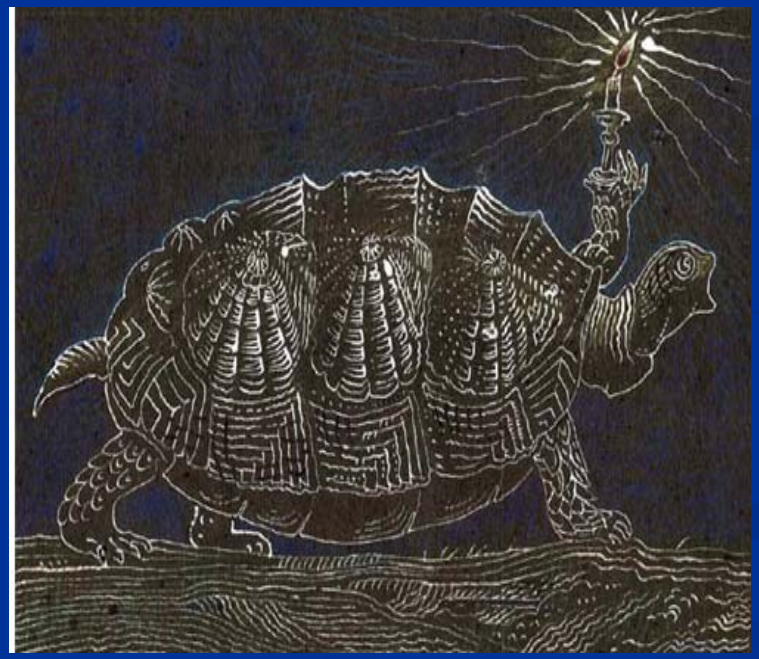
The International Summer School of ITN «SPINOPTRONICS» (ISSO-2012)

July 10 – 12, 2012, Saint-Petersburg

Slow Light: An Instructive Story

V.S.Zapasskii



Occam's razor

William of Occam
(ca. 1285-1349)

entities
should not be
multiplied
beyond necessity.

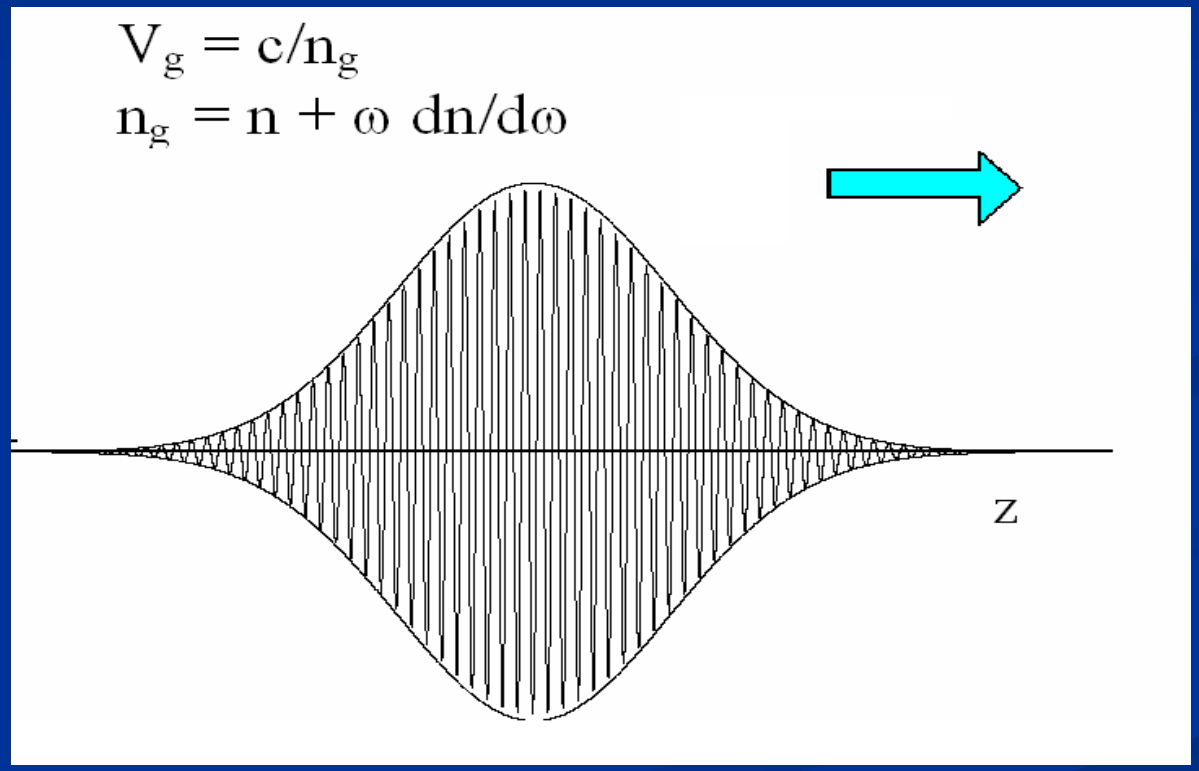
Contents

What is "slow light"
Electromagnetically induced transparency
Curiosities of slow light
Saturable absorber – "CPO-based slow light"
Light-induced anisotropy –
"degenerate EIT"
Concluding remarks

