



Magnetic and Nonmagnetic H₂O Isomers in Water and Aqueous Solutions: 4-photon Spectroscopy and MRT diagnostics of **ortho-H₂O** & **H₂O₂**

Магнитные и немагнитные изомеры H₂O в воде и водных растворах: нелинейно-оптическая спектроскопия и МРТ.

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Pershin S.M, Bunkin A.F.

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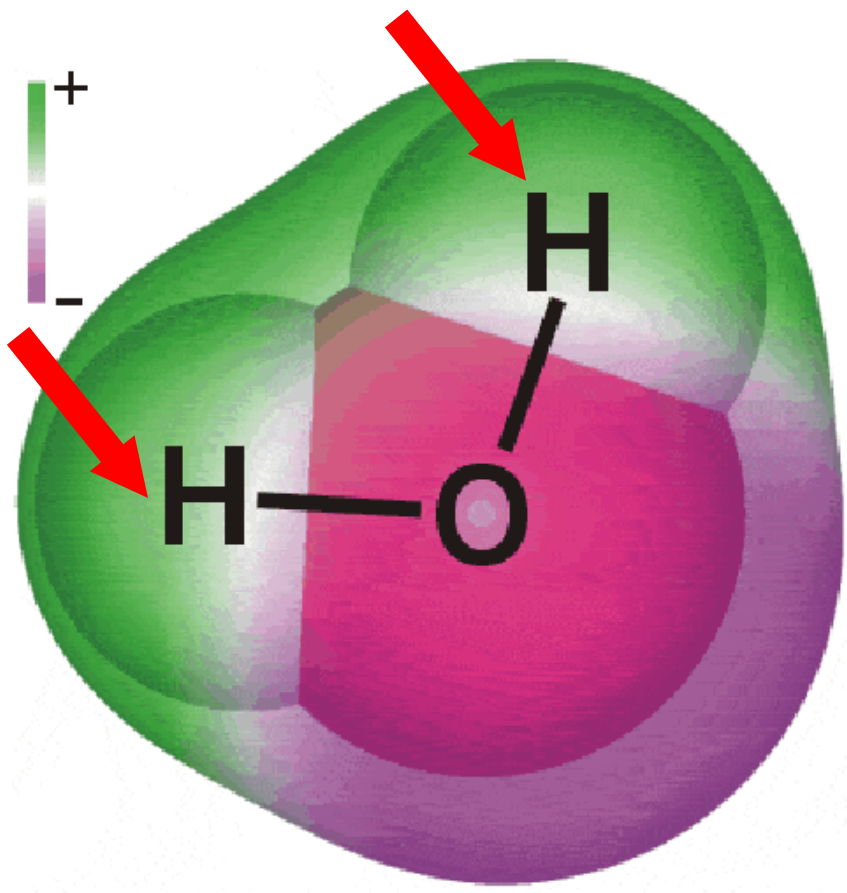
Anisimov N.V., Pirogov Yu.A.

