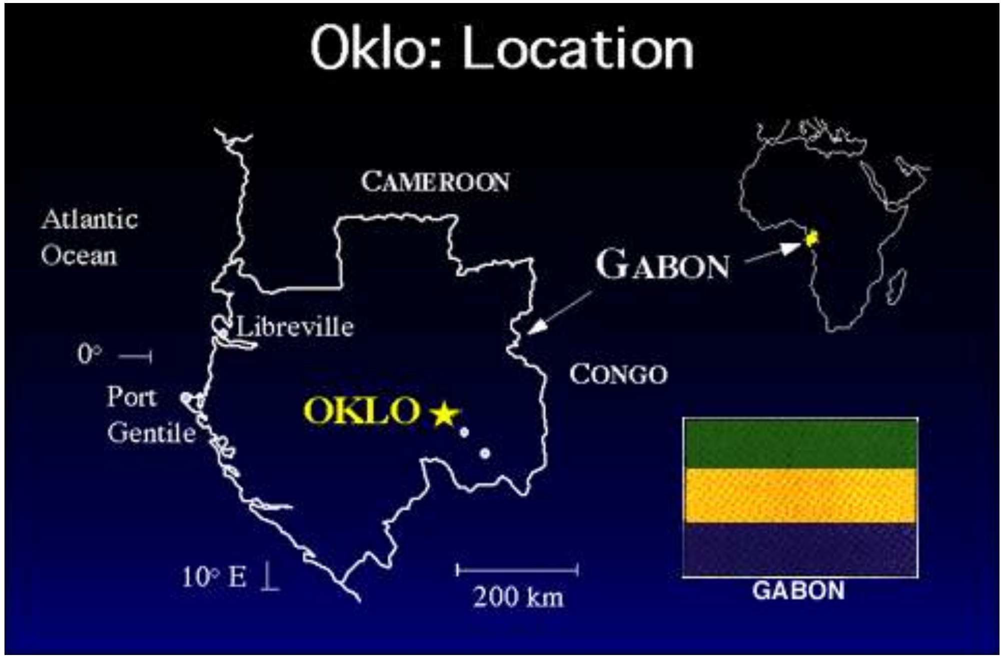
at energies corresponding to the mass of W (approx. 81 GeV) or at distances 2 x 10^{-18} m

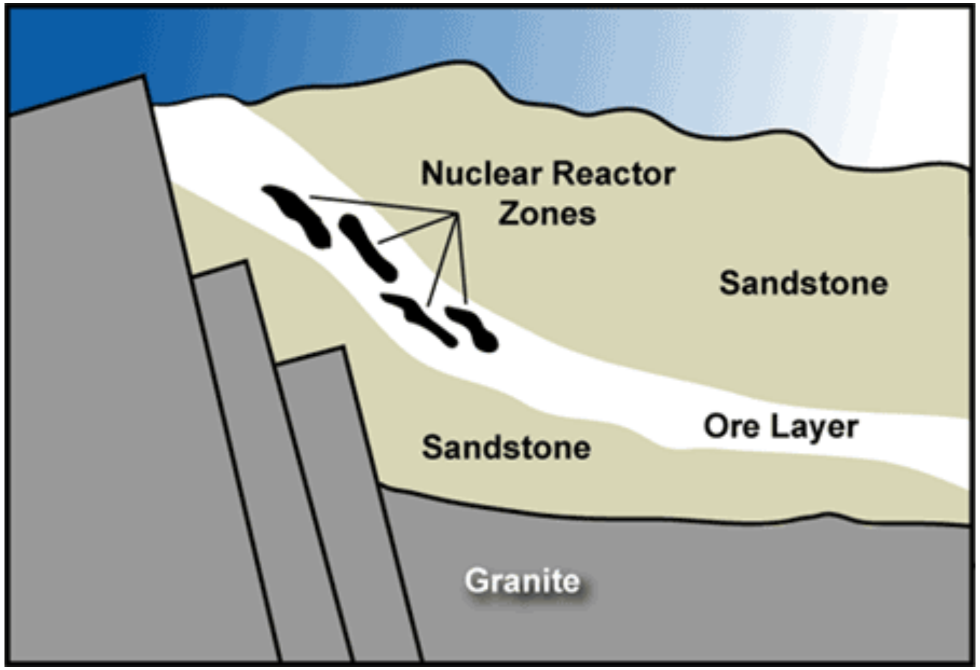
$\alpha \approx 1/128$!

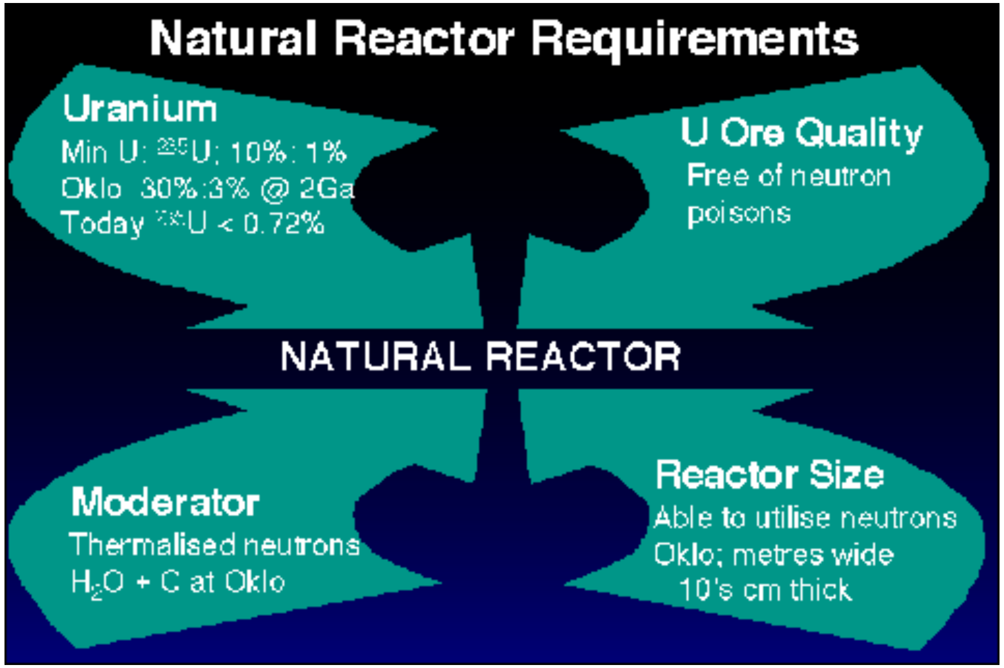


Is the value of α constant?