Group velocity

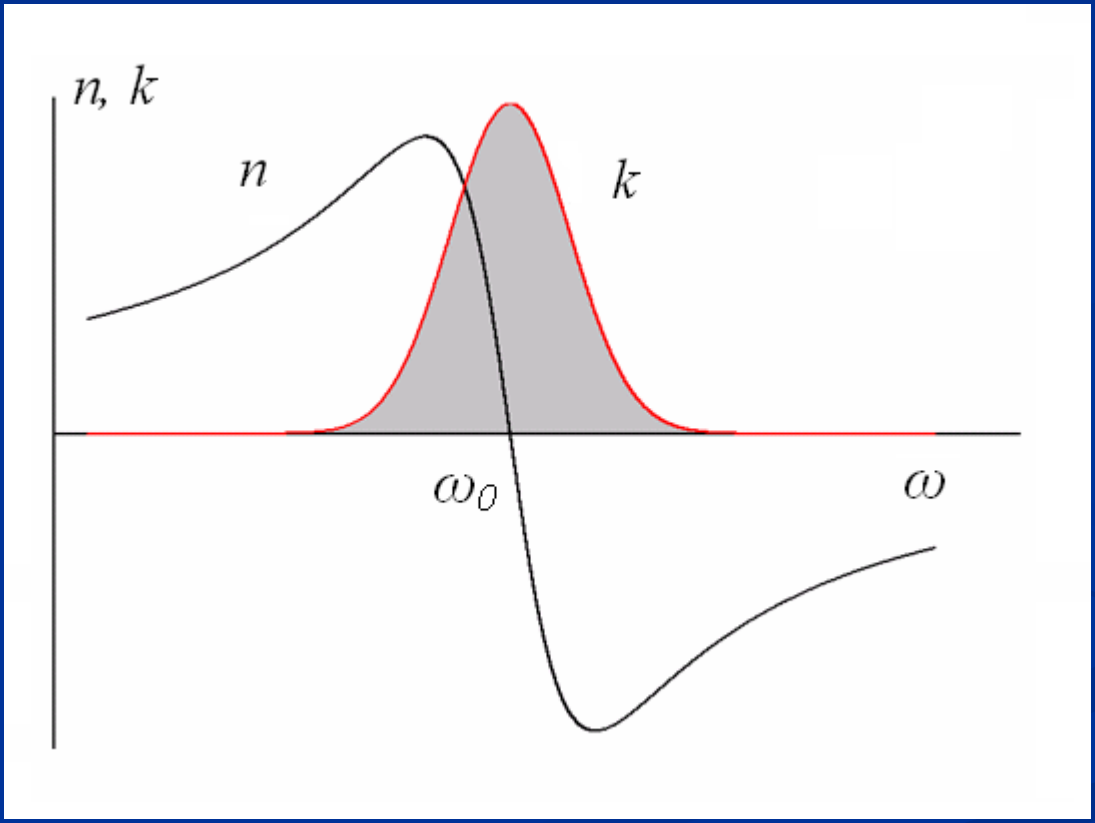
$V_g = c/n_g$

$n_g = n + \omega \, dn/d\omega$



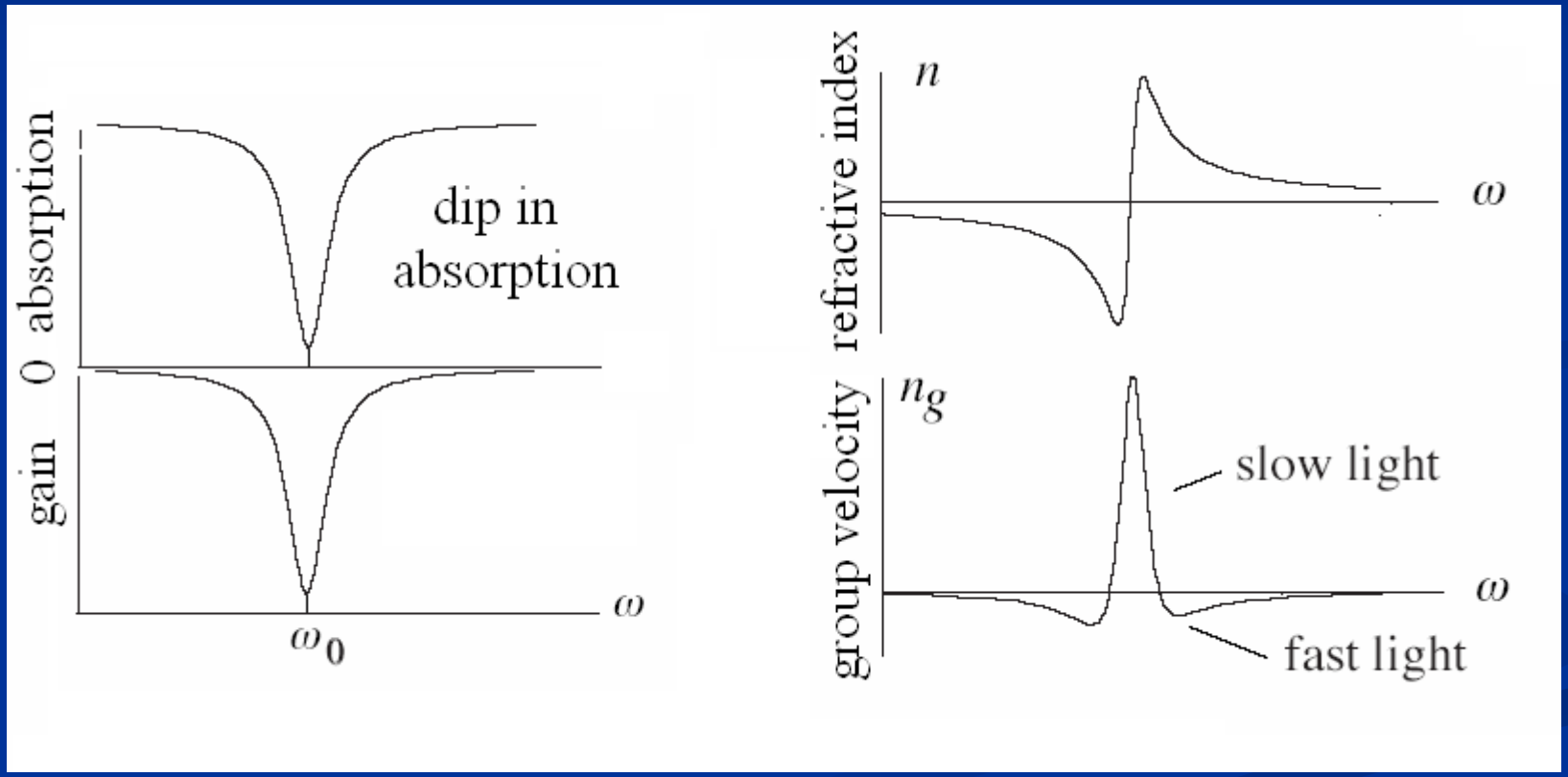
Refractive index dispersion

(absorption peak)