Center of magnetic tomography and spectroscopy MSU

It is known: spin isomers of H_2O & H_2O_2

Ortho-

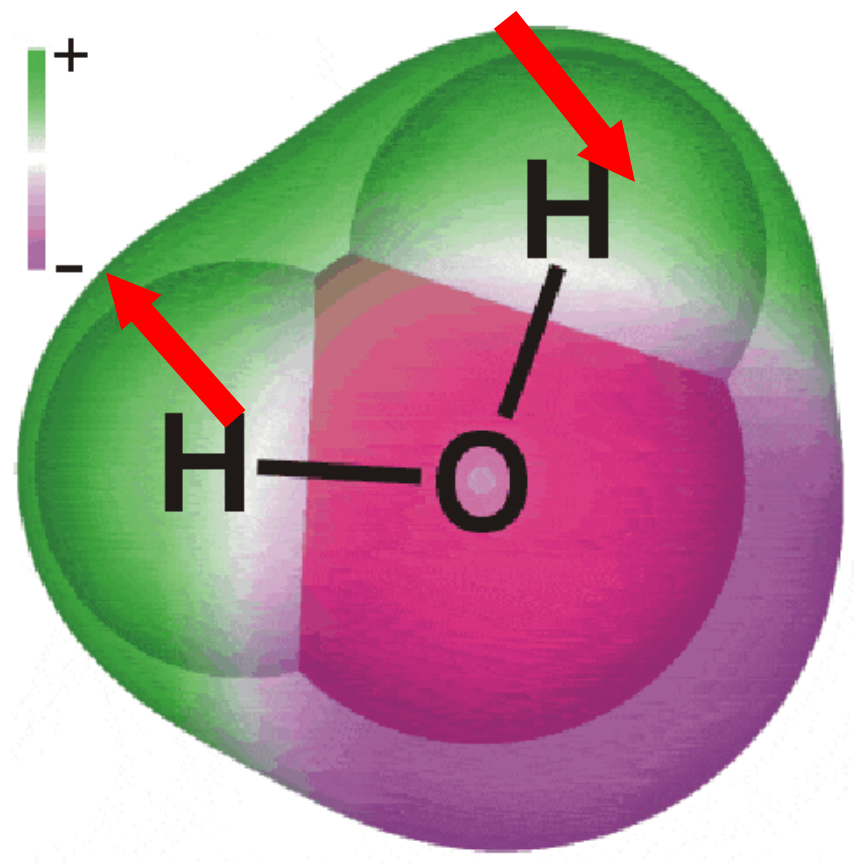
Spin $J=1$



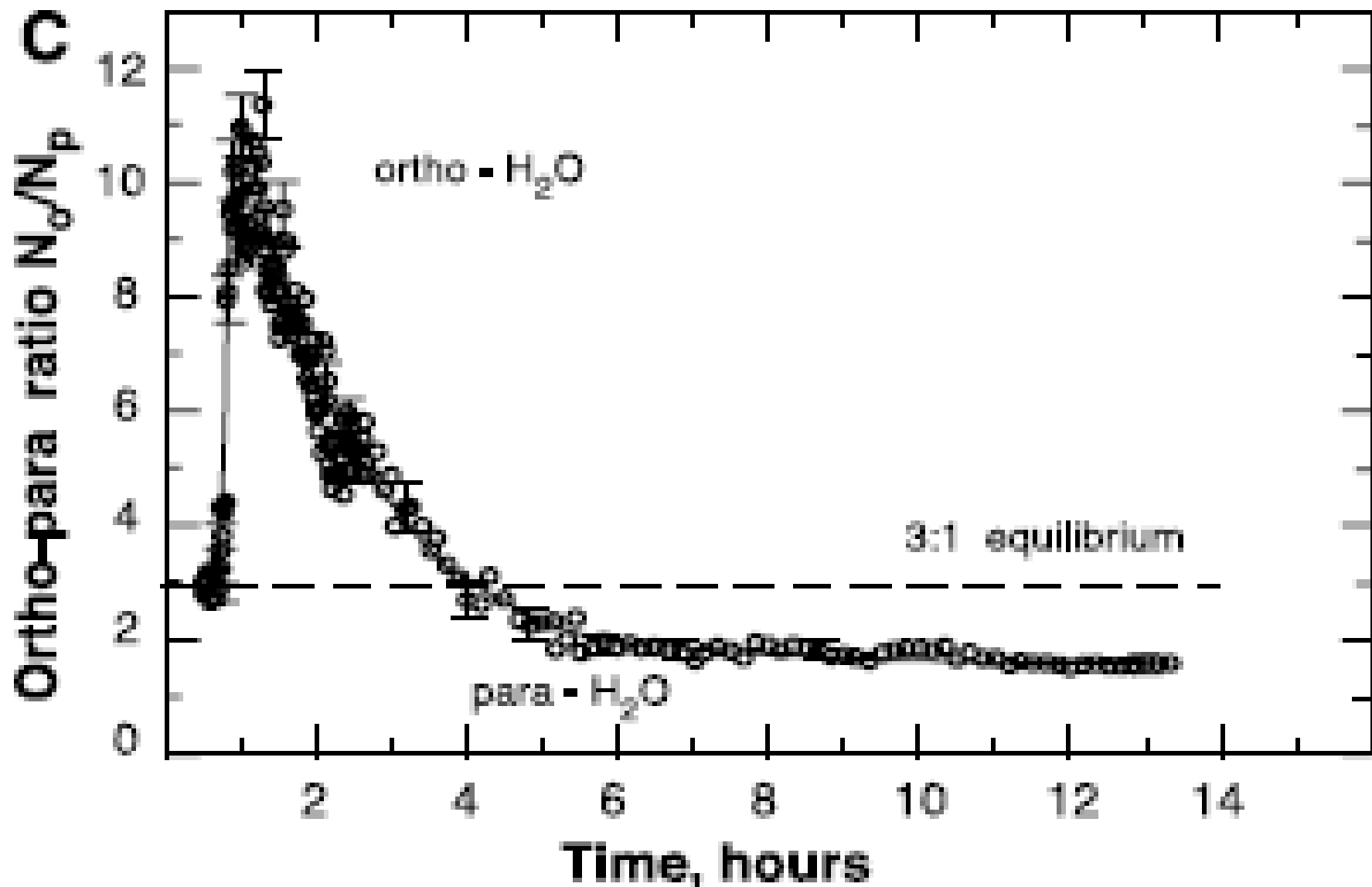
magnetic

Para-

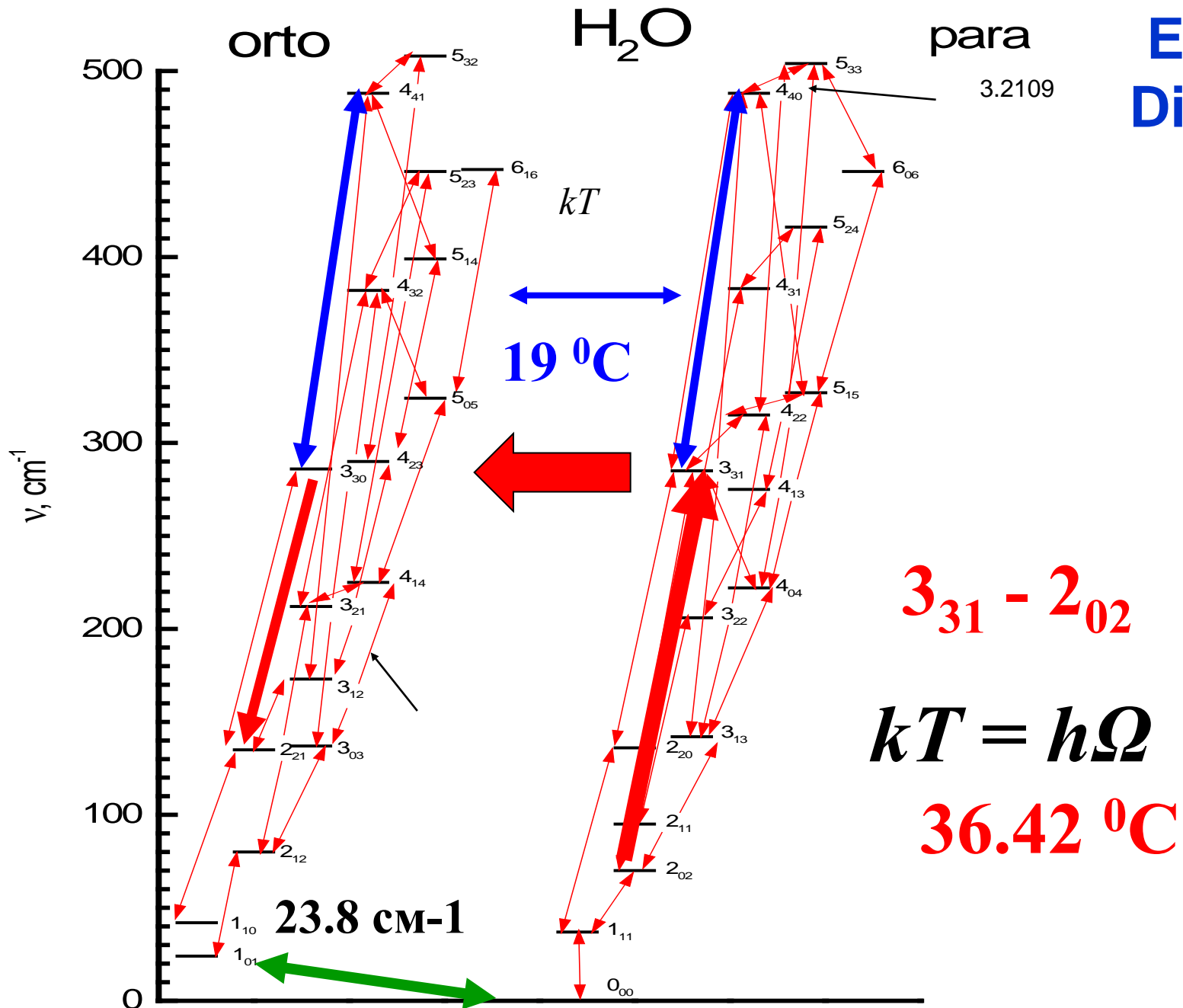
Spin $J=0$



non-magnetic



Energy Diagram



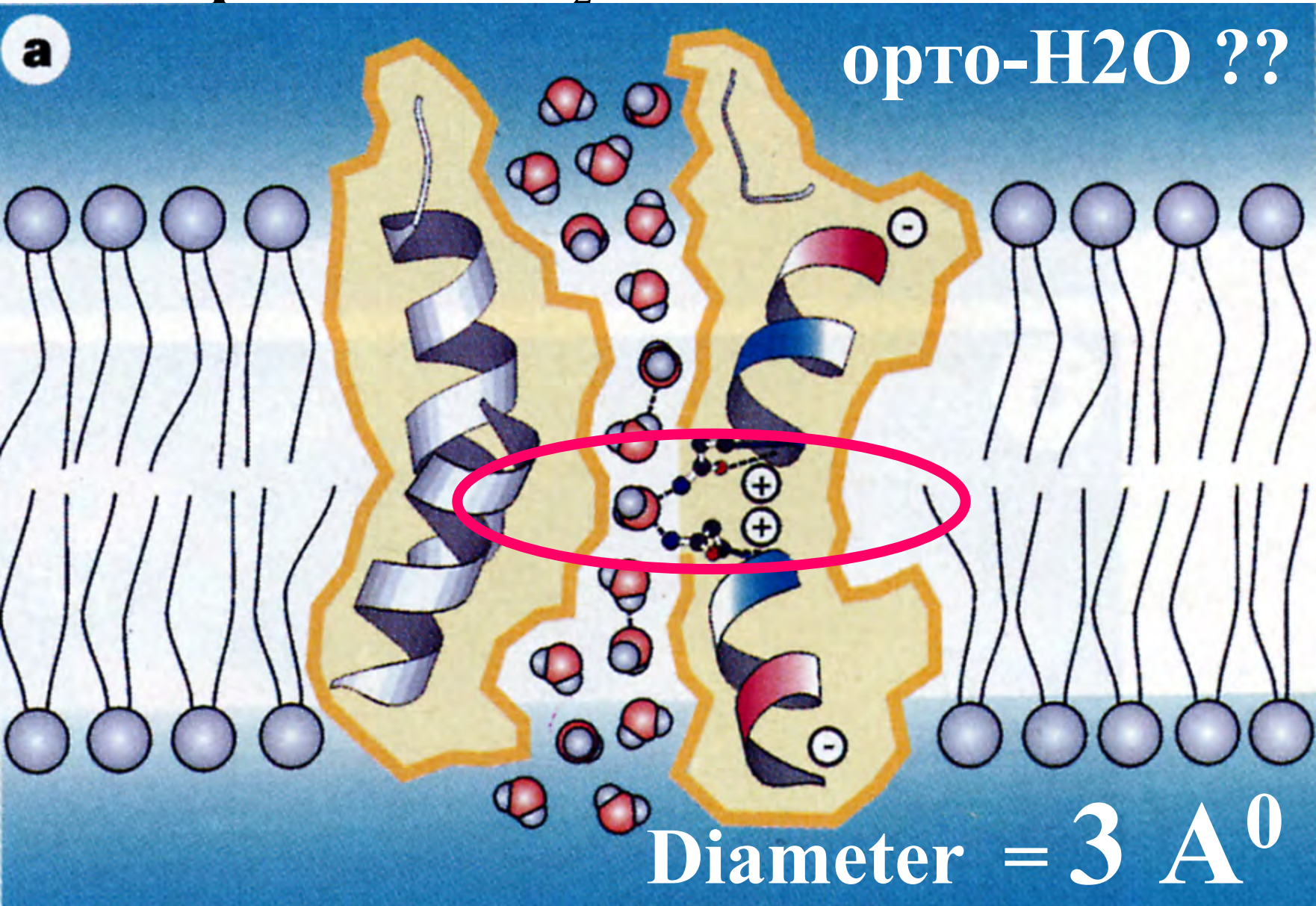
**Is monomer H_2O & H_2O_2
in bulk water?? Where??**

**• Let's find
an experimental evidence:
inside ice-like channels**

Pershin S. et al., JETP, 2012

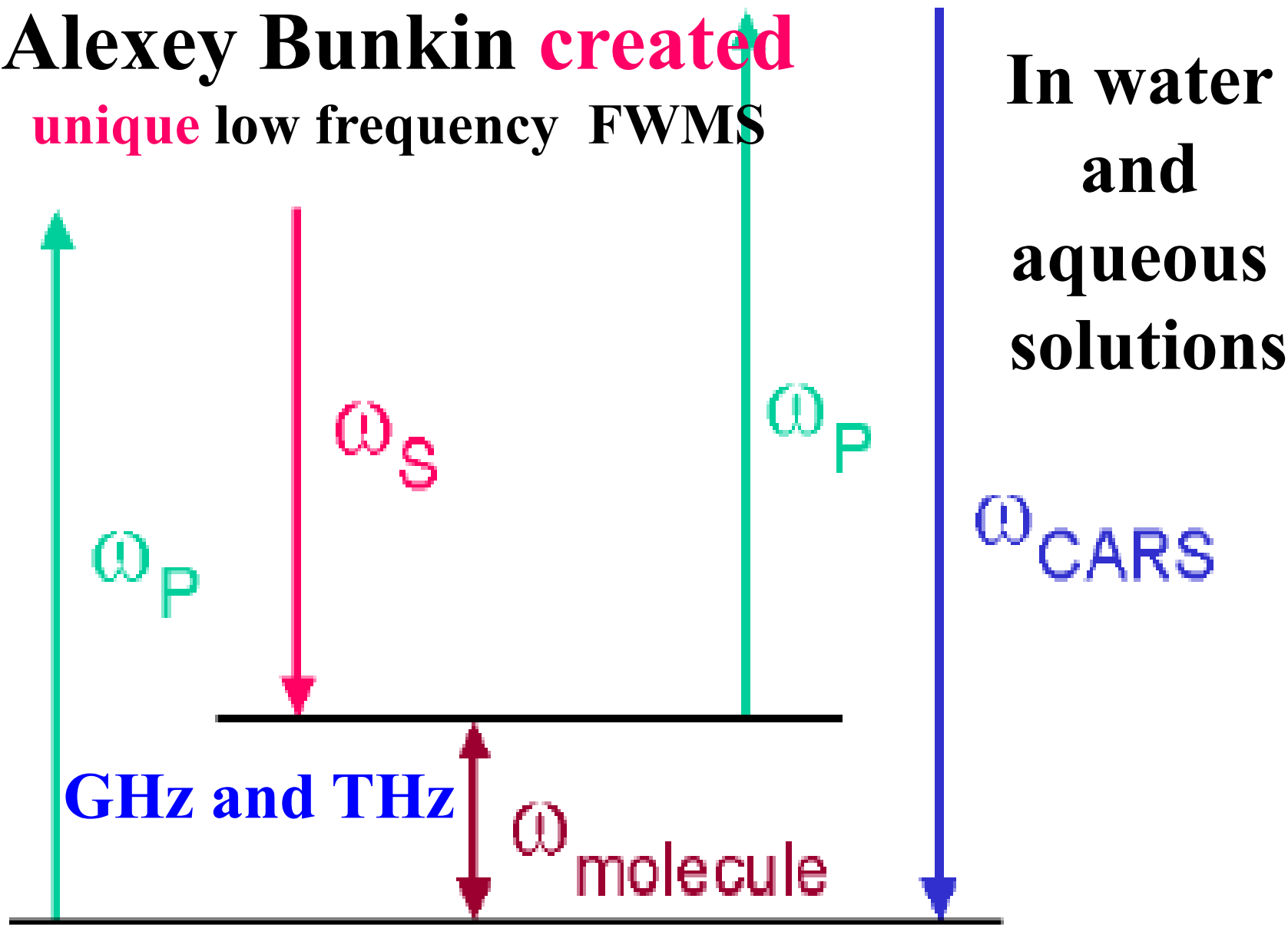
NP P. Agre, 2003, Key factor:

transportation H₂O across channel $3 \times 10^9 \text{ c}^{-1}$



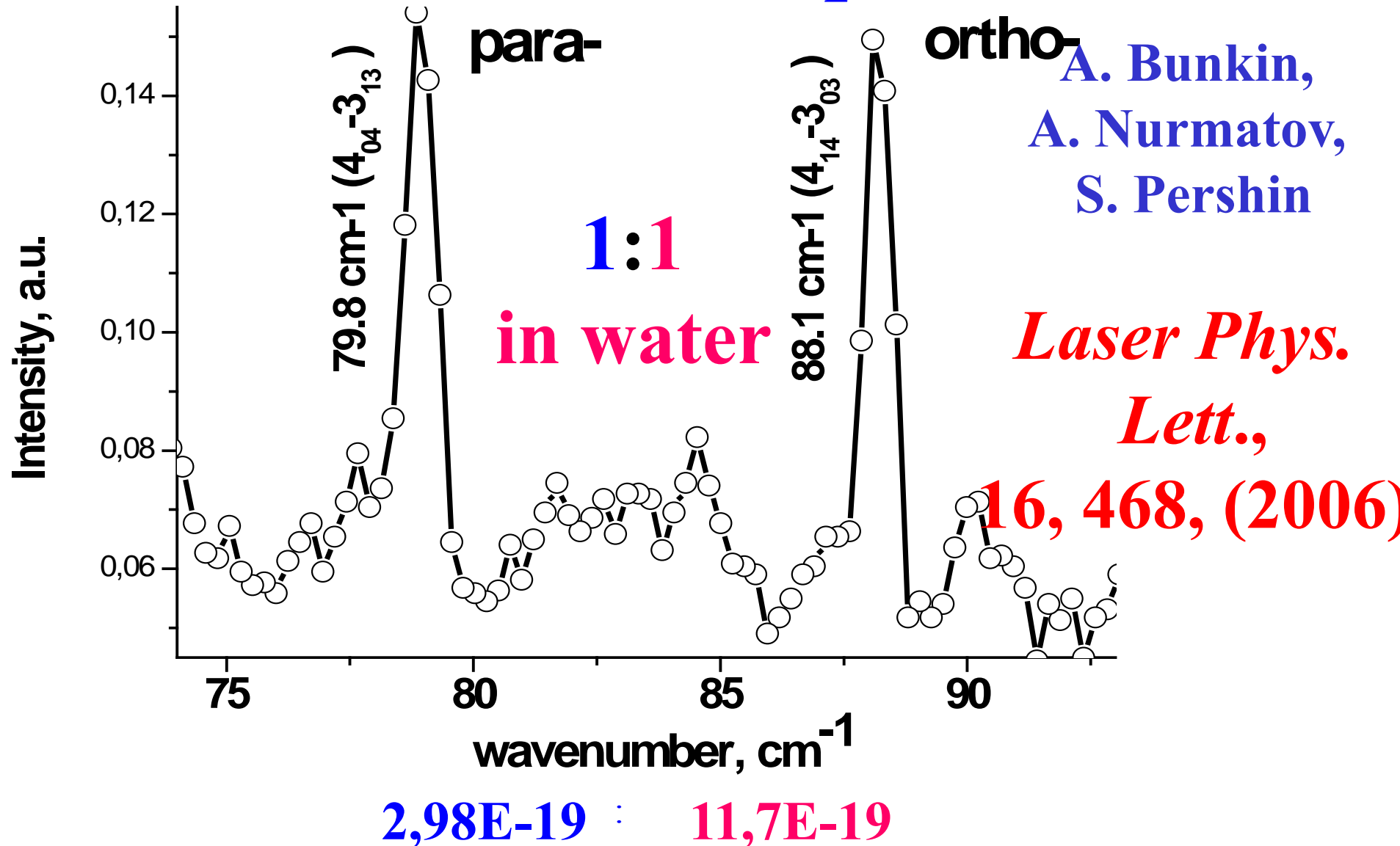
Four-wave mixing spectroscopy

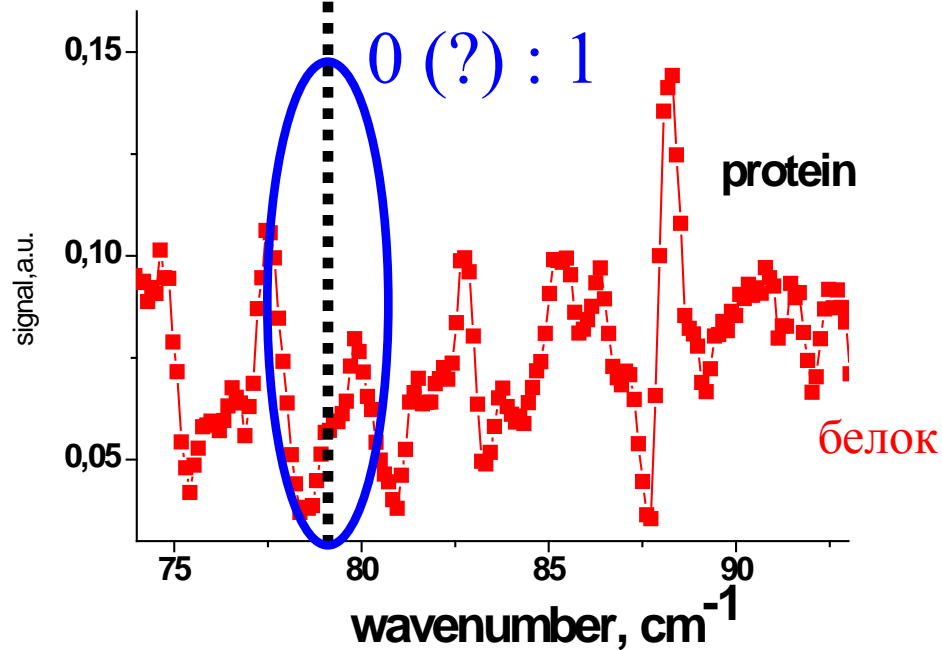
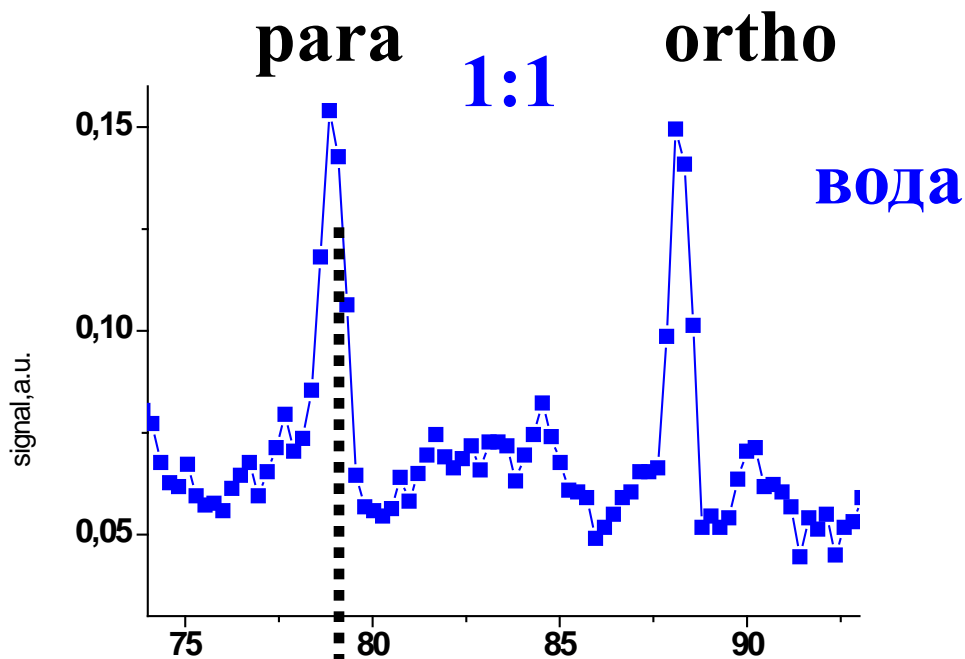
Alexey Bunkin **created**
unique low frequency FWMS