Natural nuclear reactor in Oklo




Nuclear Reactor
Zones
Sandstone
Ore Layer
Sandstone
Granite



Natural Reactor Requirements

Uranium

Min U: ^{235}U; 10%: 1%
Oklo 30%:3% @ 2Ga
Today $^{235}U < 0.72\%$

U Ore Quality

Free of neutron poisons

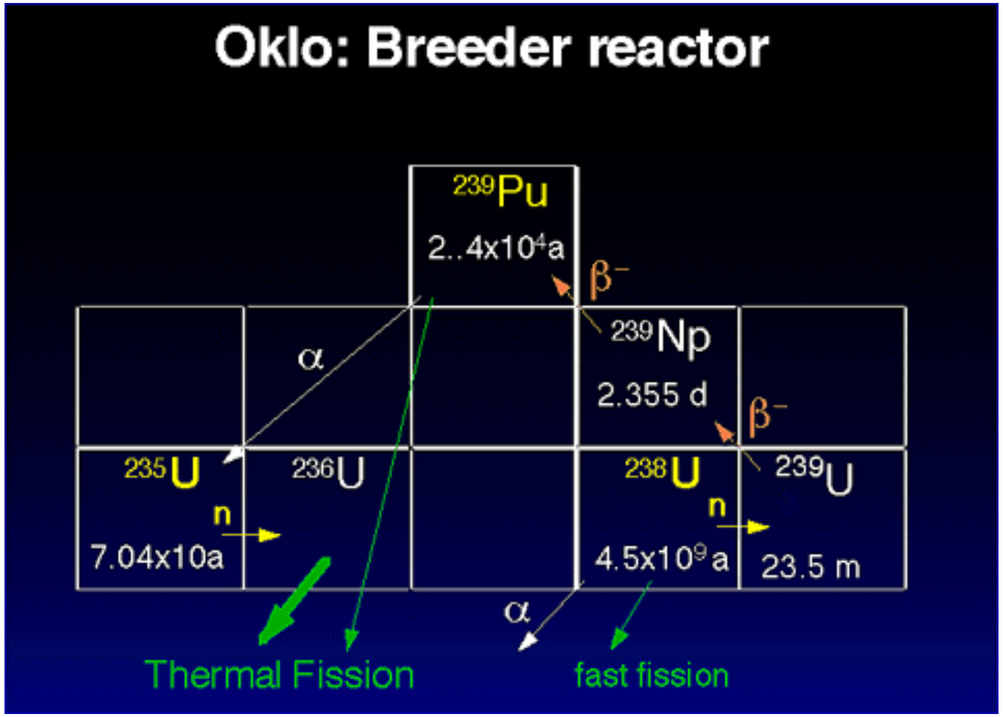
NATURAL REACTOR

Moderator

Thermalised neutrons
H_2O + C at Oklo

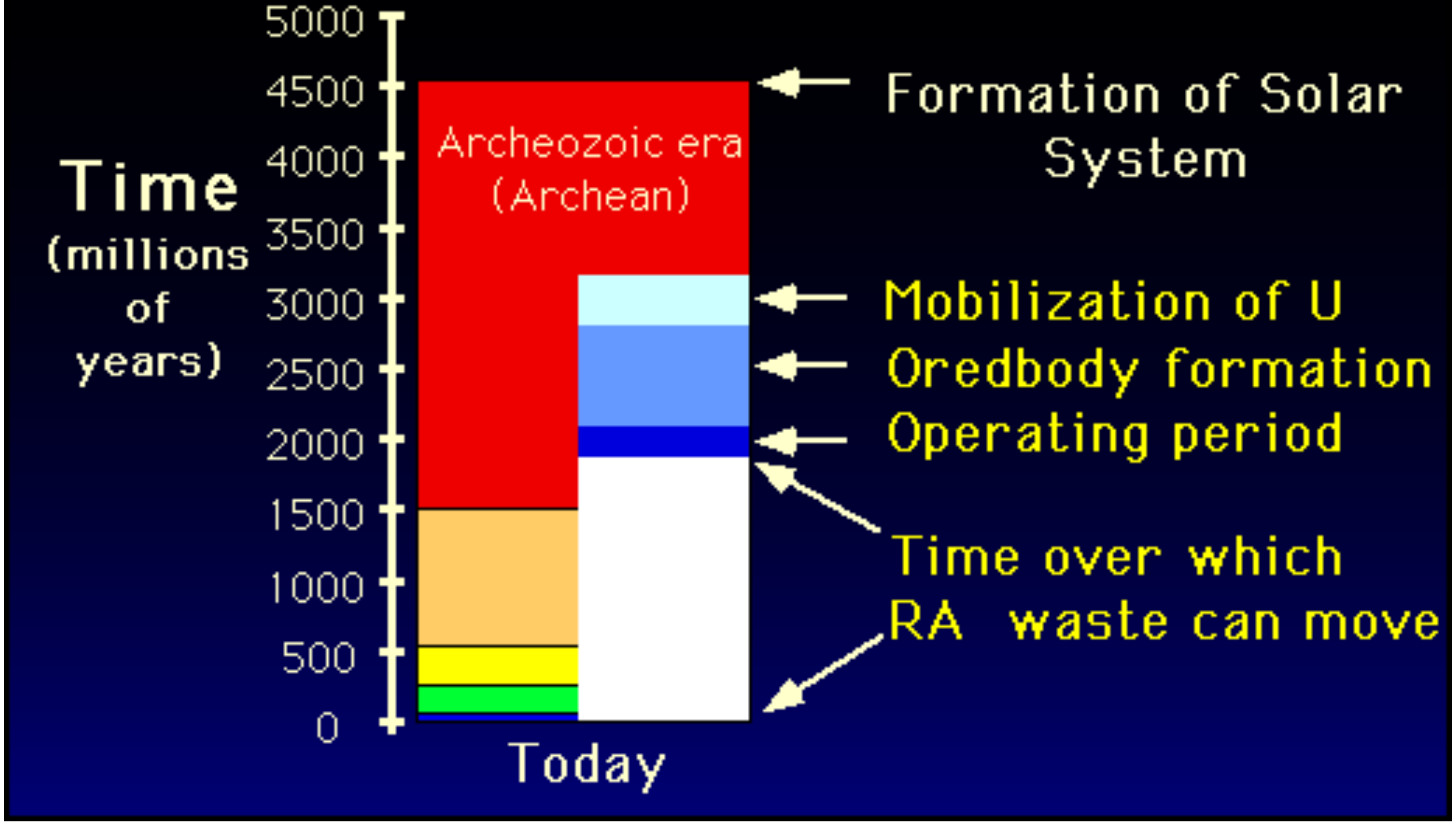
Reactor Size

Able to utilise neutrons
Oklo; metres wide
10's cm thick



Oklo: Breeder reactor

Oklo Time Scales



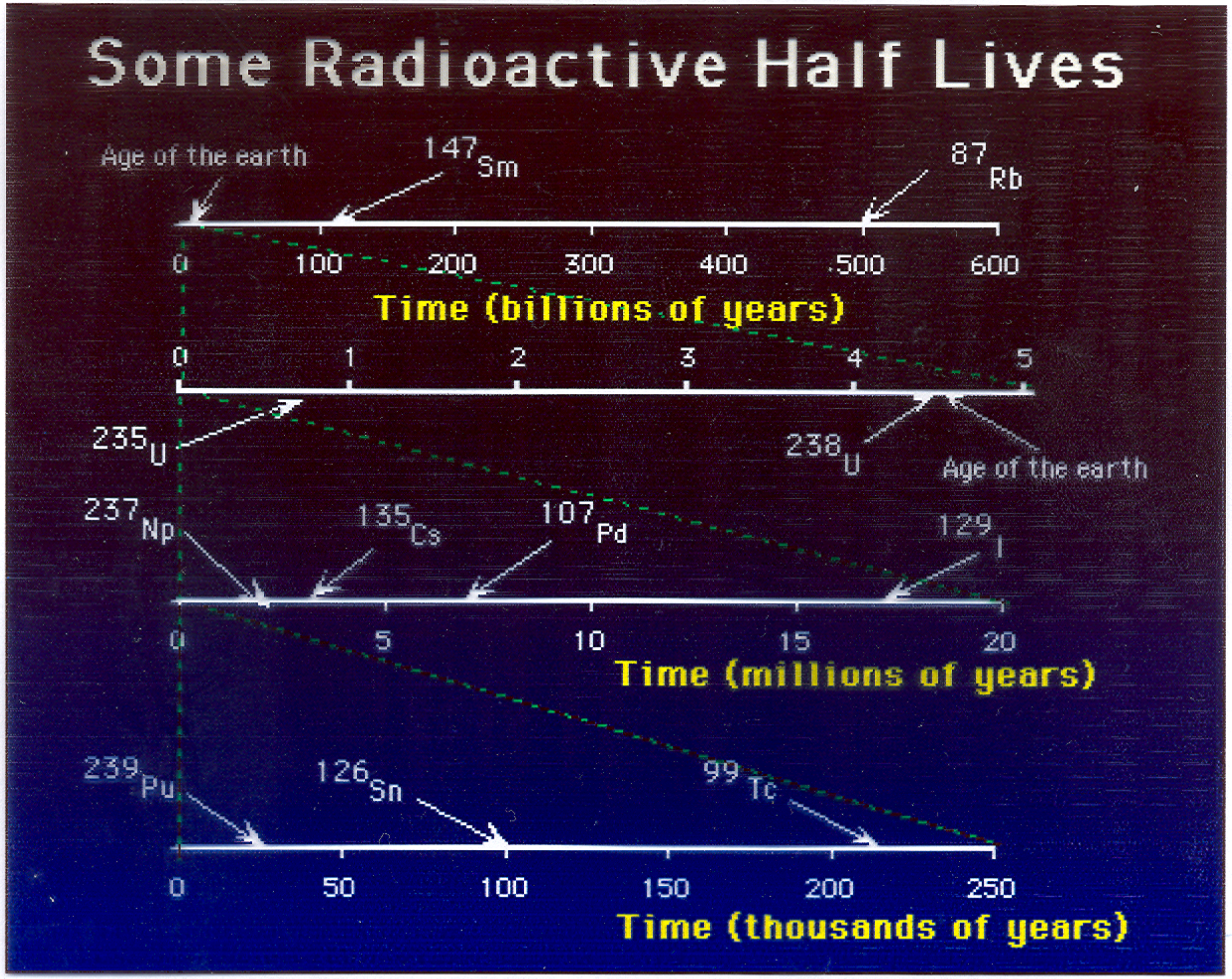
Formation of Solar System

Mobilization of U

Oredbody formation

Operating period

Time over which RA waste can move



Sm – samarium

Rb - rubidium

Cs – cezium

Pd – palladium

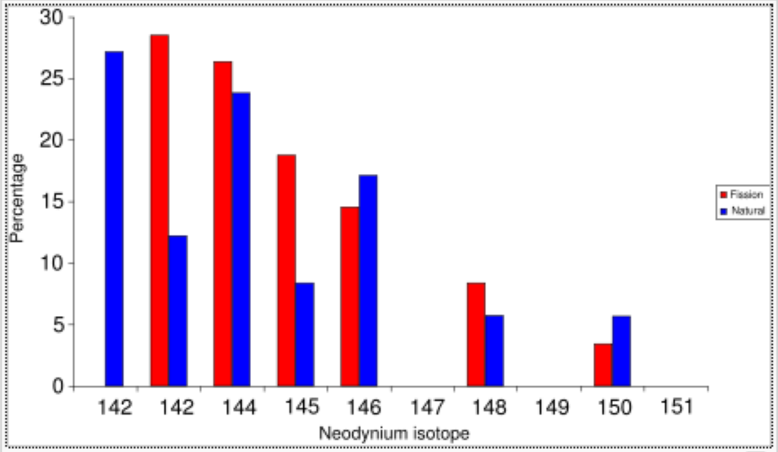
I – iodine

Sn – Tin

Tc – technetium

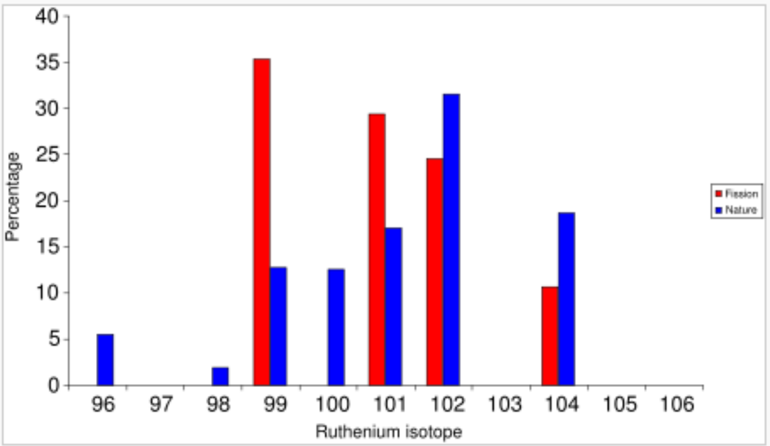
Np – neptunium

Pu - plutonium



A diagram showing the isotope signatures of natural neodymium and fission product neodymium from U-235 which had been subjected to thermal neutrons. Note that the Ce-142 (a long lived beta emitter) has not had time to decay to Nd-142 over the time since the reactors stopped working.

Neodymium and rutenium isotopes abundances found in Oklo



A diagram showing the isotope signatures of natural ruthenium and fission product ruthenium from U-235 which had been subjected to thermal neutrons. Note that the Mo-100 (a long lived double beta emitter) has not had time to decay to Ru-100 over the time since the reactors stopped working.

IHES/P/96/40

IASSNS-HEP-96/62