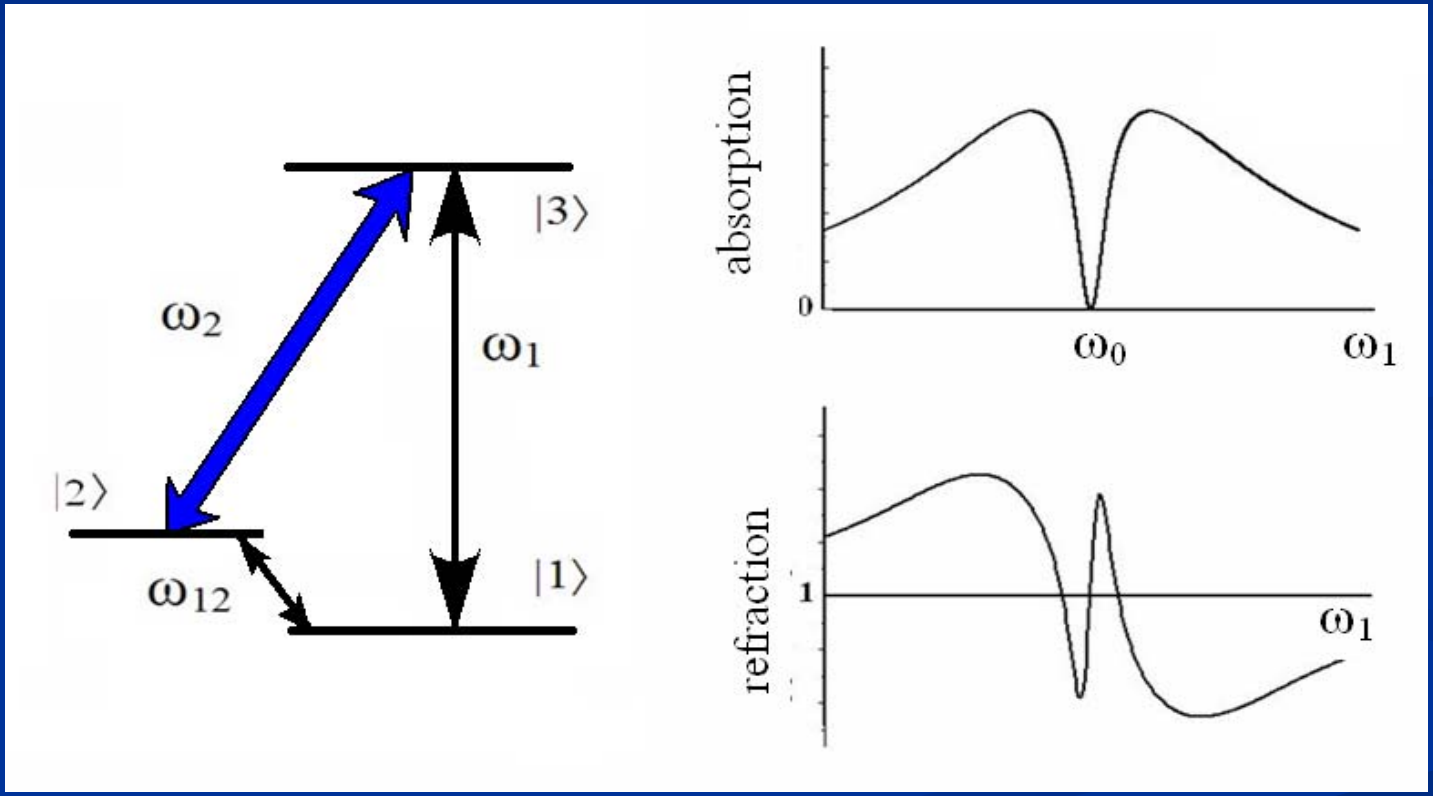


Refractive index dispersion

(absorption dip or gain peak)



Electromagnetically induced transparency



Pioneering experiment of Lene Hau et al.

Light speed reduction to 17 metres per second in an ultracold atomic gas

Lene Vestergaard Hau*†, S. E. Harris‡, Zachary Dutton*† & Cyrus H. Behroozi*§

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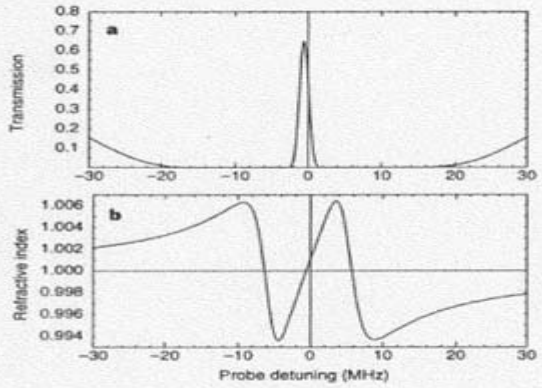
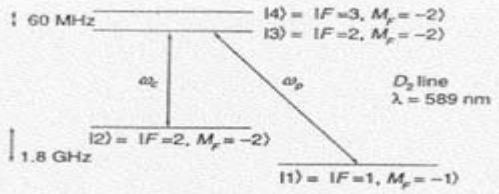
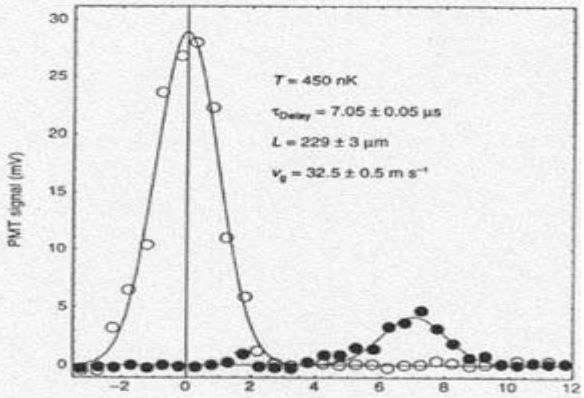
† *Department of Physics, § Division of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts 02138, USA*
‡ *Edward L. Ginzton Laboratory, Stanford University, Stanford, California 94305, USA*

Nature, 397, 594, (1999).