Ortho-para spin-isomer H₂O in water

FWM rotation spectrum

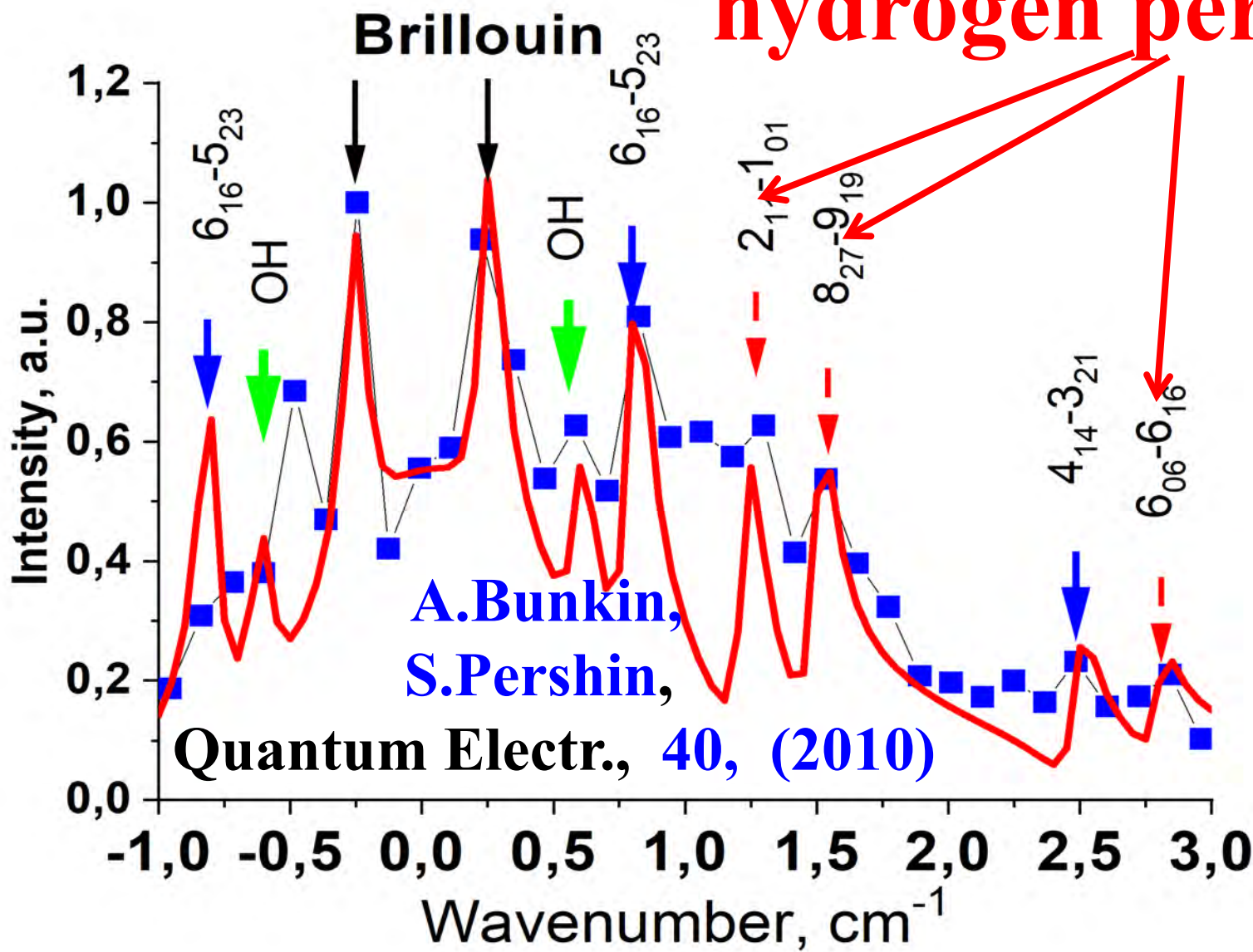




**Selective
interaction
para-H₂O
with protein
due to
formation
of
ice-like
hydration shell**

H₂O₂ generation by ultrasound fountain

hydrogen peroxide



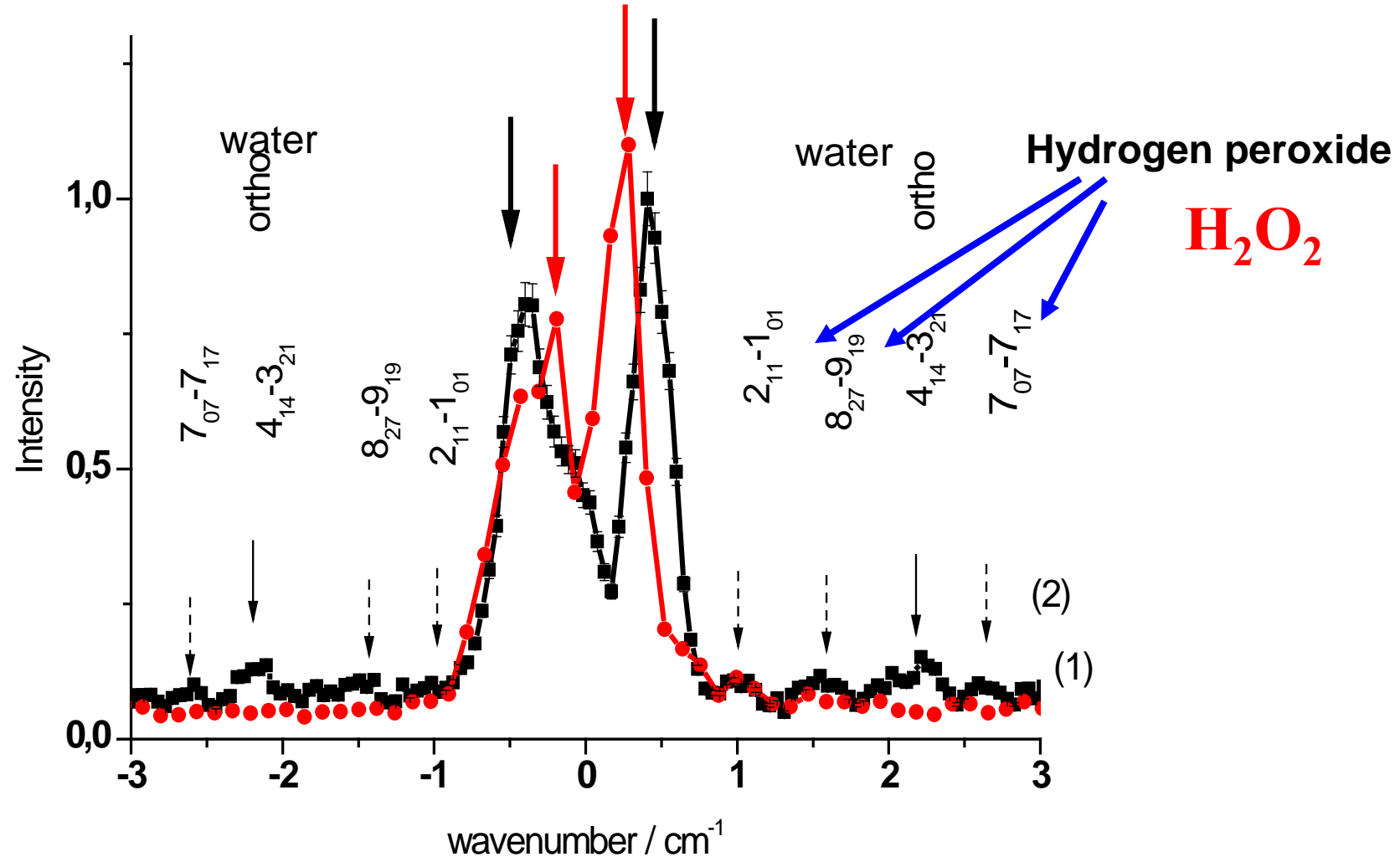


H_2O_2
generation
by
ultrasound
phountain

GHz 4-photon spectra of MQ **water**, **red**,(1) and aqueous protein solution, **black**,(2)

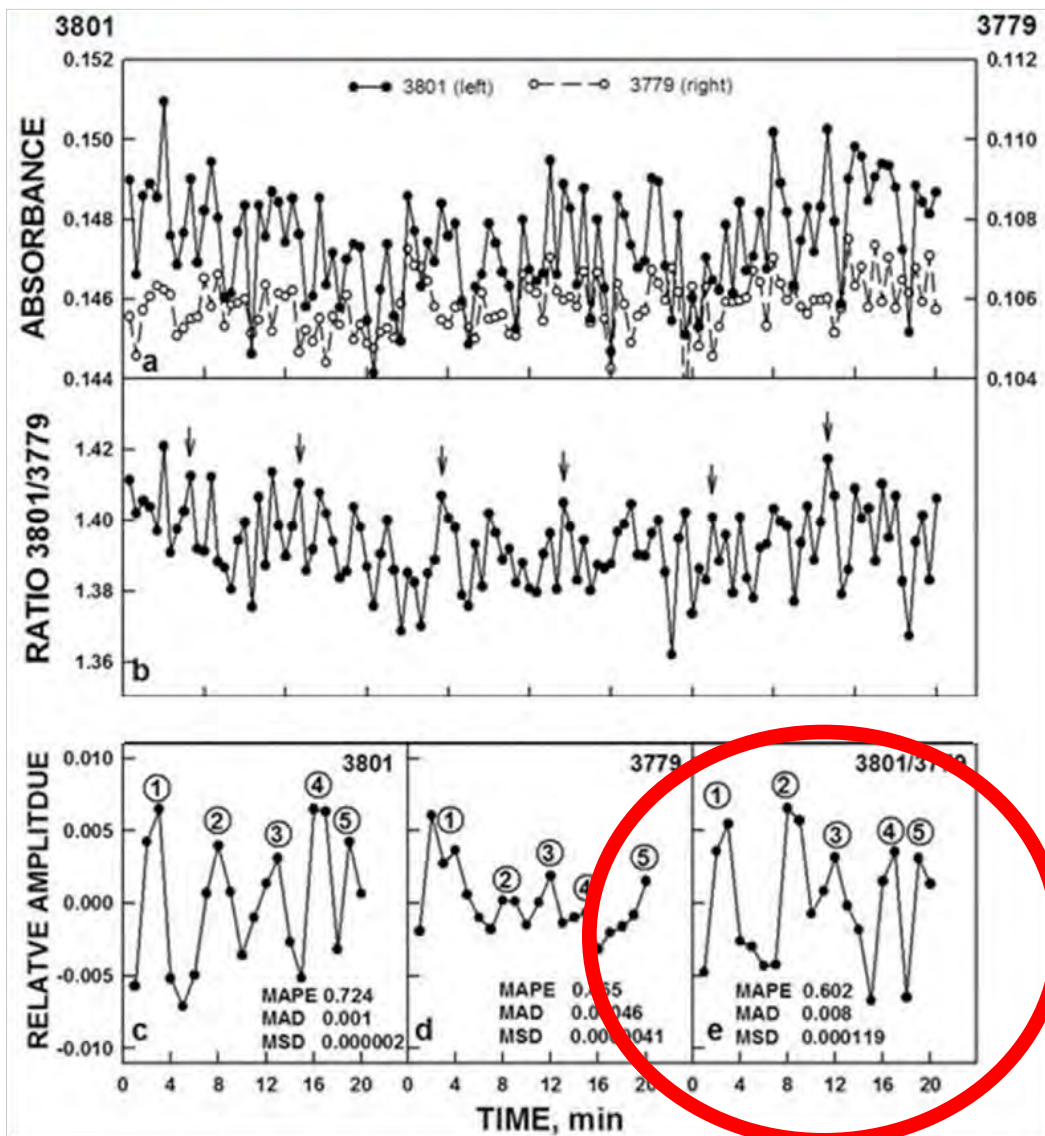
A.Bunkin, S.Pershin, Quantum Electr., 39(7), (2009)

(VS)²=(ρKS)-1, where *KS* is adiabatic compressibility



Experiment: ΔfB = ± 0.25 cm-1 for water, and ΔfB = ± 0.4 cm-1 for protein solution

OSCILLATIONS IN ORTHO-PARA HYDROGEN SPIN PAIR RATIOS OF WATER BY FTIR



**Ortho:
3801 cm-1**

**Para:
3779 cm-1**

Where the H₂O can free rotate in water as in a gas???

1. Inside of icelike channels in water and hydration shell also

2. Pershin S., Bunkin A., Golo V.,
H₂O monomers in channels of icelike water structures,
JETP, 115, 1008–1011 (2012).

3. Udo Buck et al. *Science* 337 (6101) 2012

PRL 101, 036101 (2008)

PHYSICAL REVIEW LETTERS

week ending
18 JULY 2008

Experimental Evidence for Ice Formation at Room Temperature

4.