The Oklo bound on the time variation of the fine-structure constant revisited

Thibault Damour[a,b,c], Freeman Dyson[b]
[a] Institut des Hautes Etudes Scientifiques,
F-91440 Bures-sur-Yvette, France
[b] School of Natural Sciences, Institute for Advanced Study,
Olden Lane, Princeton, NJ08540, U.S.A.
[c] DARC, Observatoire de Paris–CNRS,
F-92195 Meudon, France.

June 27, 1996

Abstract

It has been pointed out by Shlyakhter that data from the natural fission reactors which operated about two billion years ago at Oklo (Gabon) had the potential of providing an extremely tight bound on the variability of the fine-structure constant α. We revisit the derivation of such a bound by: (i) reanalyzing a large selection of published rare-earth data from Oklo, (ii) critically taking into account the very large uncertainty of the temperature at which the reactors operated, and (iii) connecting in a new way (using isotope shift measurements) the Oklo-derived constraint on a possible shift of thermal neutron-capture resonances with a bound on the time variation of α. Our final (95% C.L.) results are: $-0.9 \times 10^{-7} < (\alpha^{\mathrm{Oklo}} - \alpha^{\mathrm{now}})/\alpha < 1.2 \times 10^{-7}$ and $-6.7 \times 10^{-17}\mathrm{yr}^{-1} < \dot{\alpha}^{\mathrm{averaged}}/\alpha < 5.0 \times 10^{-17}\mathrm{yr}^{-1}$.

Limits on α variability on the basis of Oklo data:

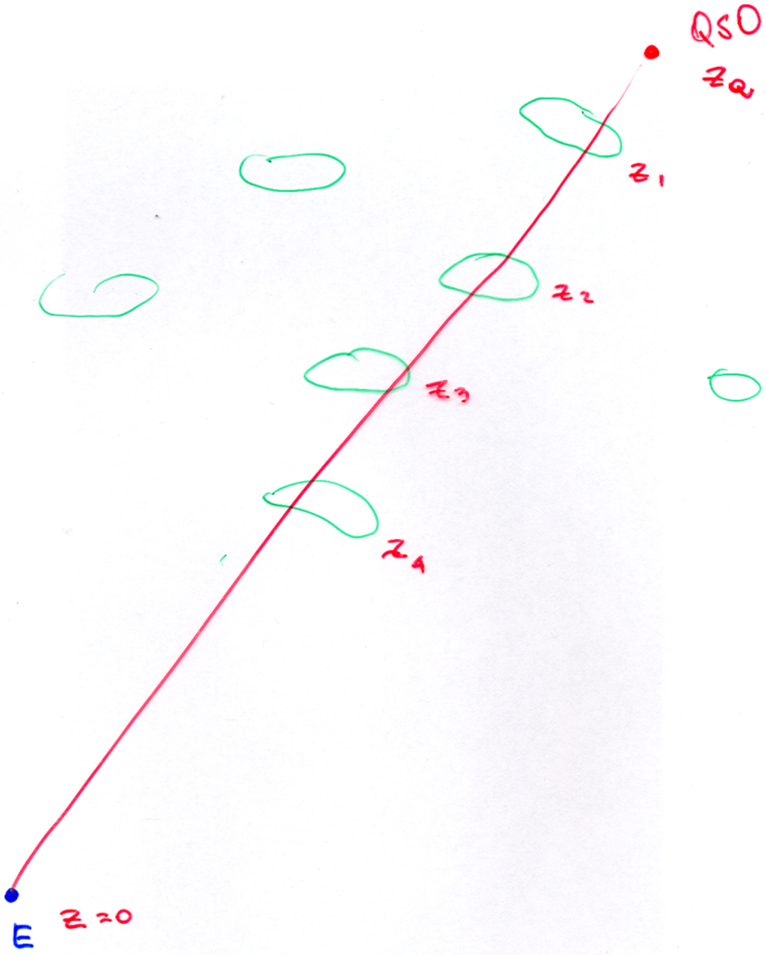
$$-0.9 \times 10^{-7} < \alpha^{\mathrm{Oklo}} - \alpha^{\mathrm{dziś}} < 1.2 \times 10^{-9}$$

$$-6.7 \times 10^{-17}\ \mathrm{y}^{-1} < (d\alpha/dt)/\alpha < 5.0 \times 10^{-17}\ \mathrm{y}^{-1}$$