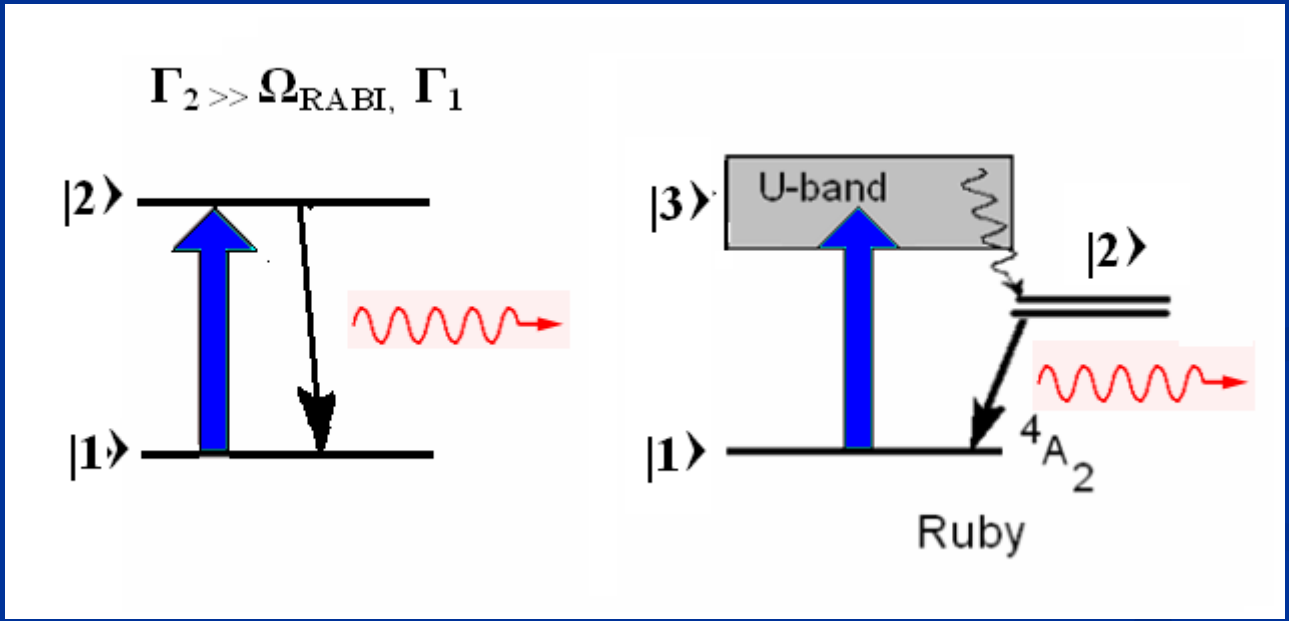




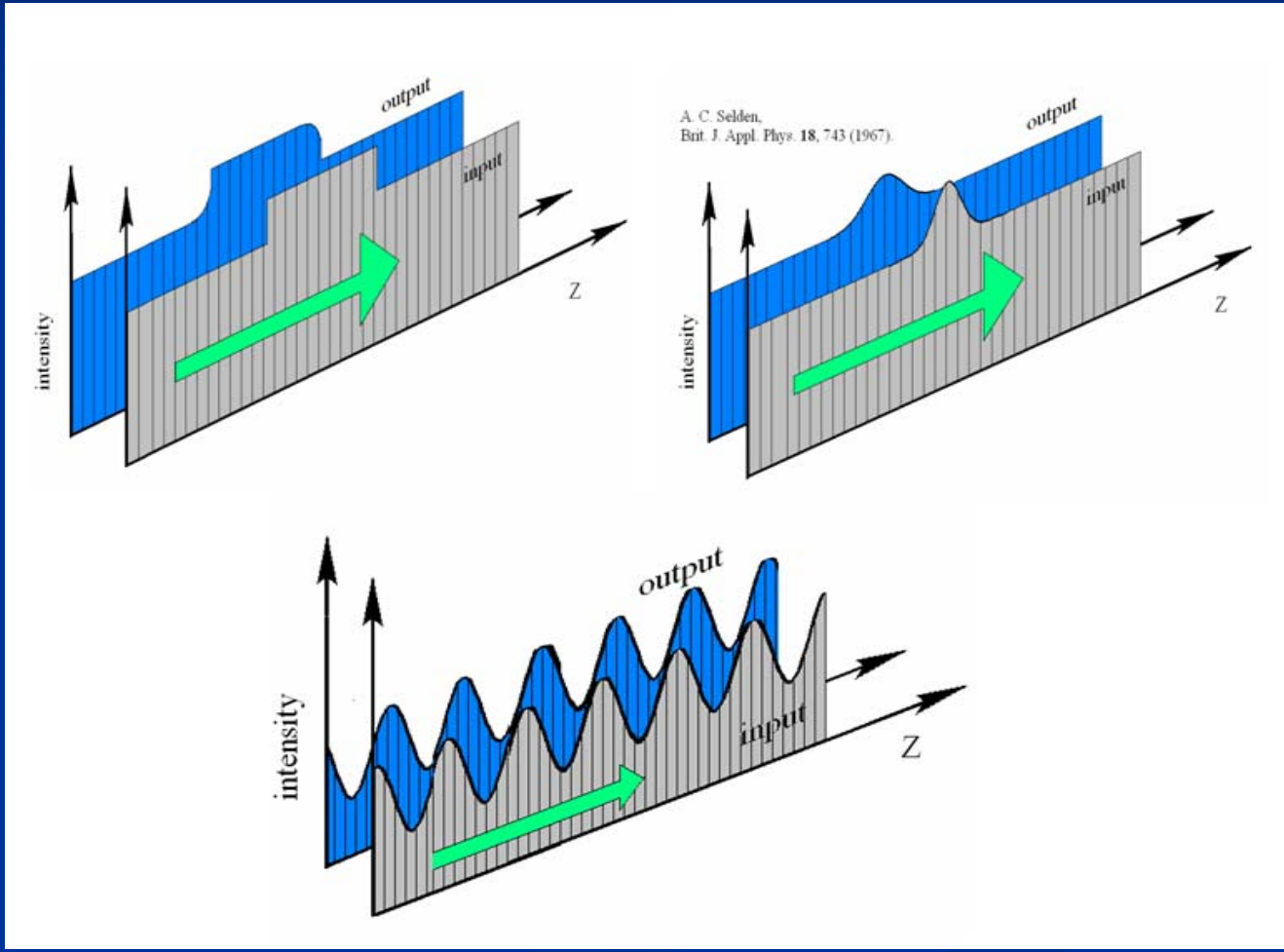
$$v_g = \frac{c}{n(\omega_p) + \omega_p \frac{dn}{d\omega_p}} \approx \frac{\hbar c \epsilon_0}{2\omega_p} \frac{|\Omega_c|^2}{|\mu_{13}|^2 N}$$



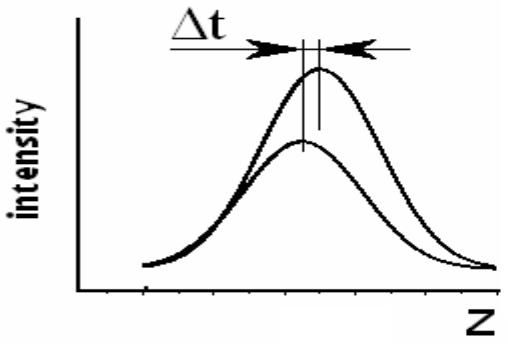
Saturable absorber



Dynamics of a saturable absorber



Saturable absorber: General properties



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and G. G. Kozlov,
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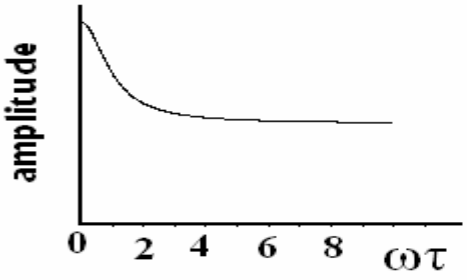
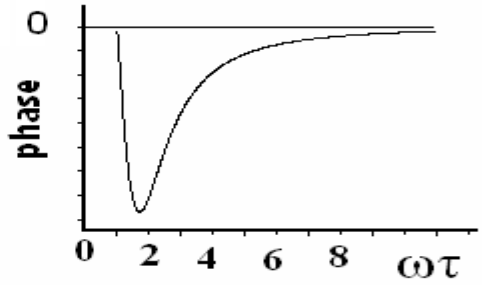
100 (3),419 (2006)



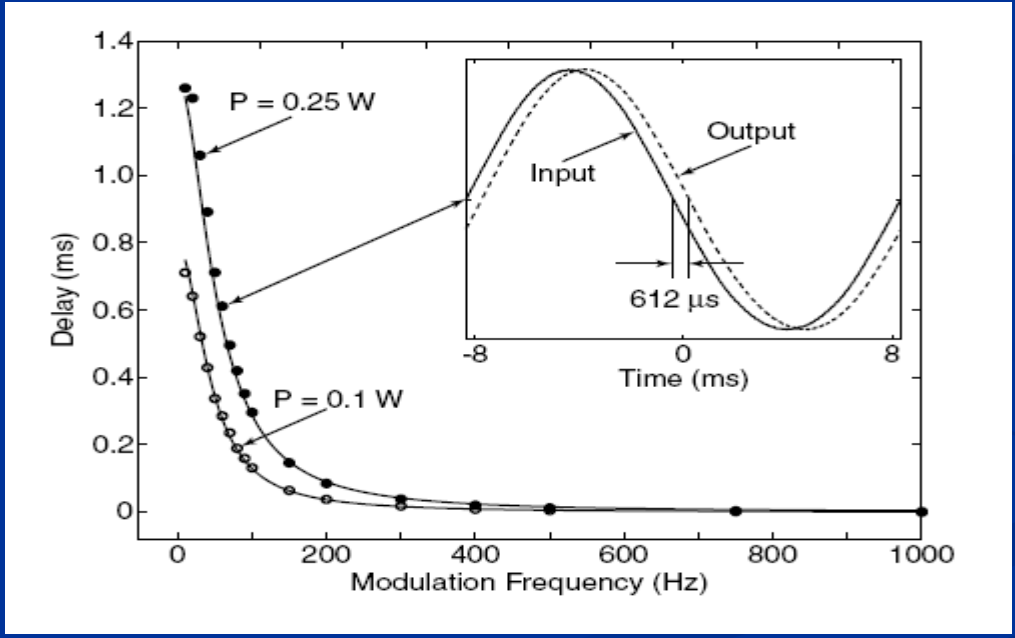


Phys. Rev. Lett. 90, 113903 (2003)