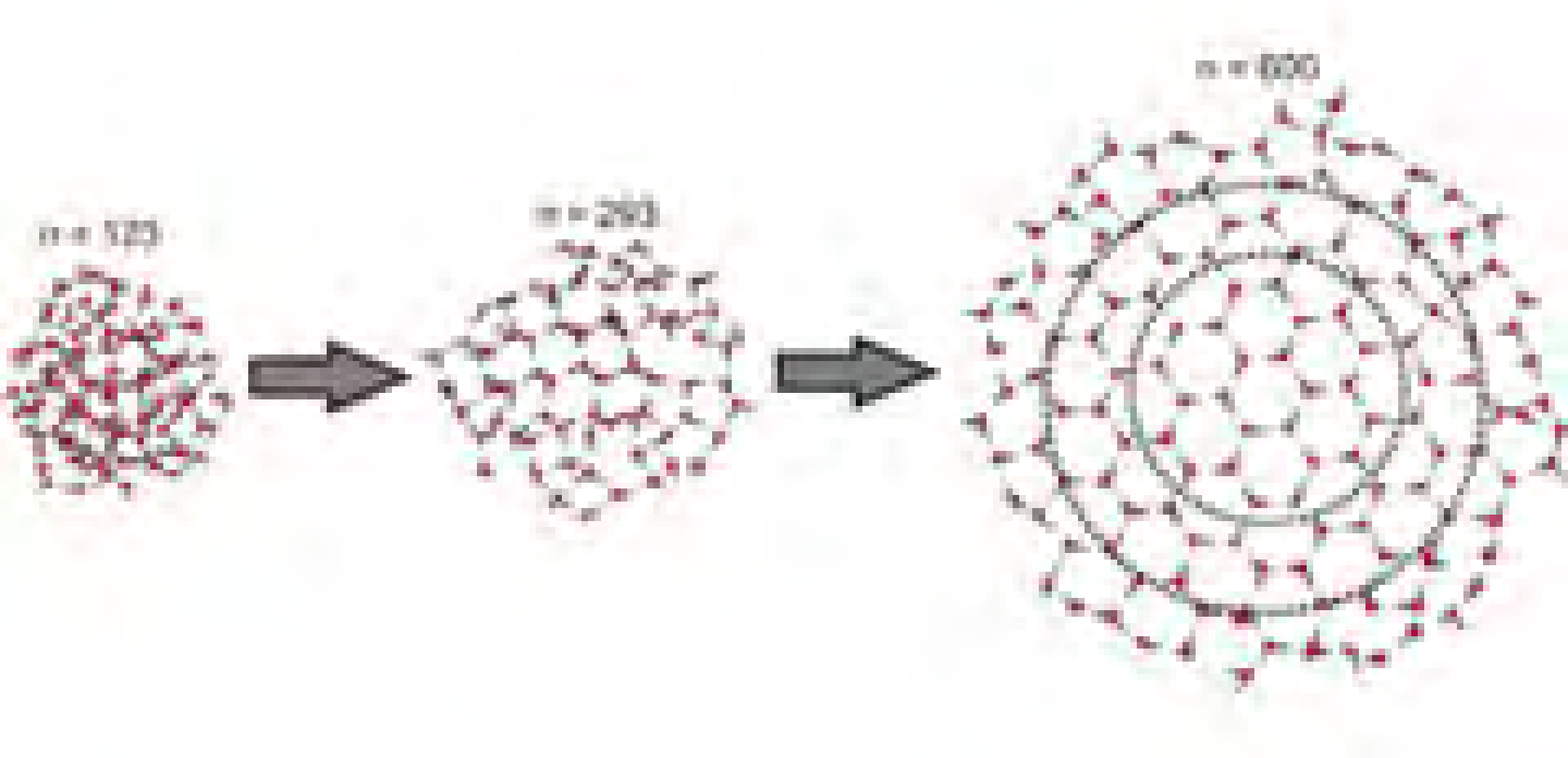
K. B. Jinesh^{*,†} and J. W. M. Frenken

Kamerlingh Onnes Laboratory, P.O. Box 9504, Leiden University, 2300 RA Leiden, The Netherlands

(Received 4 March 2008; published 15 July 2008)

Ice-like structure in water

Udo Buck et al. *Science* 337 (6101) 2012:



Does Magnetic Treatment of Water Change Its Properties?

I. Otsuka and S. Ozeki*

THE JOURNAL OF
PHYSICAL
CHEMISTRY B
LETTERS

2006, 110, 1509-1512

CaCO₃

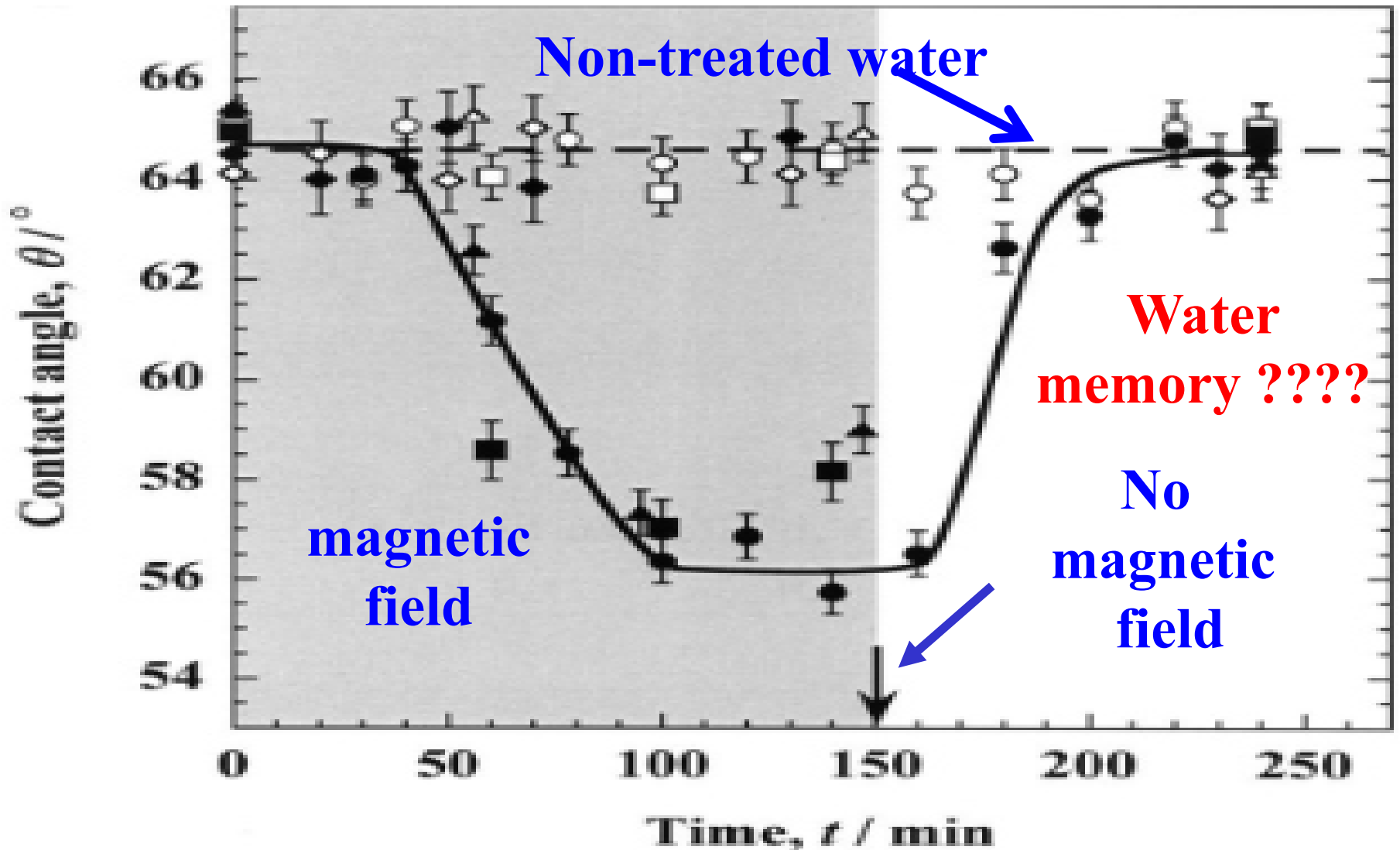


5mm
Non-treated water
(NMT)

Magnetically treated water
(MT)



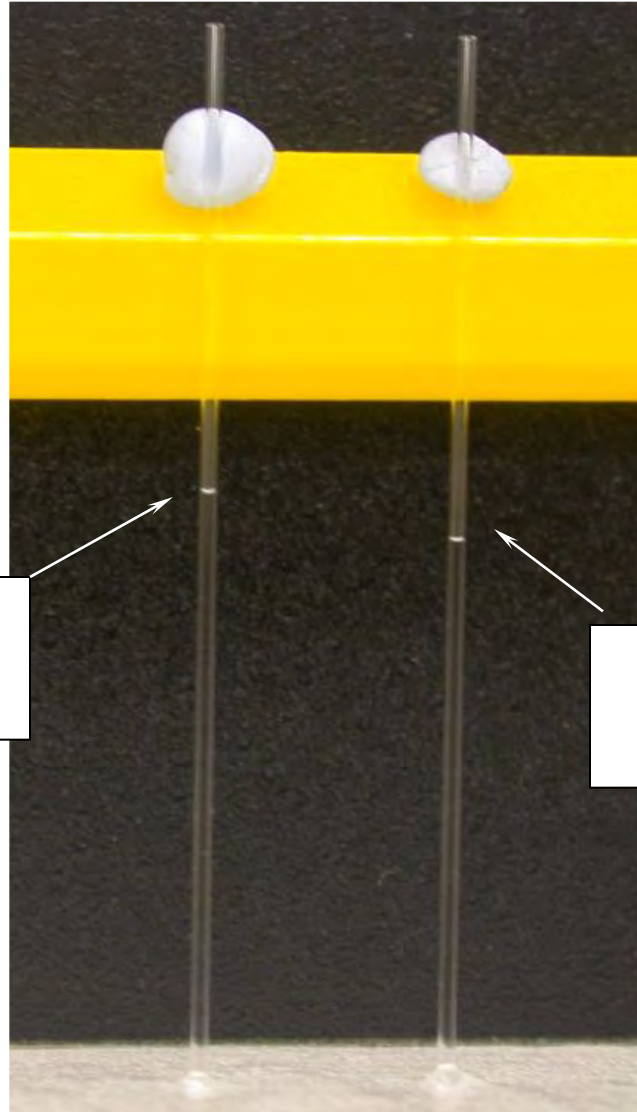
Contact angle evolution of magnetically treated water



SIMPLEST SURFACE TENSION EXPERIMENT

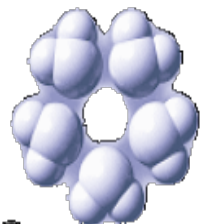
$$h = (2\sigma \cos\theta) / (r\rho g)$$

$$r = 0.4 \text{ mm}$$



**Cavitation
Water**

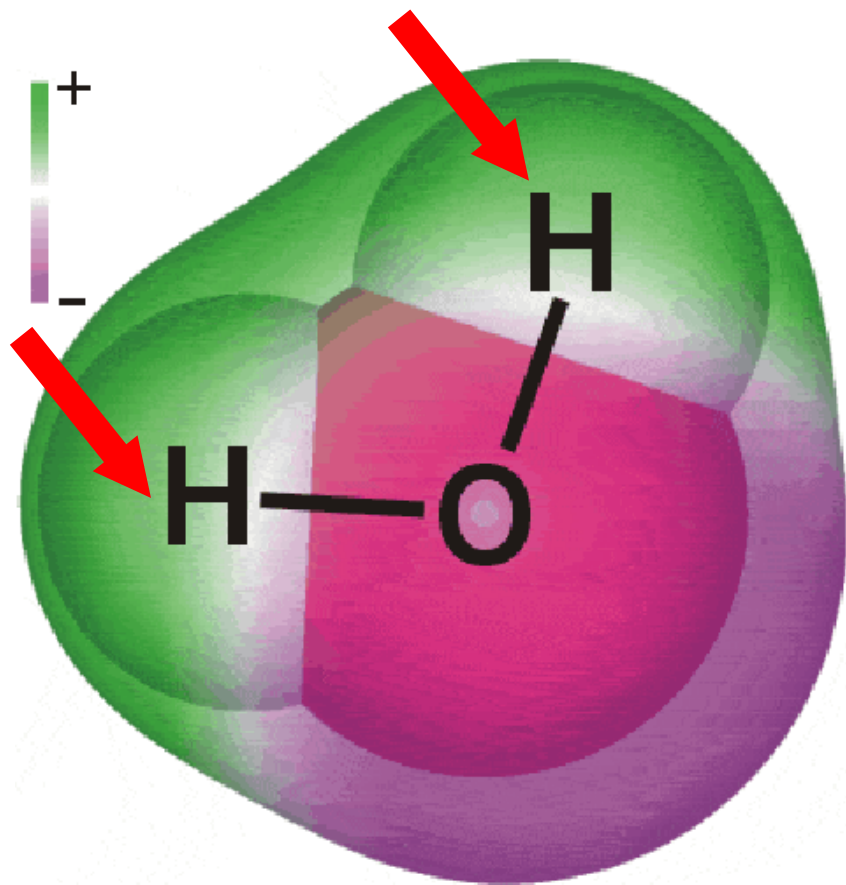
**Unprocessed
Water**



H₂O spin isomers

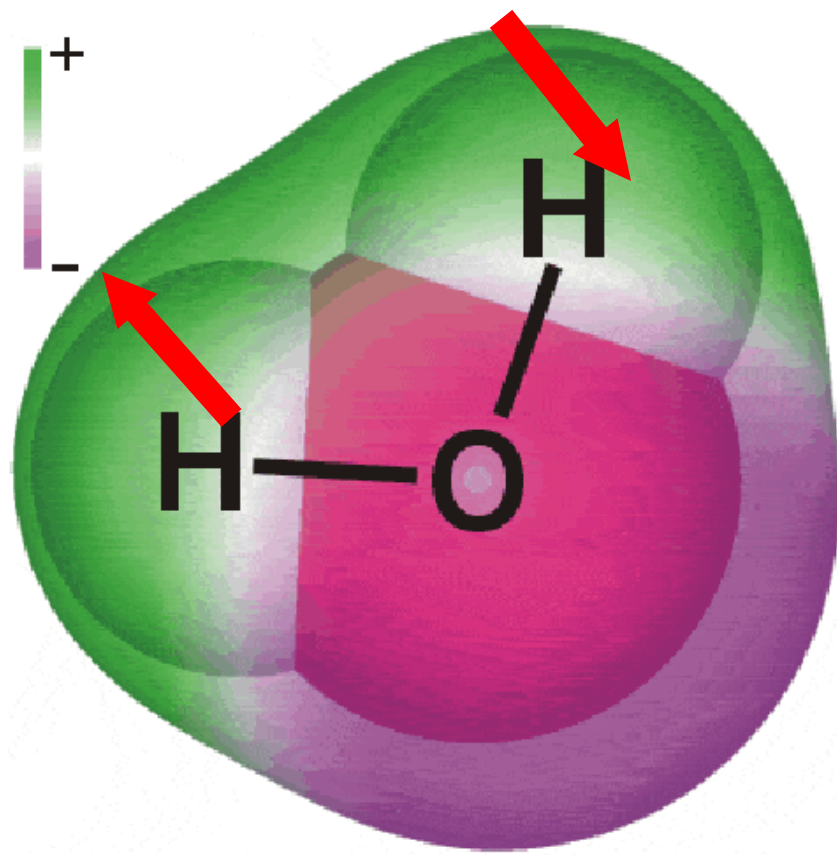
Ortho-

Spin $J=1$



Para-

Spin $J=0$



magnetic

non-magnetic

**Water samples and MRT-
diagnostic by tomograph
«Bruker» *in***

*Center of magnetic tomography
and spectroscopy*

MSU (Yu. Pirogov)