Laboratory limits:
(H i Hg+ masers, time scales 140 days):

$$(d\alpha/dt)/\alpha < 3.7 \times 10^{-14}\ \mathrm{y}^{-1}$$

Astronomical data on α



$$\lambda_{obs} = \lambda_0 (1+z)$$

$$t \sim \frac{1}{(1+z)^{1.5}} \qquad (\Omega = 1)$$

Mon. Not. R. Astron. Soc. 000, 1–31 (2003) Printed 15 May 2007 (MN LaTeX style file v2.2)

Further evidence for a variable fine-structure constant from Keck/HIRES QSO absorption spectra

M. T. Murphy,[1,2⋆] J. K. Webb[2⋆], V. V. Flambaum[2]
[1]*Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB3 0HA, UK*
[2]*School of Physics, University of New South Wales, UNSW Sydney N.S.W. 2052, Australia*

Accepted —. Received —; in original form —

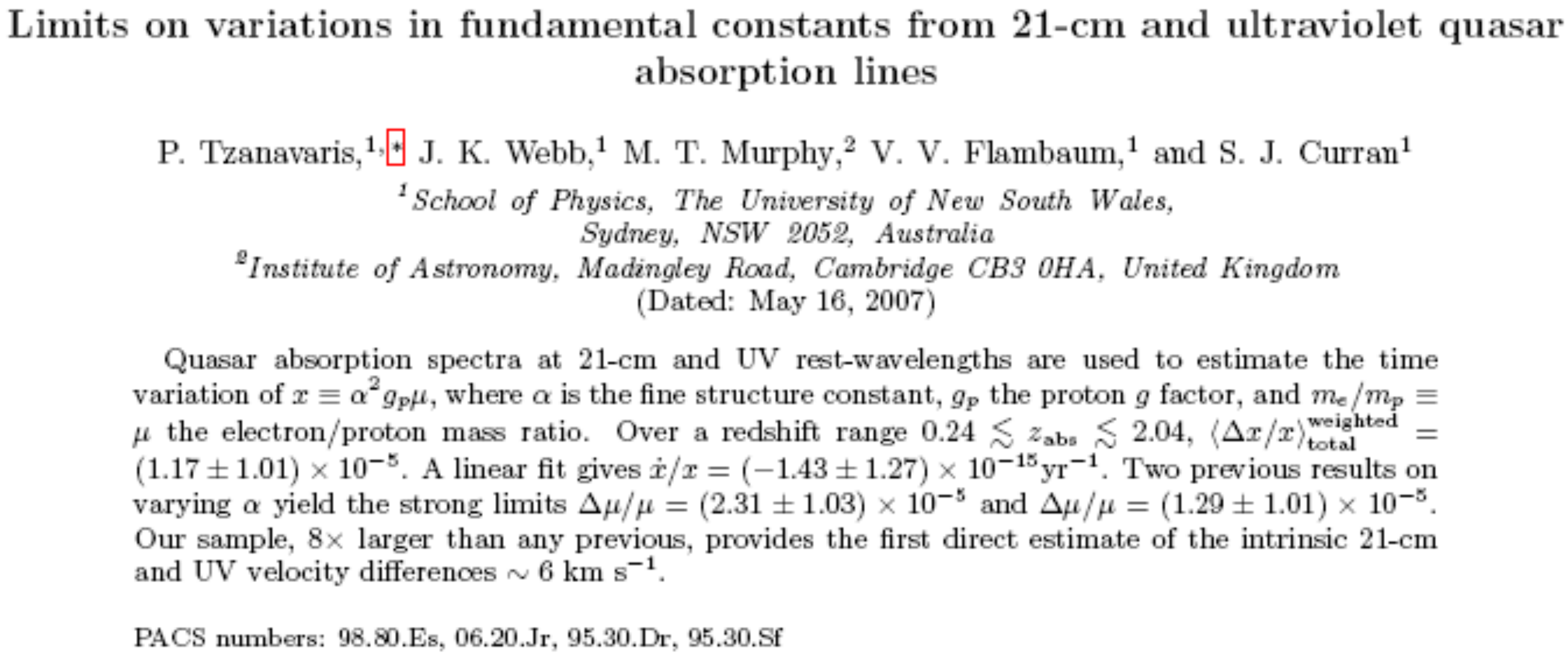
ABSTRACT

We have previously presented evidence for a varying fine-structure constant, α, in two independent samples of Keck/HIRES QSO absorption spectra. Here we present a detailed many-multiplet analysis of a third Keck/HIRES sample containing 78 absorption systems. We also re-analyse the previous samples, providing a total of 128 absorption systems over the redshift range $0.2 < z_{\rm abs} < 3.7$. The results, with raw statistical errors, indicate a smaller weighted mean α in the absorption clouds: $\Delta\alpha/\alpha = (-0.574 \pm 0.102) \times 10^{-5}$. All three samples separately yield consistent and significant values of $\Delta\alpha/\alpha$. The analyses of low-z (i.e. $z_{\rm abs} < 1.8$) and high-z systems rely on different ions and transitions with very different dependencies on α, yet they also give consistent results. We identify an additional source of random error in 22 high-z systems characterized by transitions with a large dynamic range in apparent optical depth. Increasing the statistical errors on $\Delta\alpha/\alpha$ for these systems gives our fiducial result, a weighted mean $\Delta\alpha/\alpha = (-0.543 \pm 0.116) \times 10^{-5}$, representing $4.7\,\sigma$ evidence for a varying α. Assuming that $\Delta\alpha/\alpha = 0$ at $z_{\rm abs} = 0$, the data marginally prefer a linear increase in α with time rather than a constant offset from the laboratory value: $\dot{\alpha}/\alpha = (6.40 \pm 1.35) \times 10^{-16}\,{\rm yr}^{-1}$. The two-point correlation function for α is consistent with zero over 0.2–13 Gpc comoving scales and the angular distribution of $\Delta\alpha/\alpha$ shows no significant dipolar anisotropy. We therefore have no evidence for spatial variations in $\Delta\alpha/\alpha$.

We extend our previous searches for possible systematic errors, giving detailed analyses of potential kinematic effects, line blending, wavelength miscalibration, spectrograph temperature variations, atmospheric dispersion and isotopic/hyperfine structure effects. The latter two are potentially the most significant. However, overall, known systematic errors do not explain the results. Future many-multiplet analyses of independent QSO spectra from different telescopes and spectrographs will provide a now crucial check on our Keck/HIRES results.

Key words: atomic data – line: profiles – methods: laboratory – techniques: spectroscopic – quasars: absorption lines – ultraviolet: general

2005



Limits on variations in fundamental constants from 21-cm and ultraviolet quasar absorption lines

P. Tzanavaris,[1,*] J. K. Webb,[1] M. T. Murphy,[2] V. V. Flambaum,[1] and S. J. Curran[1]

[1] *School of Physics, The University of New South Wales,*
Sydney, NSW 2052, Australia
[2] *Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, United Kingdom*

(Dated: May 16, 2007)

Quasar absorption spectra at 21-cm and UV rest-wavelengths are used to estimate the time variation of $x \equiv \alpha^2 g_p \mu$, where α is the fine structure constant, g_p the proton g factor, and $m_e/m_p \equiv \mu$ the electron/proton mass ratio. Over a redshift range $0.24 \lesssim z_{\mathrm{abs}} \lesssim 2.04$, $\langle \Delta x/x \rangle^{\mathrm{weighted}}_{\mathrm{total}} = (1.17 \pm 1.01) \times 10^{-5}$. A linear fit gives $\dot{x}/x = (-1.43 \pm 1.27) \times 10^{-15}\mathrm{yr}^{-1}$. Two previous results on varying α yield the strong limits $\Delta\mu/\mu = (2.31 \pm 1.03) \times 10^{-5}$ and $\Delta\mu/\mu = (1.29 \pm 1.01) \times 10^{-5}$. Our sample, 8× larger than any previous, provides the first direct estimate of the intrinsic 21-cm and UV velocity differences ~ 6 km s^{-1}.