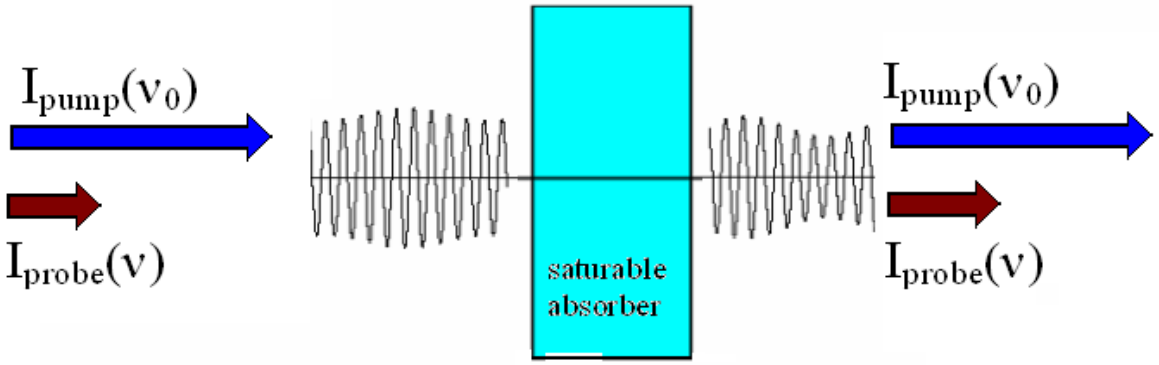
Observation of Ultraslow Light Propagation in a Ruby Crystal at Room Temperature

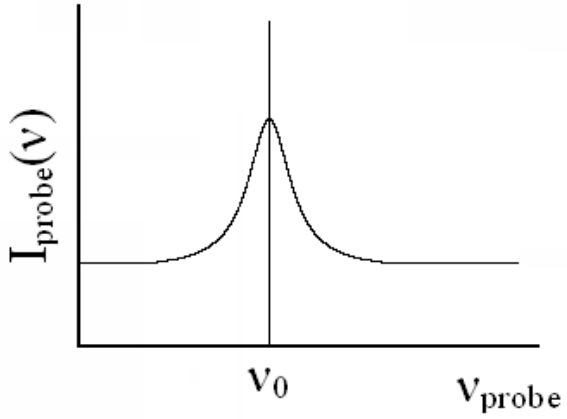
Matthew S. Bigelow, Nick N. Lepeshkin, and Robert W. Boyd
The Institute of Optics, University of Rochester, Rochester, New York 14627

We have observed slow light propagation with a group velocity as low as **57.5 m/s** at room temperature in a ruby crystal.



Coherent population oscillations





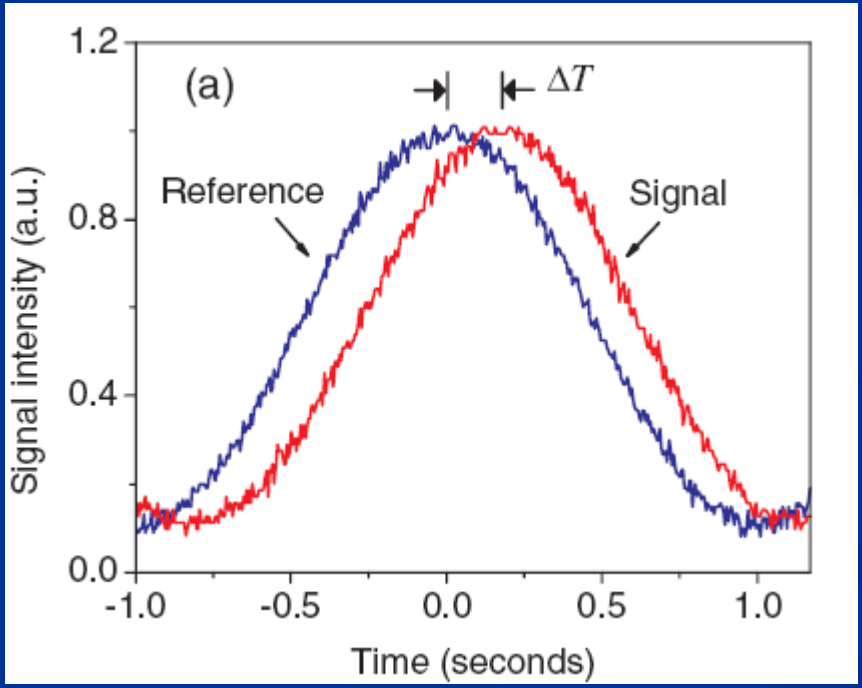
S. E. Schwarz and T. Y. Tan, Appl. Phys. Lett. **10**, 4 (1967)