(21 МГц, B = 0.5 Тл)

MRT
in
 T_1
units



Water samples before MRT diagnostics



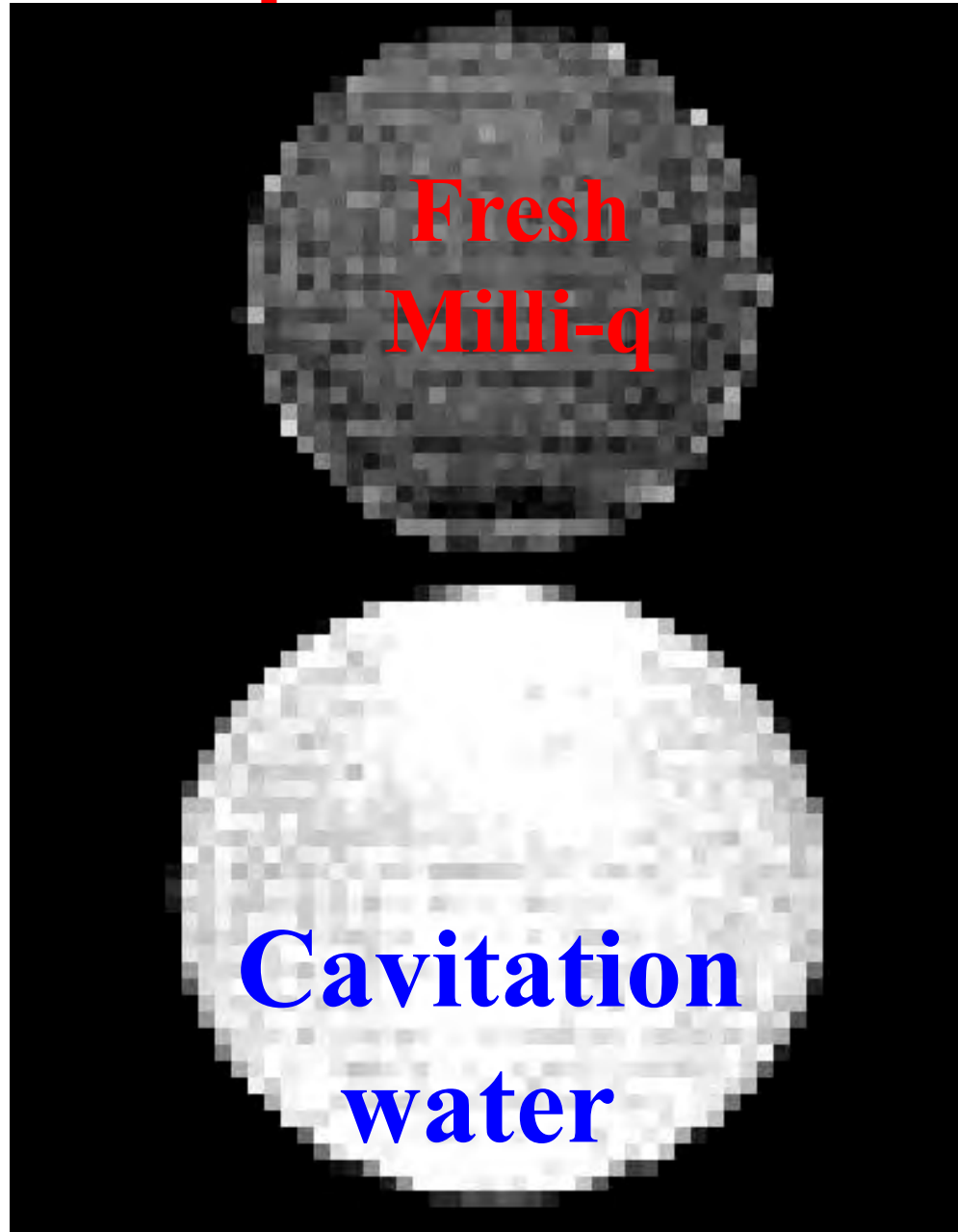
500 mL

Water samples in tomograph



MRT: **Milli-q** and **Cavitation-water**

<

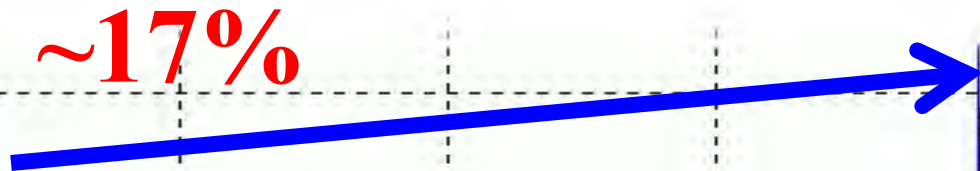


in unit
of
proton
density

**Cavitation
water**

enhancement of Cav-water by ortho H₂O

~17%



**and
H₂O₂ ?**

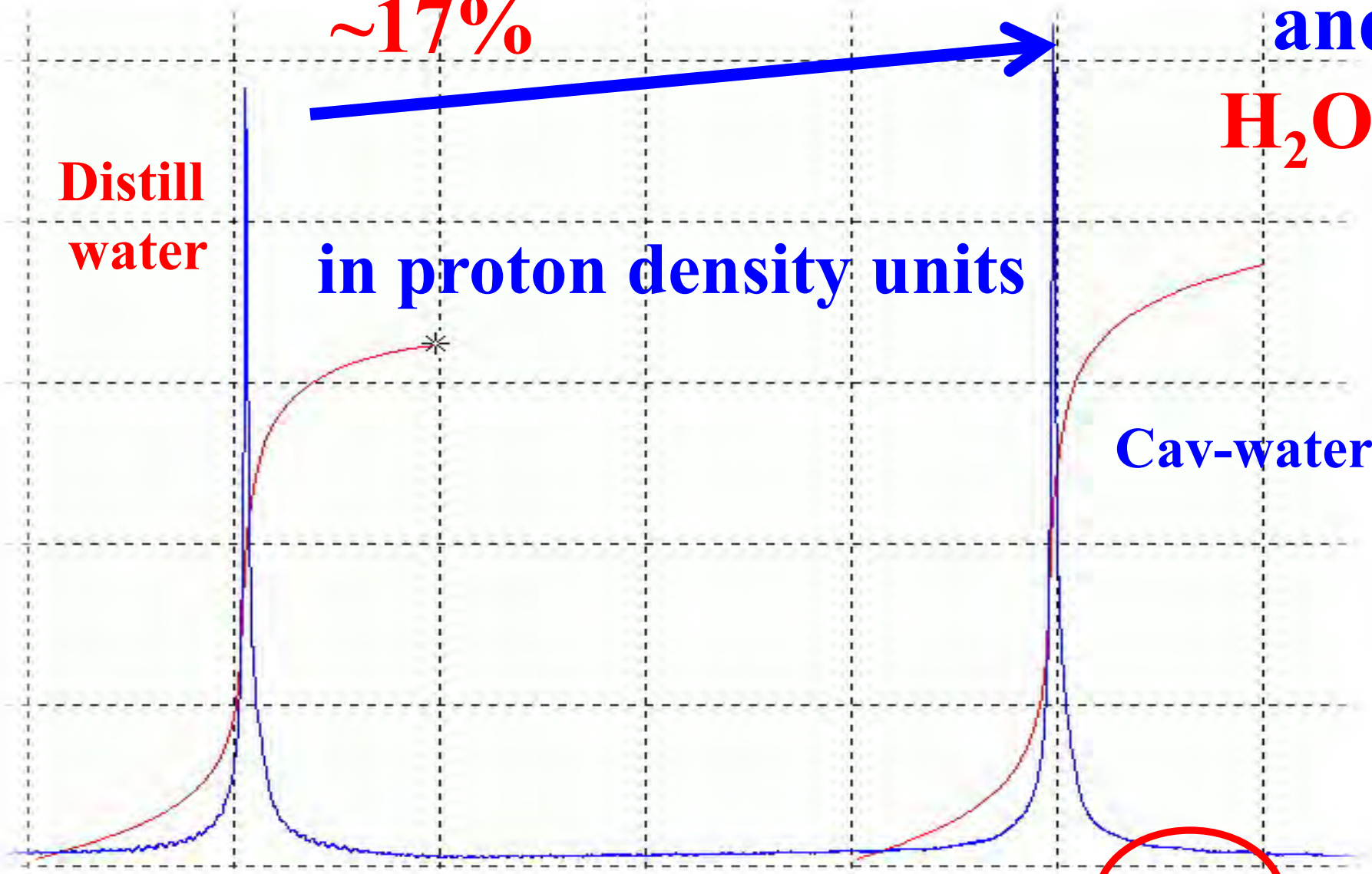
**Distill
water**

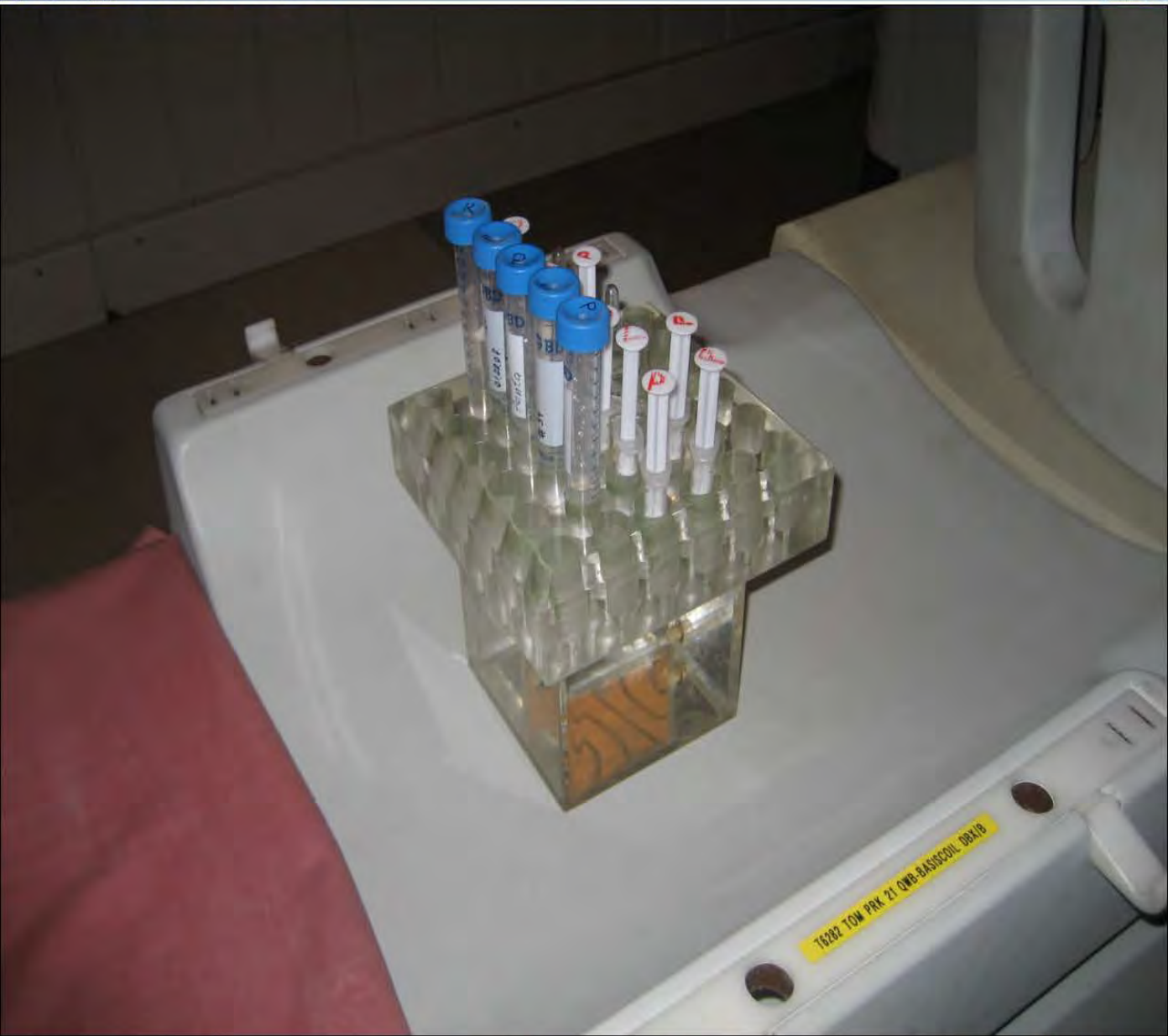
in proton density units

Cav-water

Интеграл=1

Интеграл=1.1572

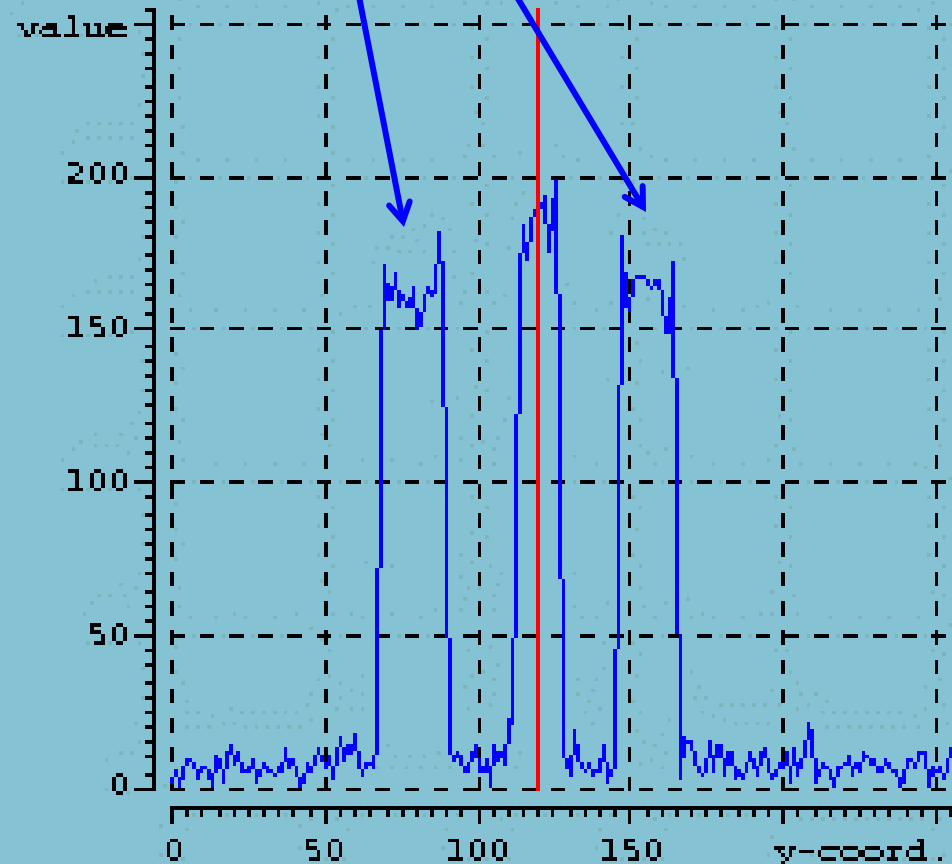