PACS numbers: 98.80.Es, 06.20.Jr, 95.30.Dr, 95.30.Sf

Do the fundamental constants vary in the course of the cosmological evolution ?

A.V. Ivanchik[1], *E. Rodriguez*[2], *P. Petitjean*[2,3], *and D.A. Varshalovich*[1]

[1] Ioffe Physical Technical Institute RAS, St.-Petersburg, Russia
[2] Institut d'Astrophysique de Paris – CNRS, France
[3] LERMA - Observatoire de Paris, France

Abstract – We estimate the cosmological variation of the proton-to-electron mass ratio $\mu = m_p/m_e$ by measuring the wavelengths of molecular hydrogen transitions in the early universe. The analysis is performed using high spectral resolution observations ($FWHM \approx$ 7 km/s) of two damped Lyman-α systems at $z_{abs} = 2.3377$ and 3.0249 observed along the lines of sight to the quasars Q 1232+082 and Q 0347−382 respectively.

The most conservative result of the analysis is a possible variation of μ over the last ∼10 Gyrs, with an amplitude

$$\Delta\mu/\mu = (5.7 \pm 3.8) \times 10^{-5}.$$

The result is significant at the 1.5σ level only and should be confirmed by further observations. This is the most stringent estimate of a possible cosmological variation of μ obtained up to now.

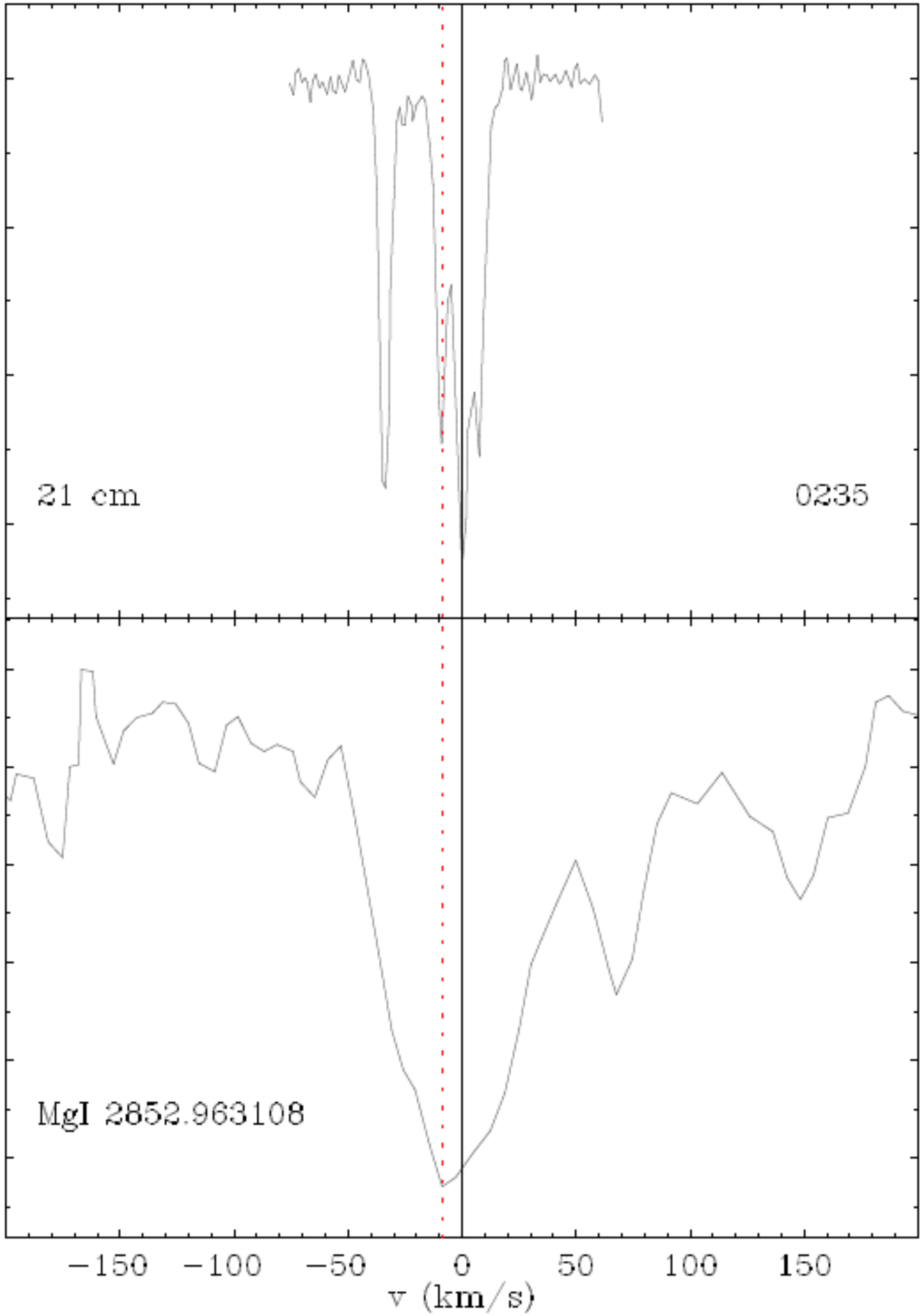


FIG. 5: Velocity plot for 21-cm and UV absorption towards quasar Q0235+164. The solid vertical line at 0 km s^{-1} is at z_{21}. The dotted vertical line is at $\langle z_{\mathrm{UV}} \rangle$.

Title: Non-variability of the fine-structure constant over cosmological time scales
Authors: Potekhin, A. Y.; Varshalovich, D. A.
Publication: Astron. Astrophys. Suppl. 104, 89-98 (1994) (A&AS Homepage)
Publication Date: 04/1994
Origin: A&A KNUDSEN
A&A Keywords: QUASARS: GENERAL, CATALOGUES, COSMOLOGY, QUASARS: ABSORPTION LINES
Bibliographic Code: 1994A&AS..104...89P

Abstract

A statistical analysis of fine splitting of C IV, N V, O VI, Mg II, Al III and Si IV doublet absorption lines in quasar spectra is carried out in order to estimate a possible time variation of the fine-structure constant α= e^2^ (h/2π)c over cosmological time scales t~10^10^yr. The observational basis of the analysis is a catalogue of 1414 pairs of wavelengths with redshifts z = 0.2 - 3.7, compiled from data published in 1980-1992. Robust statistical estimates like the "trimmed mean" are used as well as the least squares. No statistically significant time variation of α is found. The estimate α^-1^dα/dz = (-0.6+/-2.8)10^-4^ is obtained. For the 95% significance level, an upper bound on the rate of a relative variation of the fine-structure constant is |α^-1^dα/dz| < 5.6x10^-4^, which corresponds approximately to |α^-1^dα/dt| < 4x10^-14^ yr^-1^. This limit represents the strongest up-to-date restriction on the possible time variation of α for the epoch 0.2 <= z <~ 4.