PRL 95, 253601 (2005) PHYSICAL REVIEW LETTERS
16 DECEMBER 2005

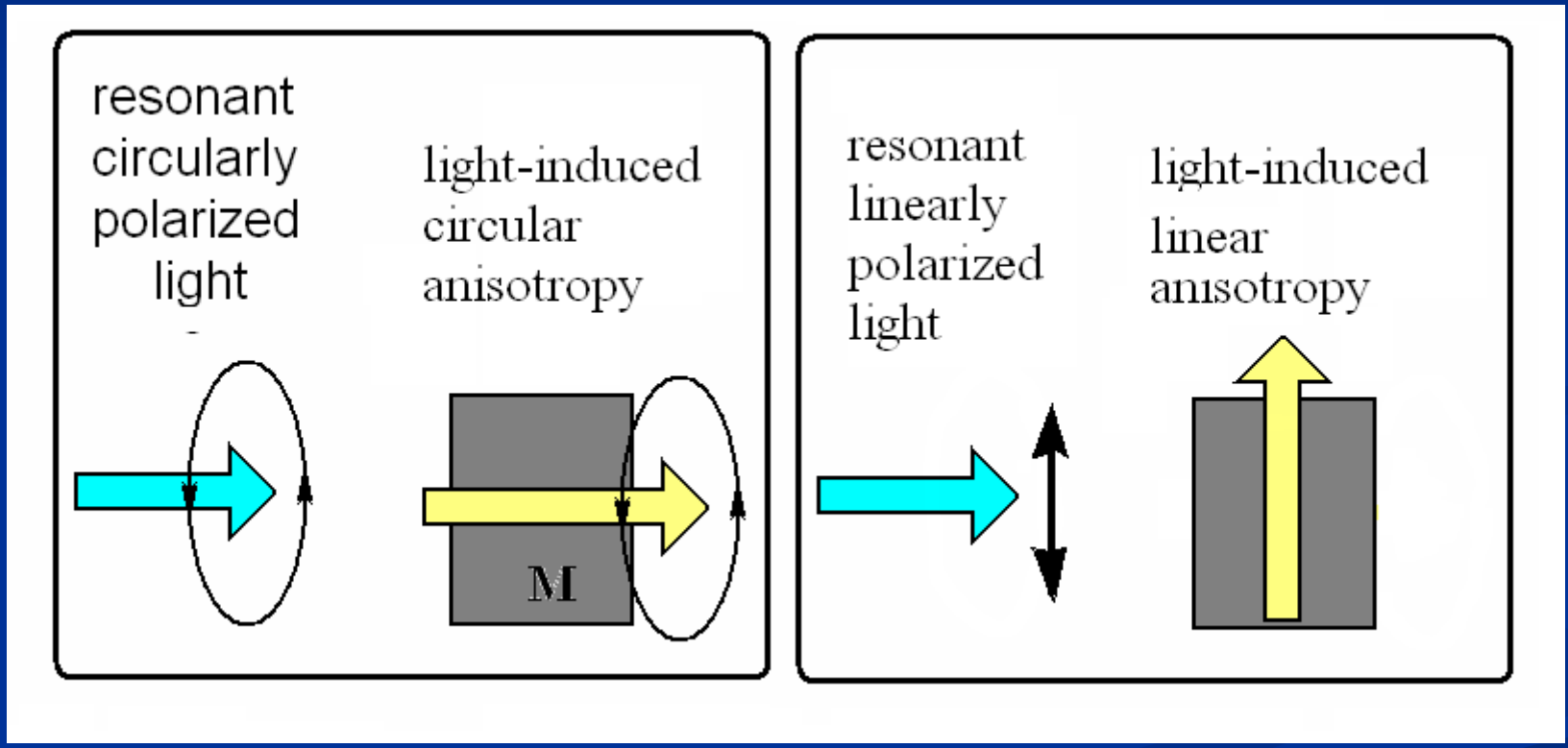
Controllable Snail-Paced Light in Biological Bacteriorhodopsin Thin Film

Pengfei Wu and D.V. G. L. N. Rao
Physics Department, University of Massachusetts, Boston, Massachusetts 02125, USA

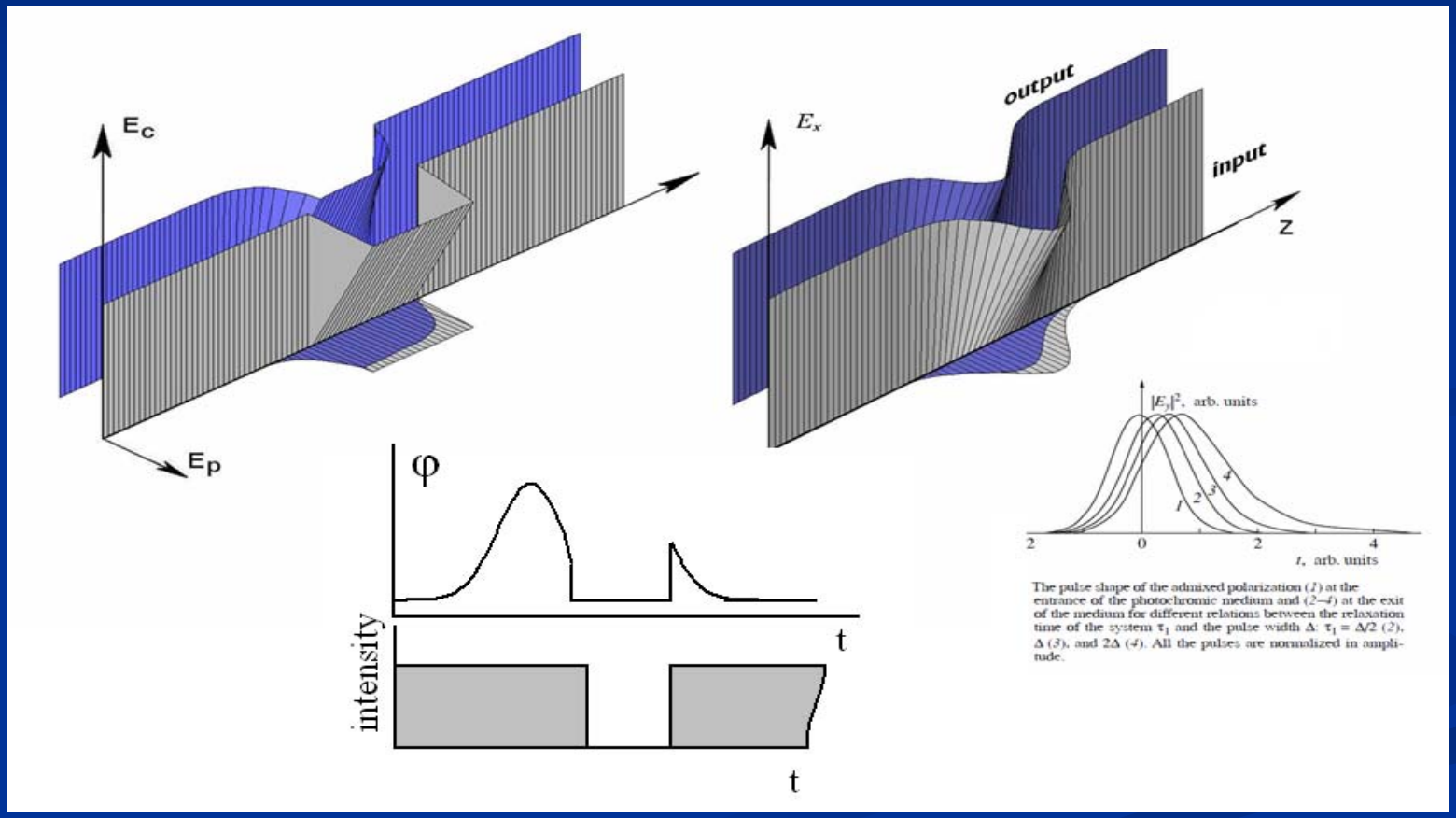
We observe that the group velocity of light is reduced to an extremely low value of **0.091 mm/s** in a biological thin film of bacteriorhodopsin at room temperature.



Light-induced anisotropy



Dynamics of the light-induced anisotropy (alignment)



The pulse shape of the admixed polarization (*1*) at the entrance of the photochromic medium and (*2–4*) at the exit of the medium for different relations between the relaxation time of the system τ_1 and the pulse width Δ: $\tau_1 = \Delta/2$ (*2*), Δ (*3*), and 2Δ (*4*). All the pulses are normalized in amplitude.