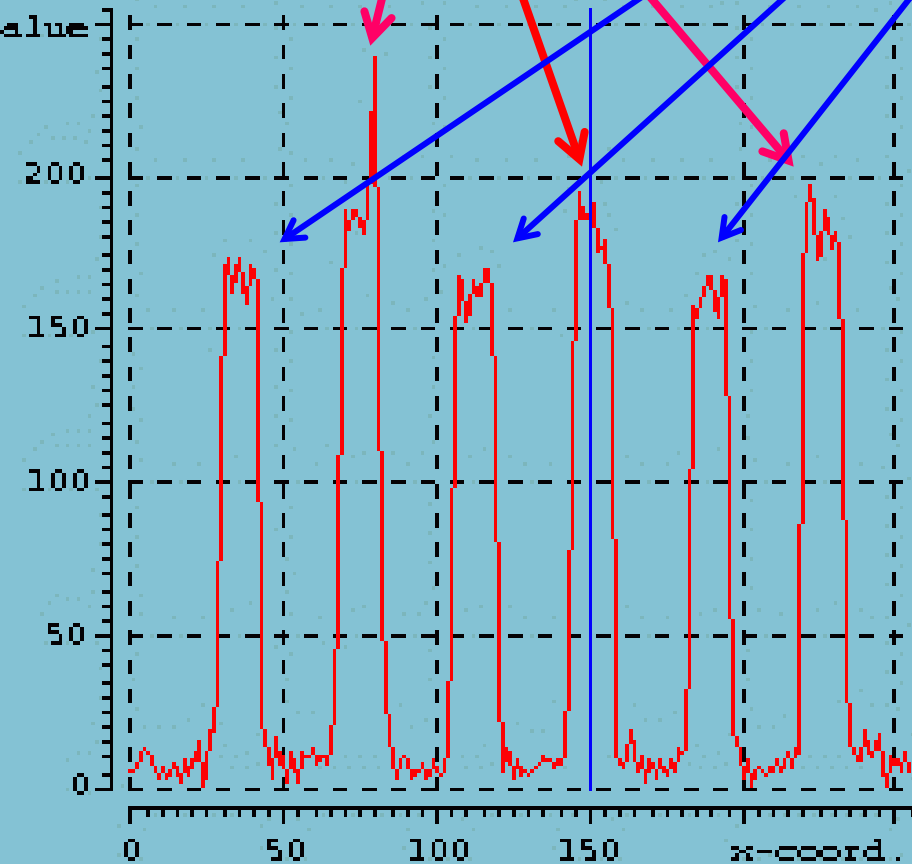




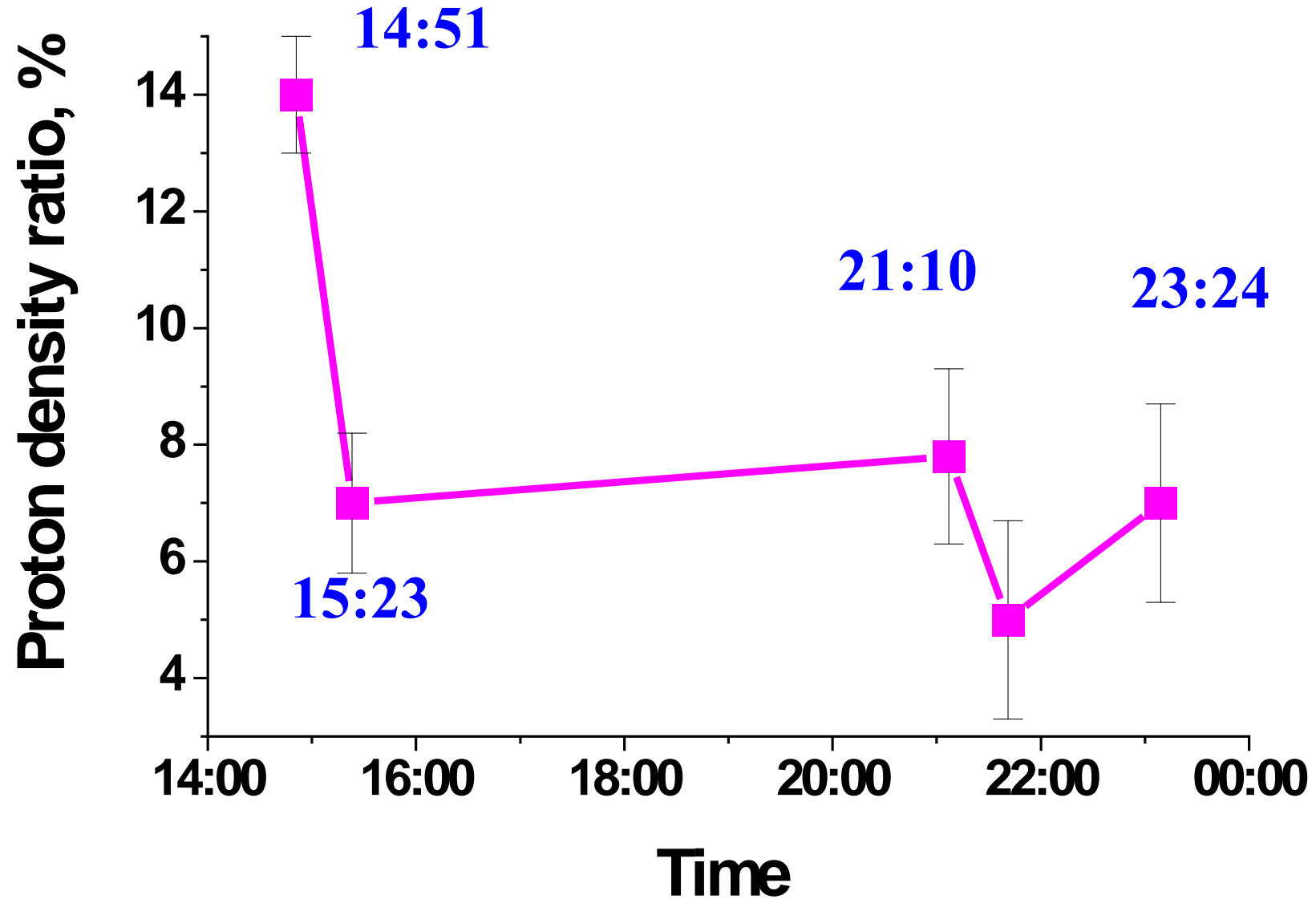
MRT – diagnostic of water samples (Anisimov N.V.)



MRT-diagnostics of Distill and Cavitation – water

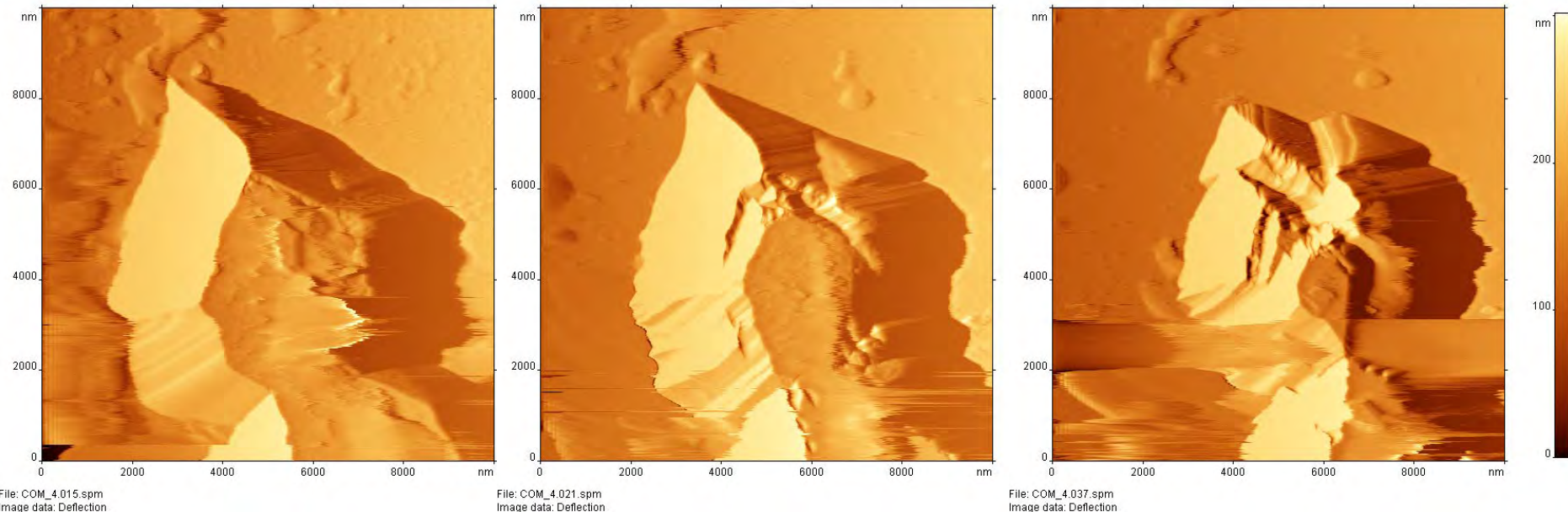


Enhancement **reduction** vs MRT sets



Dynamics of Dissolving Calcium Oxalate Monohydrate Crystal in Cavitation Water

10 μm



6

49

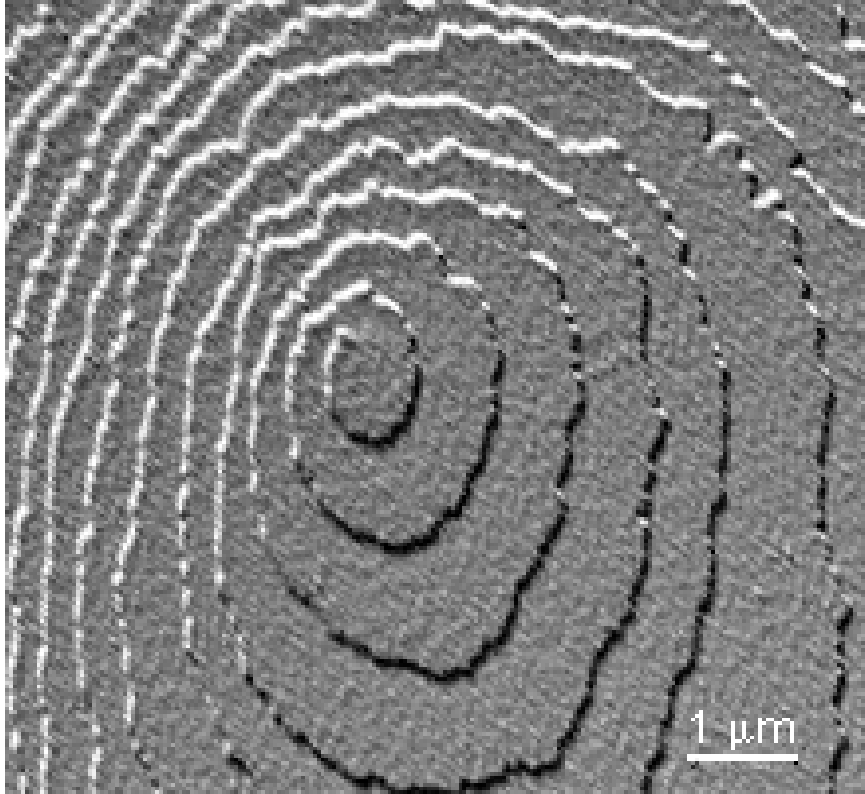
121 min

Atomic force microscopy

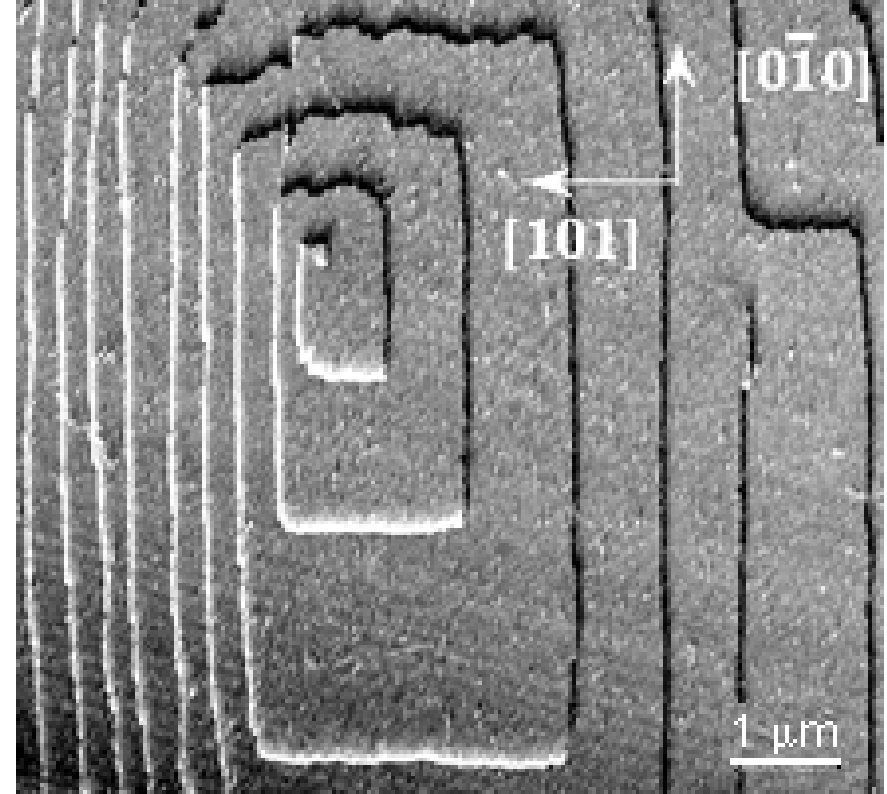
Water flow is 125 $\mu\text{l}/\text{min}$ through the flow-cell ($V=25 \text{ mm}^3$)