METHOD

Energy transition :

$$E_z = E_c + Q_1 Z^2\left[\left(\frac{\alpha_z}{\alpha_0}\right)^2 - 1\right] + K_1(\bar{L}\bar{S}) Z^2\left(\frac{\alpha_z}{\alpha_0}\right)^2$$

$$+ K_2 (\bar{L}\bar{S})^2 Z^4 \left(\frac{\alpha_z}{\alpha_0}\right)^4$$

Z - nuclear charge

L - electron total orbital angular momentum

S - electron total spin

E_c - energy of the configuration center

$$E_z = E_{z=0} + [Q_1 + K_1(LS)] Z^2\left(\left(\frac{\alpha_z}{\alpha_0}\right)^2 - 1\right)$$

$$+ K_2 (LS)^2 Z^4 \left[\left(\frac{\alpha_z}{\alpha_0}\right)^4 - 1\right]$$

Q_1, K_1 K_2 from many body calculations and experimental data

strong dependence on Z

Mg II 2796/2803 Å $z = 12$

Fe II 2344, 2374, 2383, 2587, 2600 Å

$z = 26$

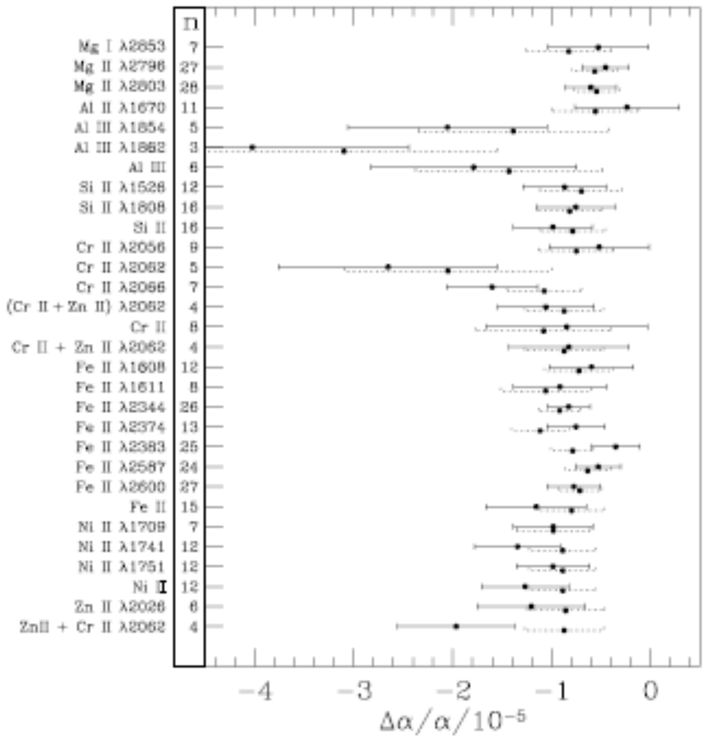


Figure 4. Comparison of the weighted mean of $\Delta\alpha/\alpha$ before (dotted error bar) and after (solid error bar) line removal. The transitions removed are listed on the left together with the number of systems, n, for which removal of that transition was possible. It is stressed that comparing the values and error bars before and after line removal is difficult since these quantities are not independent. Note that there may be some confusion due to the occasional blending of the Cr II and Zn II λ2062 lines: '(Cr II + Zn II) λ2062' refers to cases where both transitions had to be removed simultaneously; 'Cr II + Zn II λ2062' refers to cases when all Cr II transitions were removed along with the blended Zn II line; a similar definition applies to 'Zn II + Cr II λ2062'; 'Cr II' then refers only to the removal of all Cr II transitions in cases where there was no blending with the Zn II line. Only one similar case occurred for removal of all Zn II lines and so we do not present this result.

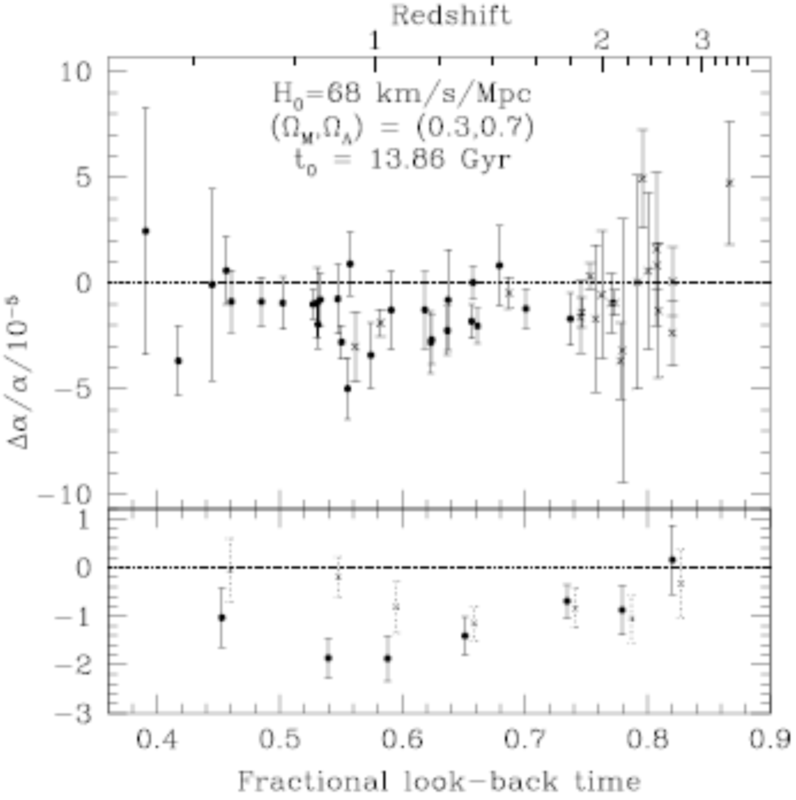


Figure 7. Results after removal of atmospheric dispersion effects. The top panel shows our raw results for $\Delta\alpha/\alpha$ as a function of look-back time in a flat, Λ cosmology. The redshift scale is also provided for comparison. The lower panel shows an arbitrary binning of the results which emphasizes the susceptibility of the low-z sample to this systematic error (the dotted lines are the results of M01a and W01, slightly shifted for clarity). Note, however, that the correction made here is an extreme and will be diminished by seeing and tracking effects.

$\Delta\alpha/\alpha \sim (1.9 \pm 0.5) \times 10^{-5}$ (dla z > 1)

Spatial variation in the fine-structure constant -- new results from VLT/UVES
Julian A. King, John K. Webb, Michael T. Murphy, Victor V. Flambaum, Robert F. Carswell, Matthew B. Bainbridge, Michael R. Wilczynska, F. Elliot Koch
(Submitted on 21 Feb 2012)

We present a new analysis of a large sample of quasar absorption-line spectra obtained using UVES (the Ultraviolet and Visual Echelle Spectrograph) on the VLT (Very Large Telescope) in Chile. In the VLT sample (154 absorbers), we find evidence that alpha increases with increasing cosmological distance from Earth. However, as previously shown, the Keck sample (141 absorbers) provided evidence for a smaller alpha in the distant absorption clouds. Upon combining the samples an apparent variation of alpha across the sky emerges which is well represented by an angular dipole model pointing in the direction RA=(17.3 +/- 1.0) hr, dec. = (-61 +/- 10) deg, with amplitude (0.97 +0.22/-0.20) x 10^(-5). The dipole model is required at the 4.1 sigma statistical significance level over a simple monopole model where alpha is the same across the sky (but possibly different to the current laboratory value). The data sets reveal a number of remarkable consistencies: various data cuts are consistent and there is consistency in the overlap region of the Keck and VLT samples. Assuming a dipole-only (i.e. no-monopole) model whose amplitude grows proportionally with `lookback-time distance' (r=ct, where t is the lookback time), the amplitude is (1.1 +/- 0.2) x 10^(-6) GLyr^(-1) and the model is significant at the 4.2 sigma confidence level over the null model [Delta alpha]/alpha = 0). We apply robustness checks and demonstrate that the dipole effect does not originate from a small subset of the absorbers or spectra. We present an analysis of systematic effects, and are unable to identify any single systematic effect which can emulate the observed variation in alpha