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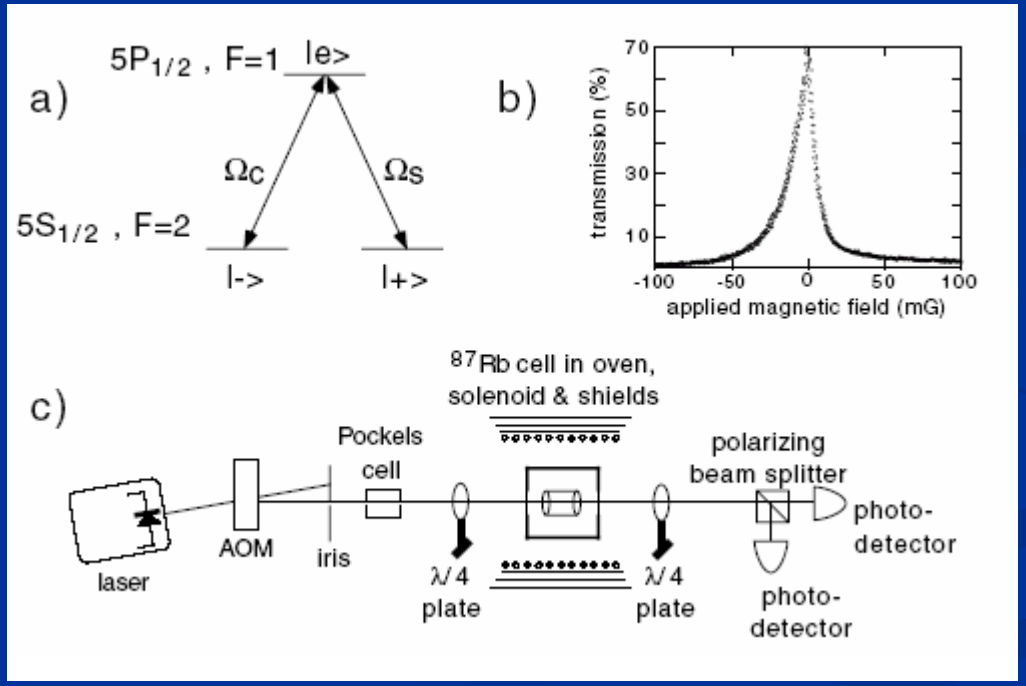
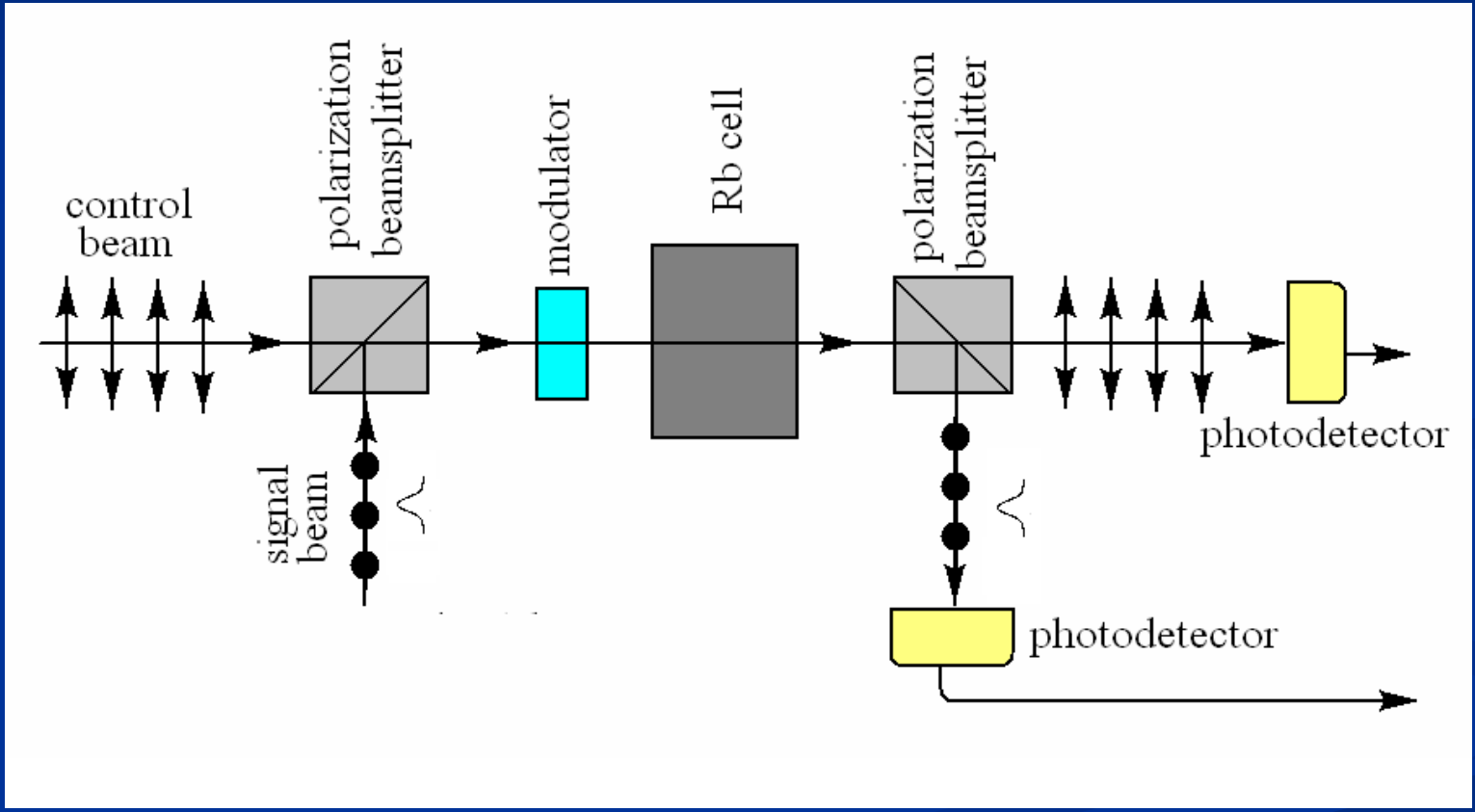
Storage of Light in Atomic Vapor