Dr.Rashkovich, Moscow University, Departments of Physics, November 2002

Lyzosyme crystal growth in Cav-water



in Cavitation water



in distilled water

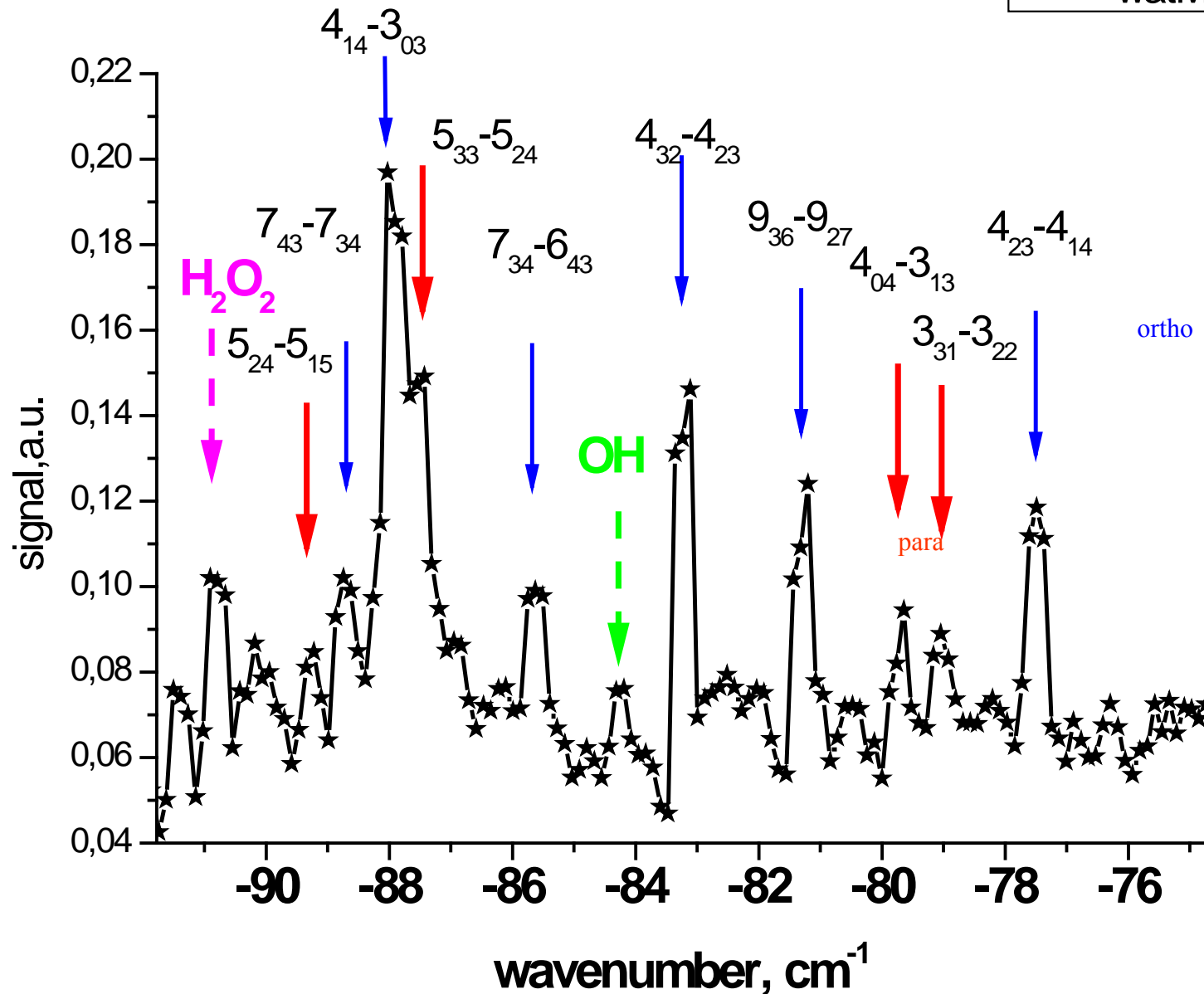
Conclusion

1. H_2O and H_2O_2 exist in water as free rotation monomer: Ortho (magnetics) and para (non magnetics) spin-isomers;
2. 15% ortho enhancement due to water cavitation, ultrasound fountain
3. By experimental evidence: **aqua-channel**
4. 4-wave mixing spectroscopy
5. magnetic treatment of water
6. **and MRT diagnostics**
7. **icelike structure in water**

**Thank you
for
attention**

4-photon spectrum of water

—★— watMQ



Milli-q

**Cav-
water**

Distill

MRT images:

Milli-q

Cavitation

Дистиллят

ВОДЫ



Введите вопрос

Конструктор Создать слайд

Разметк

Применить разметк

Макеты текста

Макеты содержимого

EEG

Density

H 100

L 0

3 4

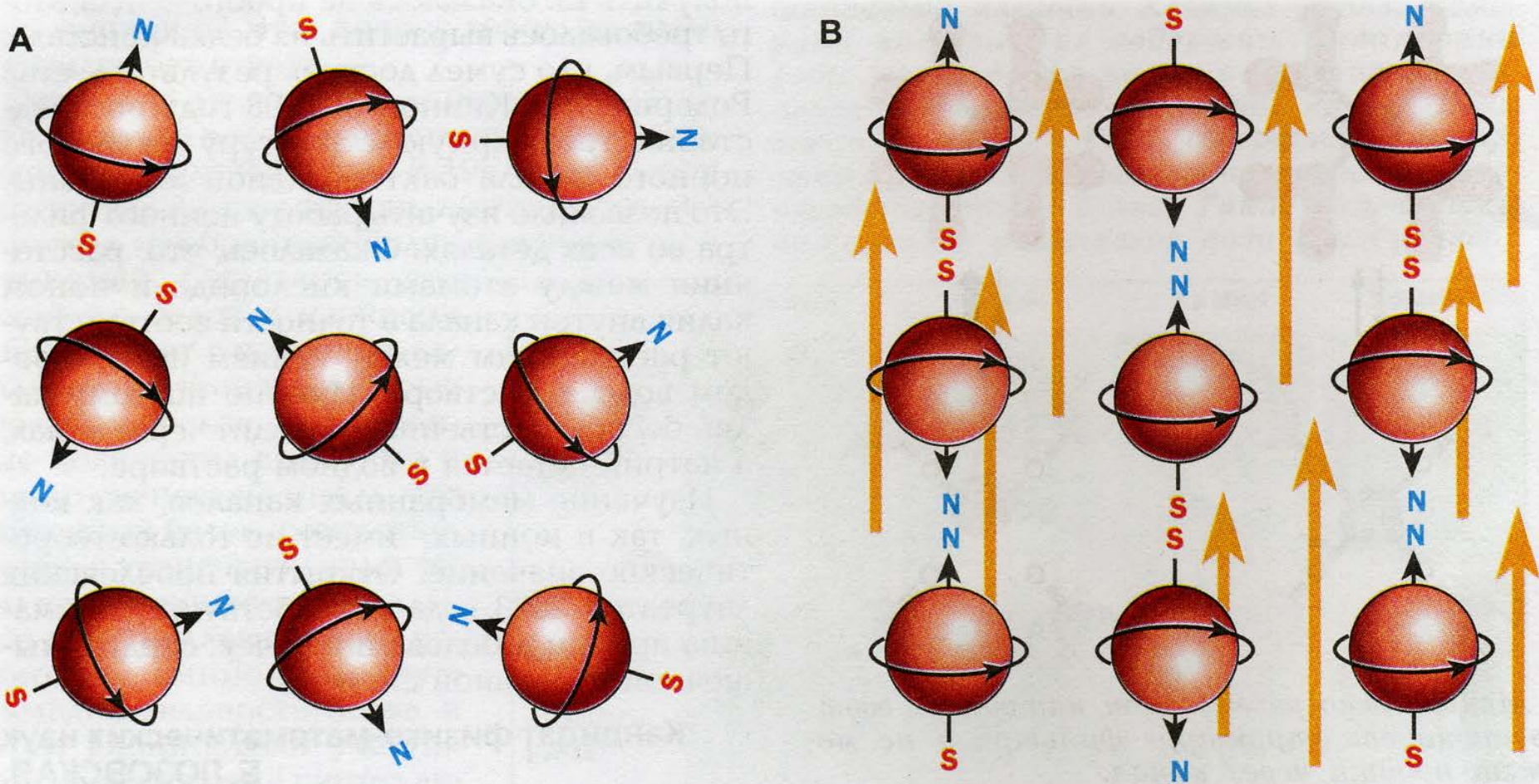
Z 0

0

S 5

Показывать при вс

Принцип МРТ



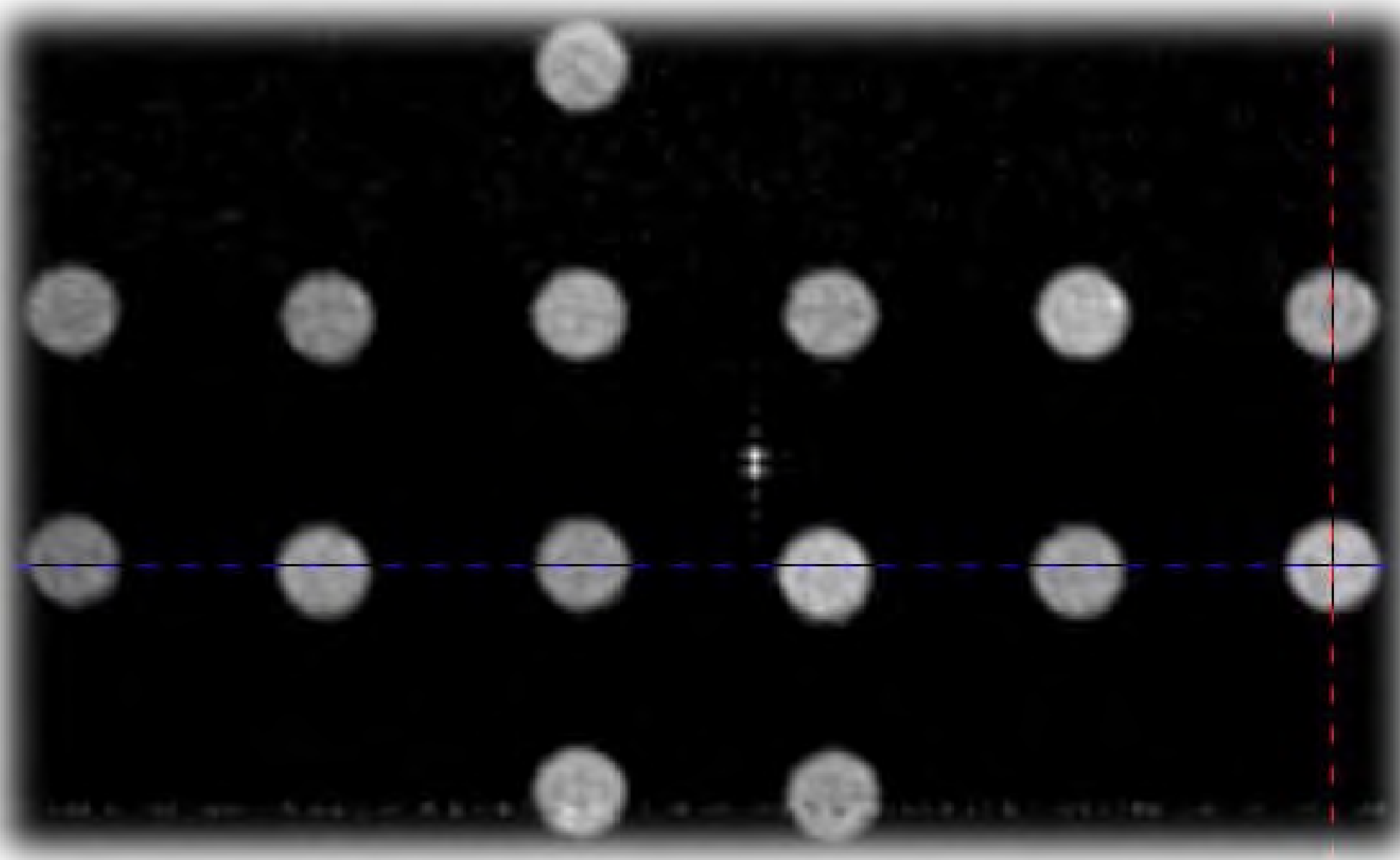
протоны без М-поля

протоны в М-поле

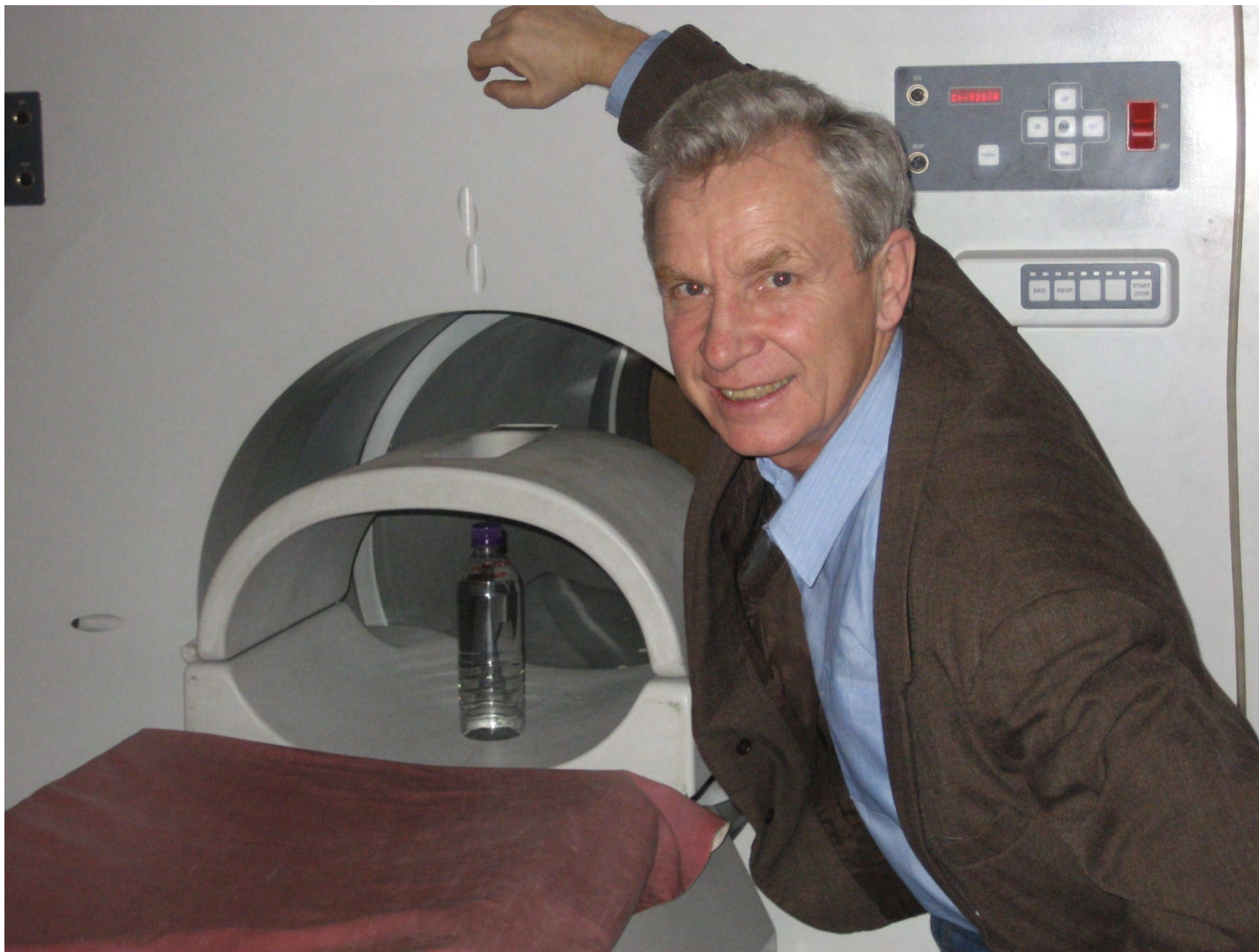
Сигнал ЯМР-спектроскопии воды определяется протонной плотностью (или орто-изомерами H_2O : $J=1$)

- Бломберген, Парселл и Паунд
- (Phys. Rev. 73, 679, (1948))
- Bloembergen N. *Dissertation*, Utrecht, 1948,
- *Ядерная магнитная релаксация*
- Bloembergen N. *Phys. Rev.* 75, 1326 (1949)
- *Тонкая структура спектра протонного магнитного резонанса в $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.*
- А. Лёше, *Ядерная индукция*, М., 1963г., 684.

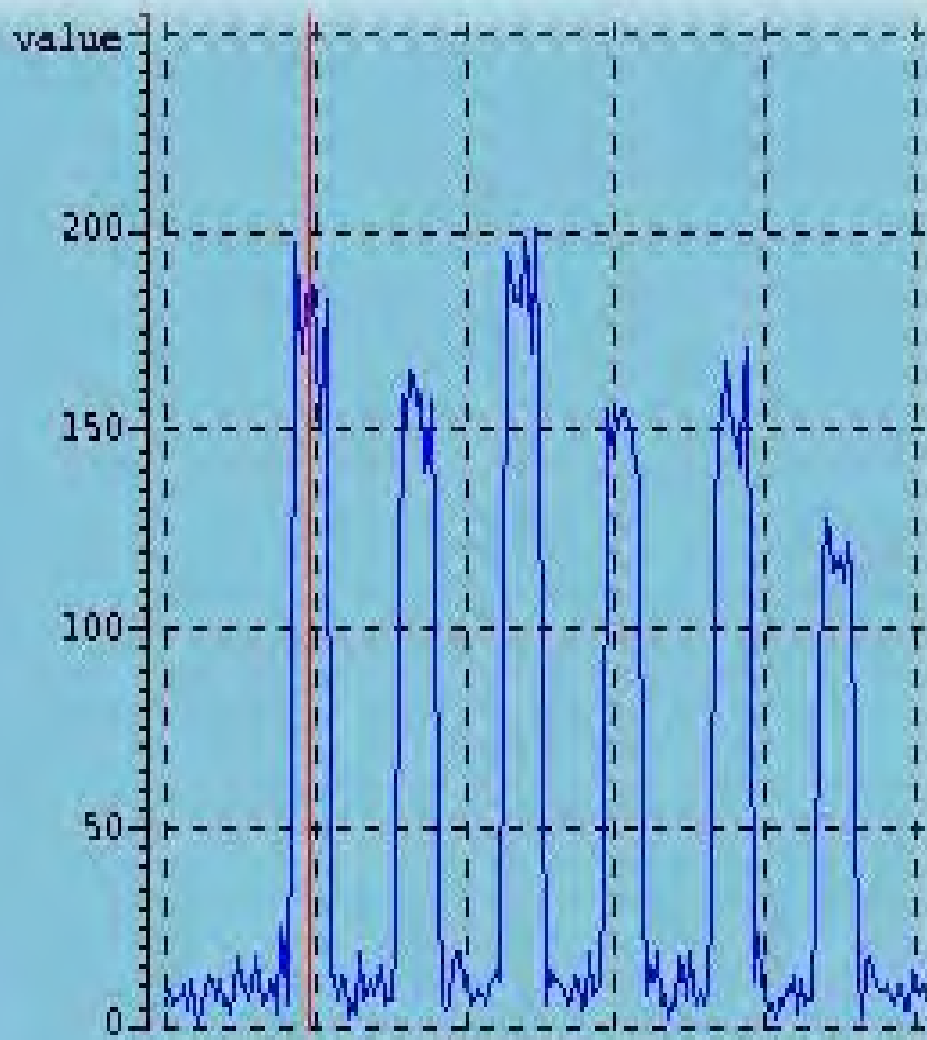
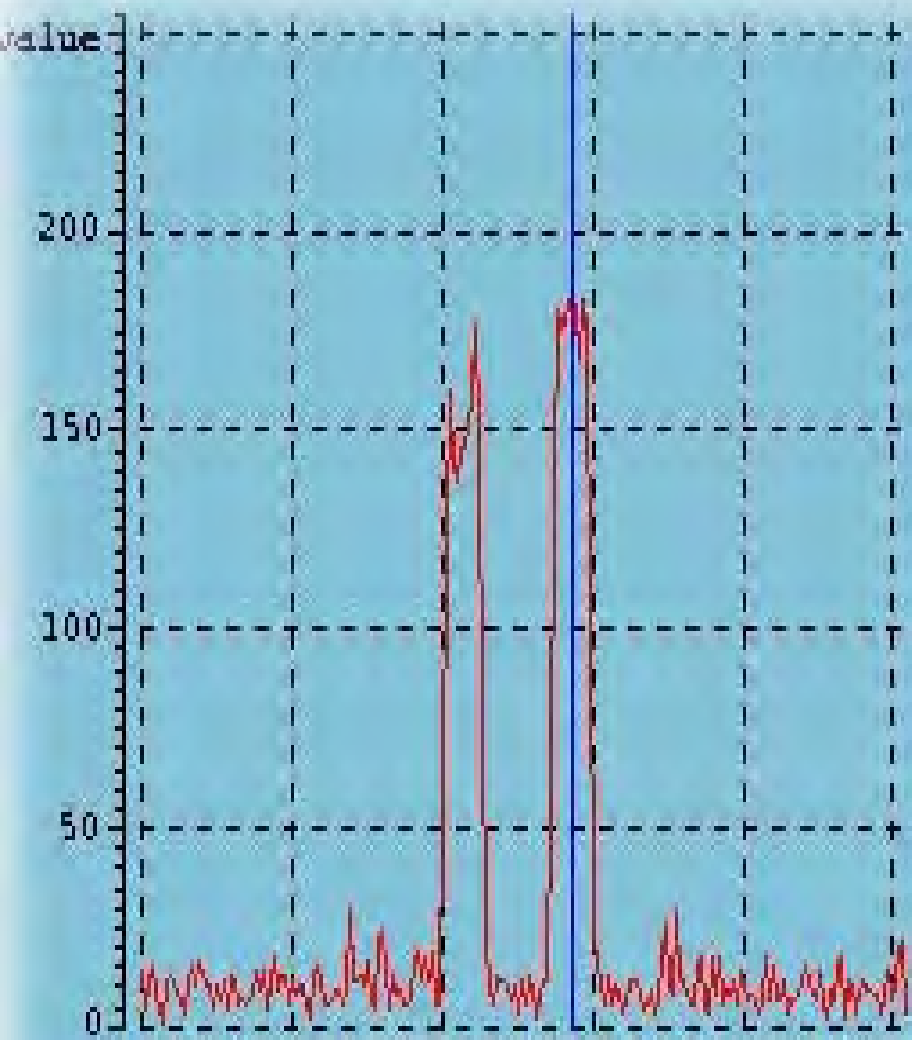
Изображение Дист. и К-воды 29.11.07



**Измерение протонной плотности К-воды
15 февраля 2008 на «Bruker»**

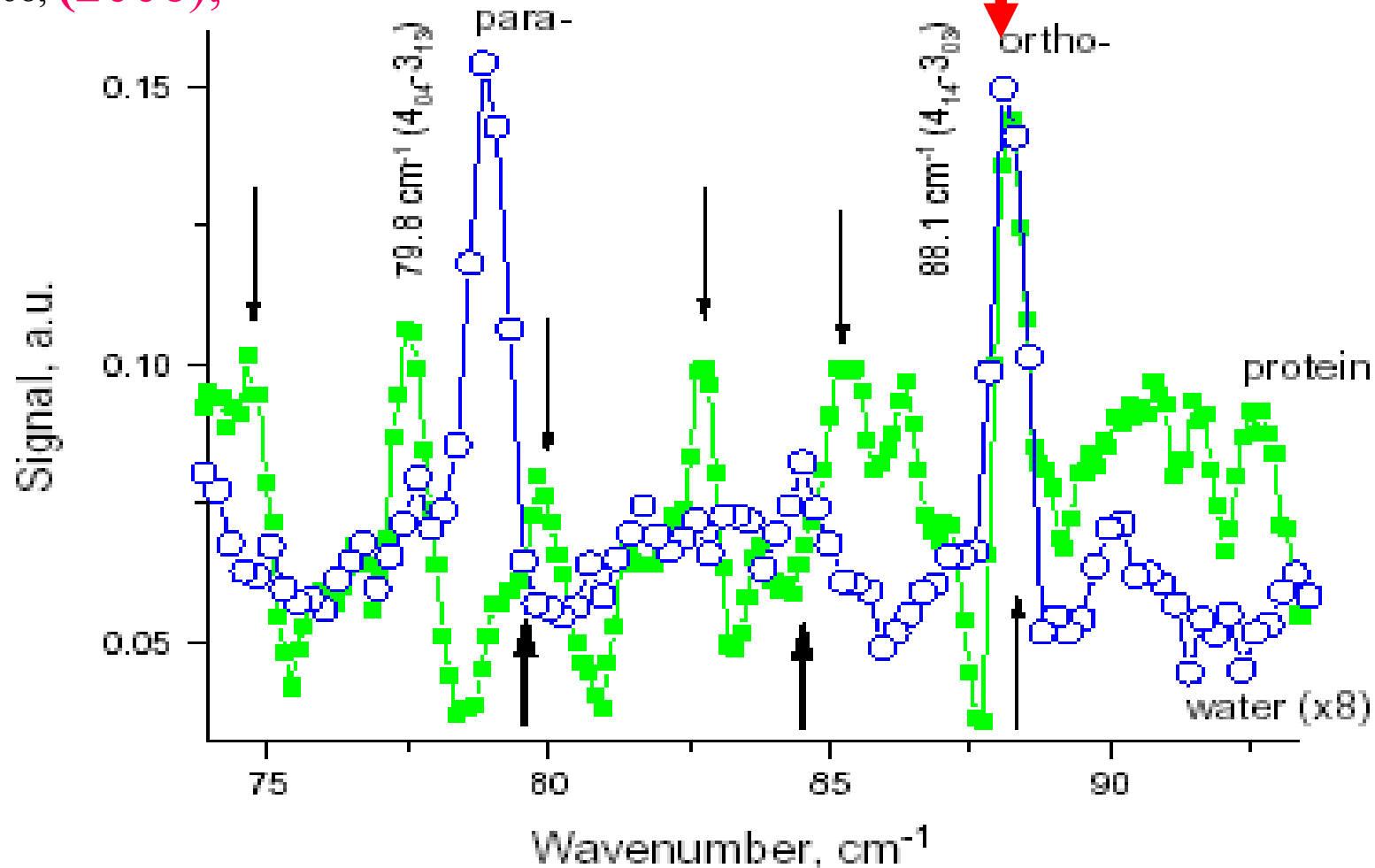


МРТ интенсивность Д-воды и К-воды после первого измерения 29.11.07



Селективное **обогащение** воды *орто-изомерами* в растворе белков

A.F. Bunkin, A.A. Nurmatov, S.M. Pershin, Four-photon spectroscopy of *ortho/para* spin-isomer H₂O molecule in liquid water in sub-millimeter range, *Laser Phys. Lett.* 16, 468, (2006);



МРТ
В
единицах
T2



МРТ-изображение сечений образцов воды