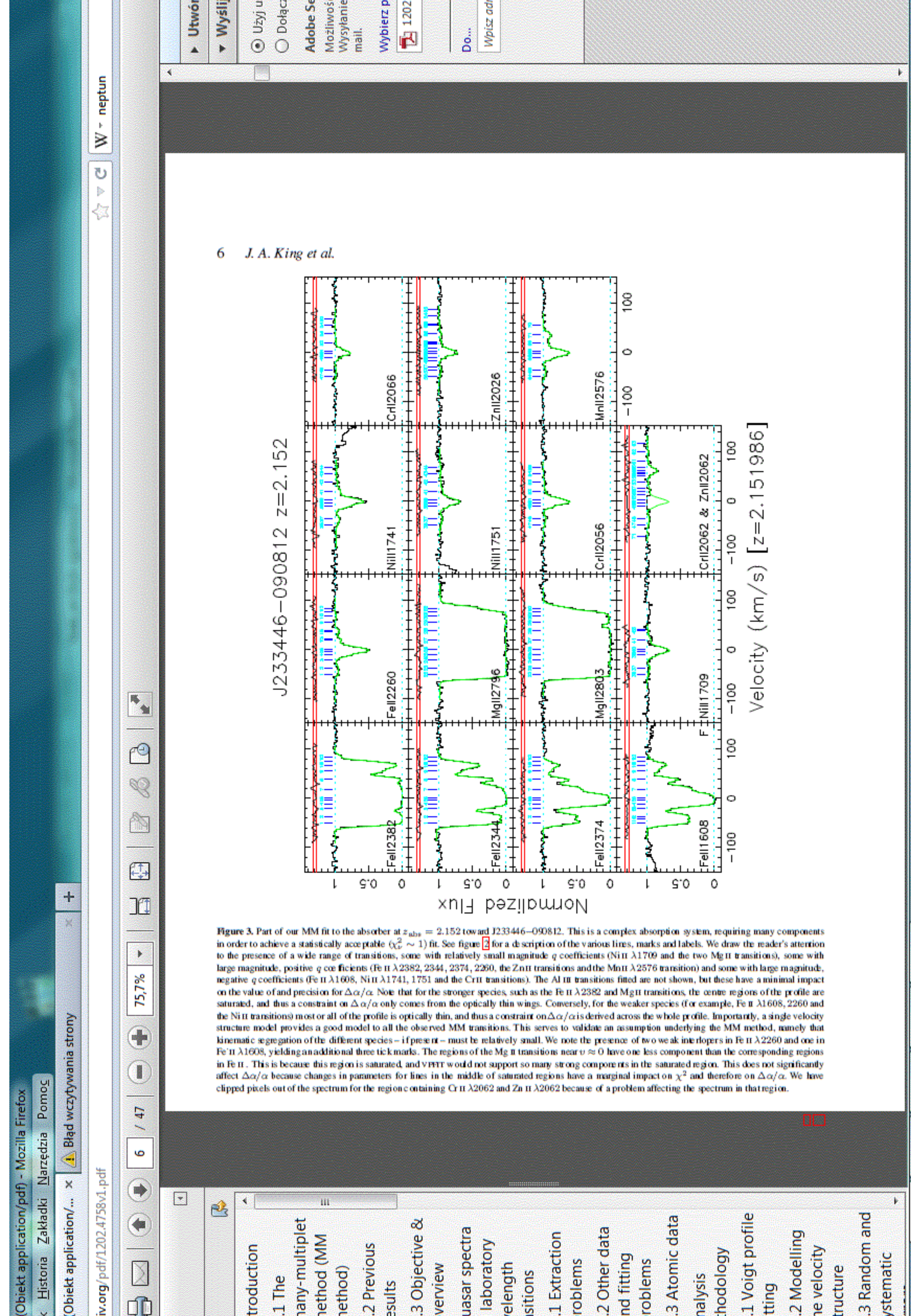


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Figure 3. Part of our MM fit to the absorber at $z_{\rm abs} = 2.152$ toward J233446−090812. This is a complex absorption system, requiring many components in order to achieve a statistically acceptable ($\chi^2_\nu \sim 1$) fit. See figure 2 for a description of the various lines, marks and labels. We draw the reader's attention to the presence of a wide range of transitions, some with relatively small magnitude q coefficients (Ni II λ1709 and the two Mg II transitions), some with large magnitude, positive q coefficients (Fe II λ2382, 2344, 2374, 2260, the Zn II transitions and the Mn II λ2576 transition) and some with large magnitude, negative q coefficients (Fe II λ1608, Ni II λ1741, 1751 and the Cr II transitions). The Al III transitions fitted are not shown, but these have a minimal impact on the value of and precision for $\Delta\alpha/\alpha$. Note that for the stronger species, such as the Fe II λ2382 and Mg II transitions, the centre regions of the profile are saturated, and thus a constraint on $\Delta\alpha/\alpha$ only comes from the optically thin wings. Conversely, for the weaker species (for example, Fe II λ1608, 2260 and the Ni II transitions) most or all of the profile is optically thin, and thus a constraint on $\Delta\alpha/\alpha$ is derived across the whole profile. Importantly, a single velocity structure model provides a good model to all the observed MM transitions. This serves to validate an assumption underlying the MM method, namely that kinematic segregation of the different species – if present – must be relatively small. We note the presence of two weak interlopers in Fe II λ2260 and one in Fe II λ1608, yielding an additional three tick marks. The regions of the Mg II transitions near $v \approx 0$ have one less component than the corresponding regions in Fe II. This is because this region is saturated, and VPFIT would not support so many strong components in the saturated region. This does not significantly affect $\Delta\alpha/\alpha$ because changes in parameters for lines in the middle of saturated regions have a marginal impact on χ^2 and therefore on $\Delta\alpha/\alpha$. We have clipped pixels out of the spectrum for the region containing Cr II λ2062 and Zn II λ2062 because of a problem affecting the spectrum in that region.

Future constraints on variations of the fine structure constant from combined CMB and weak lensing measurements

Matteo Martinelli[1], Eloisa Menegoni[2], Alessandro Melchiorri[3]

[1] SISSA/ISAS, Via Bonomea 265, 34136, Trieste, Italy
[2] I.C.R.A. and INFN, Universita’ di Roma “La Sapienza”, Ple Aldo Moro 2, 00185, Rome, Italy. and
[3] Physics Department and INFN, Universita’ di Roma “La Sapienza”, Ple Aldo Moro 2, 00185, Rome, Italy.

(Dated: February 23, 2012)

We forecast the ability of future CMB and galaxy lensing surveys to constrain variations of the fine structure constant. We found that lensing data, as those expected from satellite experiments as Euclid could improve the constraint from future CMB experiments leading to a
$= 8 \times 10^{-4}$
accuracy. A variation of the fine structure constant is strongly degenerate with the Hubble constant H_0 and with inflationary parameters as the scalar spectral index n_s. These degeneracies may cause significant biases in the determination of cosmological parameters if a variation in as
large as 0.5% is present at the epoch of recombination.

arXiv:1202.4373v3

GPS test of the local position invariance of Planck’s constant

J. Kentosh[*] and M. Mohageg[†]

Department of Physics and Astronomy, California State University,
Northridge, Northridge, California 91330-8268, USA

(Dated: February 29, 2012)

Publicly available clock correction data from the Global Positioning System was analyzed and used in combination with the results of terrestrial clock comparison experiments to confirm the local position invariance (LPI) of Planck’s constant within the context of general relativity. The results indicate that h is invariant within a limit of $|_{h}| < 0.007$, where $_{h}$ is a dimensionless parameter that represents the extent of LPI violation.