D. F. Phillips, A. Fleischhauer, A. Mair, and R. L. Walsworth
Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138

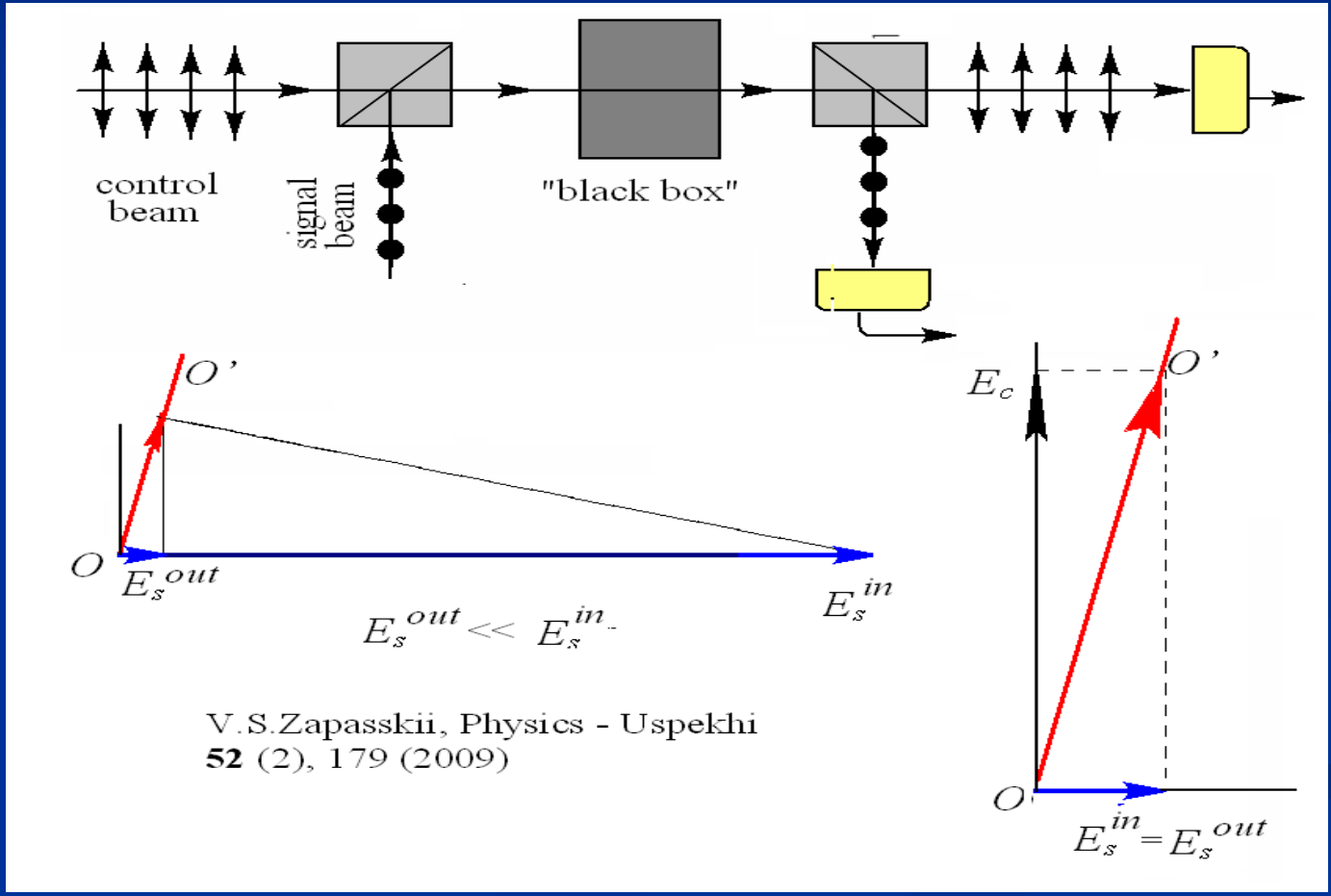
M. D. Lukin
ITAMP, Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138
(Received 22 December 2000)



Schematic of the setup

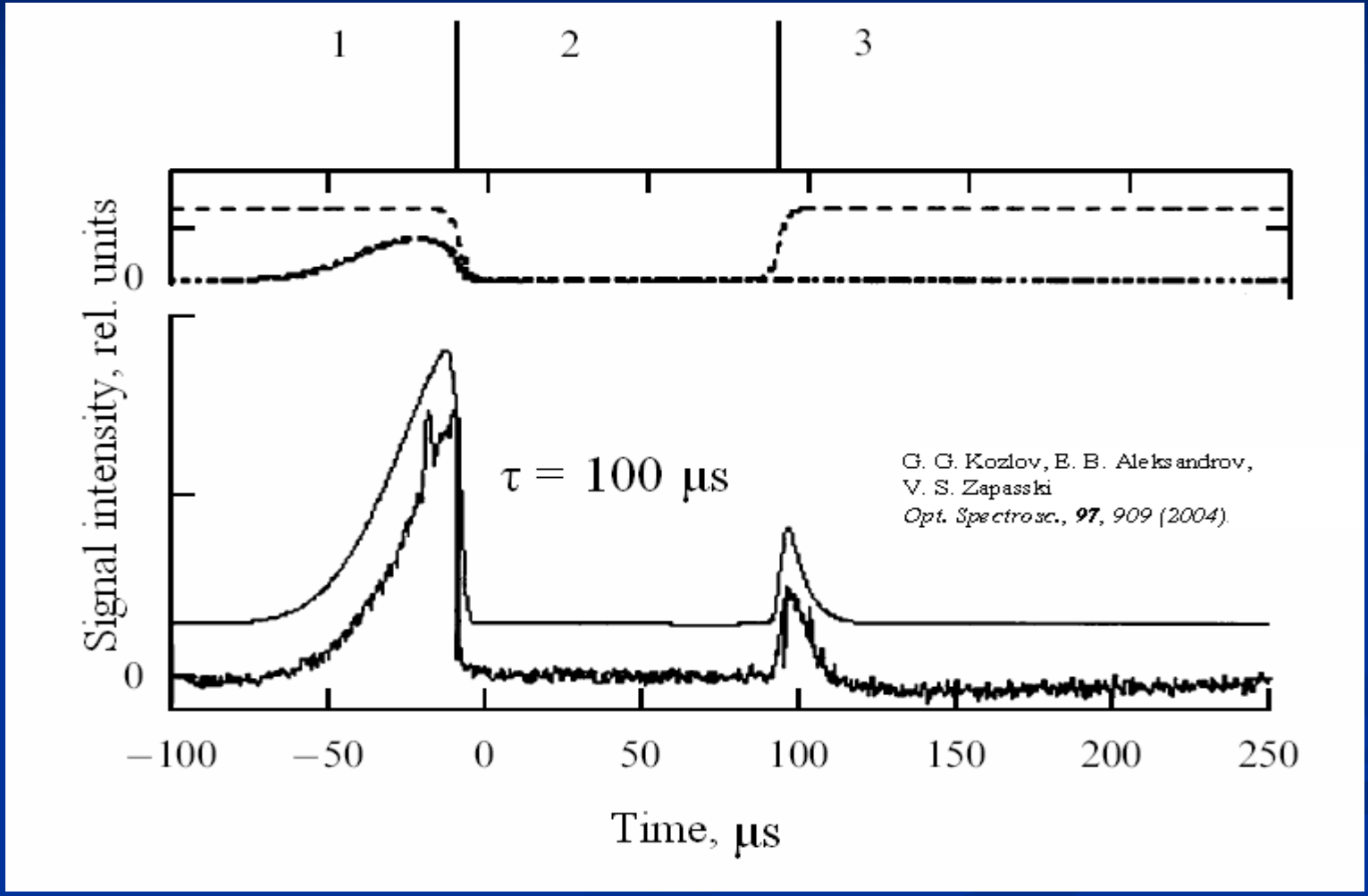


EIT in the degenerate Λ-scheme and interference of polarized beams



V.S.Zapasskii, Physics - Uspekhi
52 (2), 179 (2009)

"Stopped light": Experiment & theory



Physics – Uspekhi **47** (10) 1033 – 1036 (2004)

METHODOLOGICAL NOTES

A fairy tale of stopped light

E B Aleksandrov, V S Zapasskiĭ

Contents

Occam's razor

William of Occam
(ca. 1285-1349)

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Thank you!