PACS numbers: 06.20.Jr, 04.80.Cc, 06.30.Ft

arXiv:1203.0102v1 [gr-qc] 1 Mar 2012

Comment on “Global Positioning System Test of the Local Position Invariance of Planck’s Constant”

J. C. Berengut and V. V. Flambaum

School of Physics, University of New South Wales, Sydney, NSW 2052, Australia

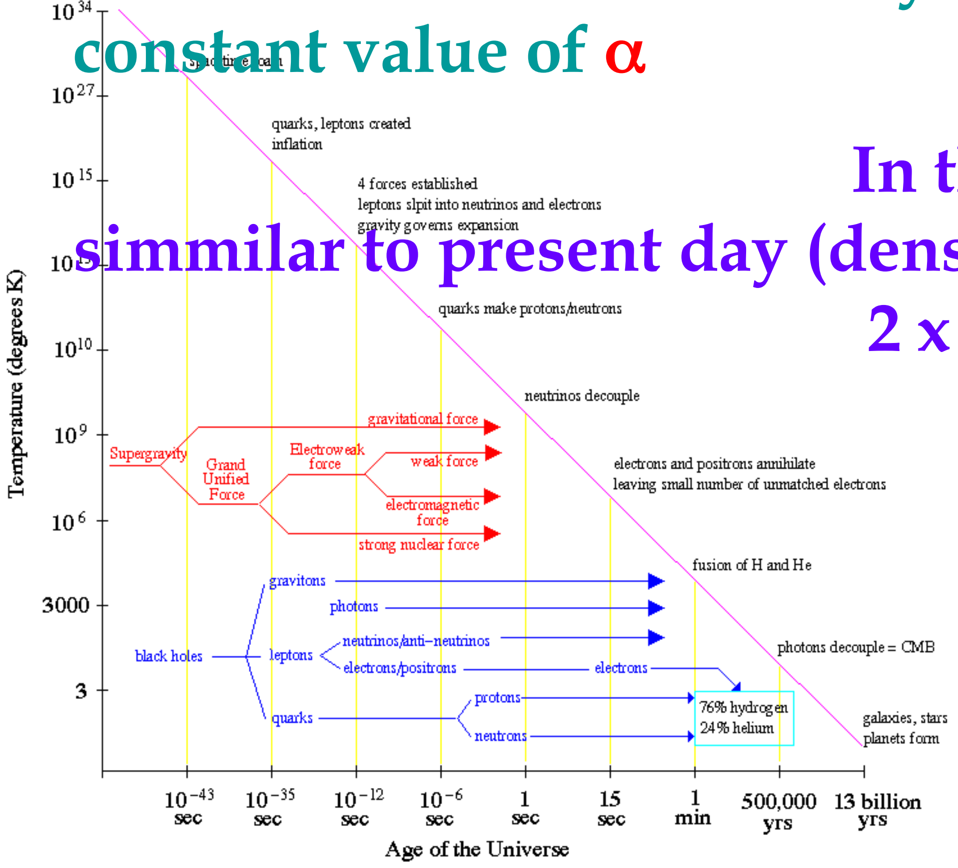
(Dated: 26 March 2012)

http://arxiv.org/abs/1203.5592v1

In their Letter, Kentosh and Mohageg [Phys. Rev. Lett. 108, 110801 (2012)] seek to use data from clocks aboard global positioning system (GPS) satellites to place limits on local position invariance (LPI) violations of Planck's constant, h. It is the purpose of this comment to show that discussing limits on variation of dimensional constants (such as h) is not meaningful; that even within a correct framework it is not possible to extract limits on variation of fundamental constants from a single type of clock aboard GPS satellites; and to correct an important misconception in the authors' interpretation of previous Earth-based LPI experiments.

What would it possibly mean?

In the past changes of the values of physical constants did take place (e.g. coupling constants)



Laboratory data provide evidence for a constant value of α

In the epoch $z \approx 1$ conditions simmilar to present day (density and temperature only 2 x higher)

change in the epoch

when Λ starts to dominate

A coincidence?

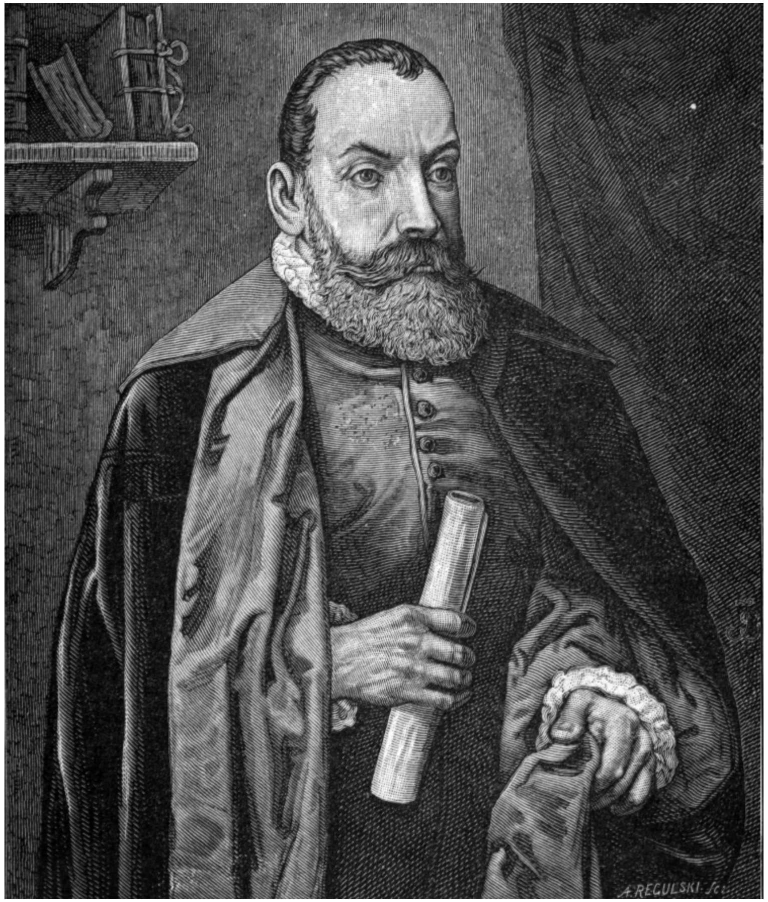
Explanations?

Systematical errors?

John Wilmot, 2nd Earl of Rochester (1 April 1647 – 26 July 1680),

Since ’tis Nature’s law to change,
Constancy alone is strange.

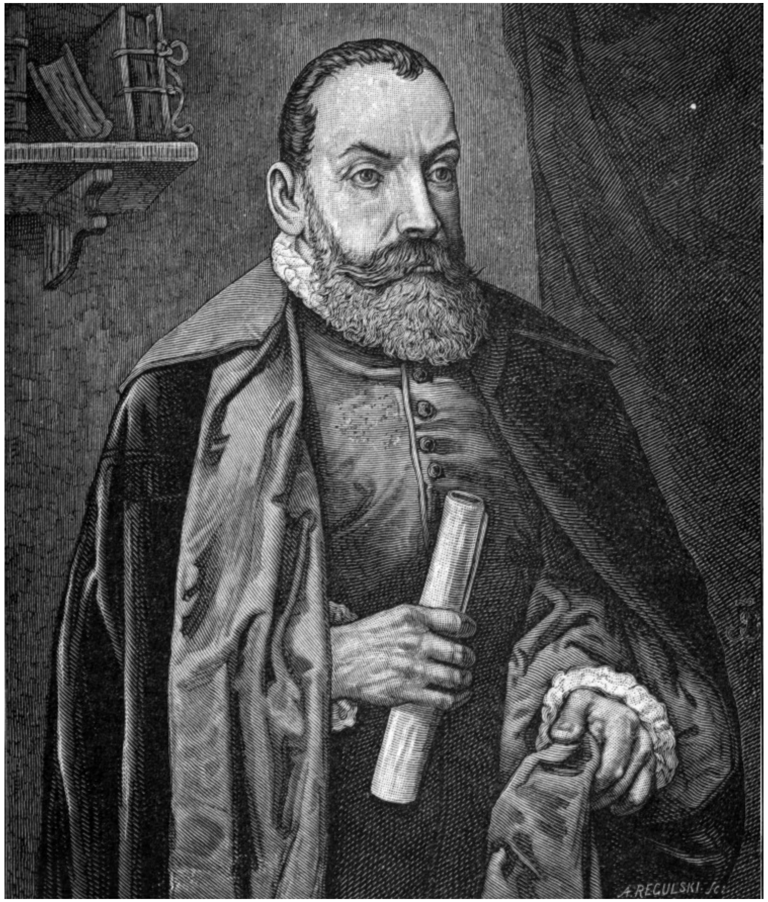
Works (1926) *A Dialogue betweenStrephon and Daphne*



Jan Kochanowski (1530 – 1584)

„Nic wiecznego na świecie: …”

— Jan Kochanowski



Jan Kochanowski (1530 – 1584)

„Nic wiecznego na świecie:
Radość się z troską plecie.”

— **Jan Kochanowski**