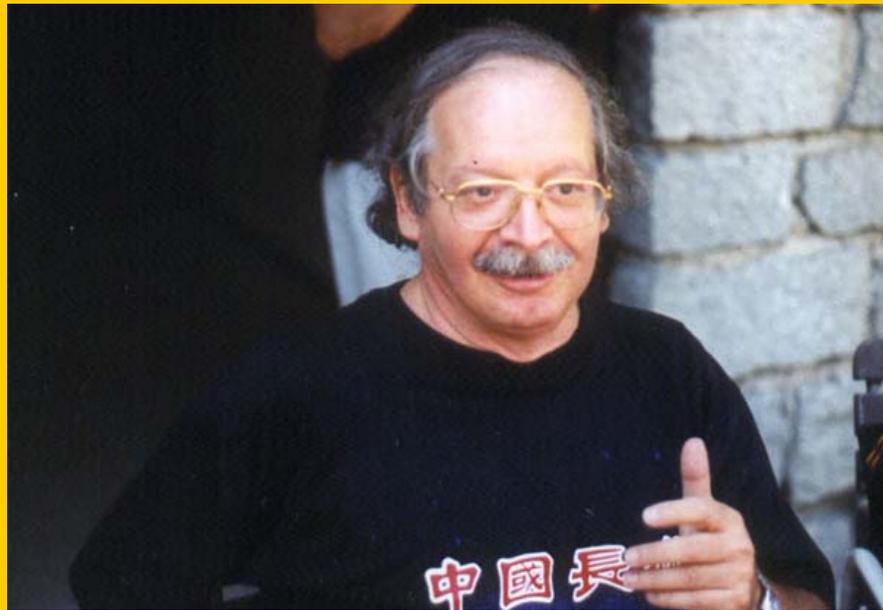


Giuliano Preparata A Quintessential Physicist



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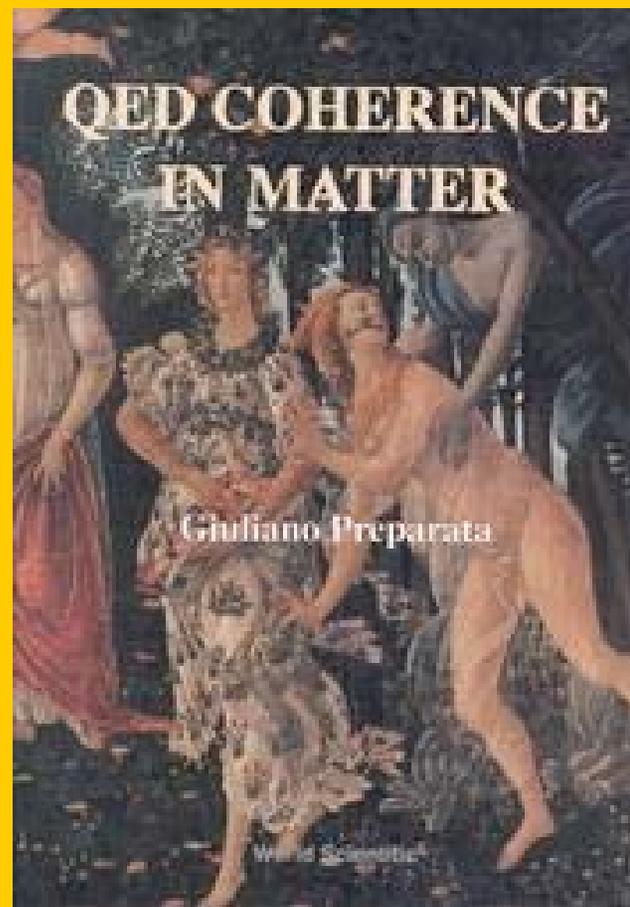
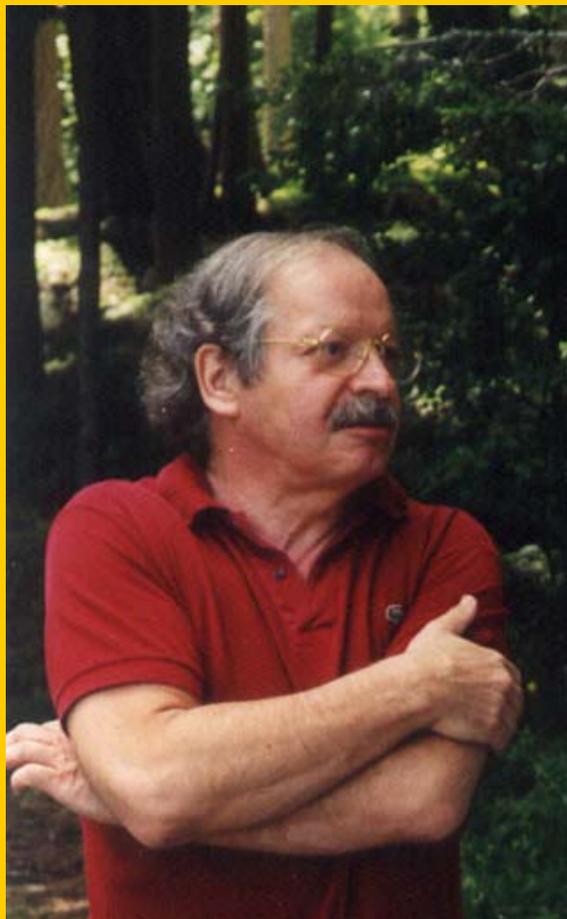
La Fisica di Giuliano Preparata



Y.N. Srivastava { Physics Department & INFN University of Perugia }

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Giuliano Preparata

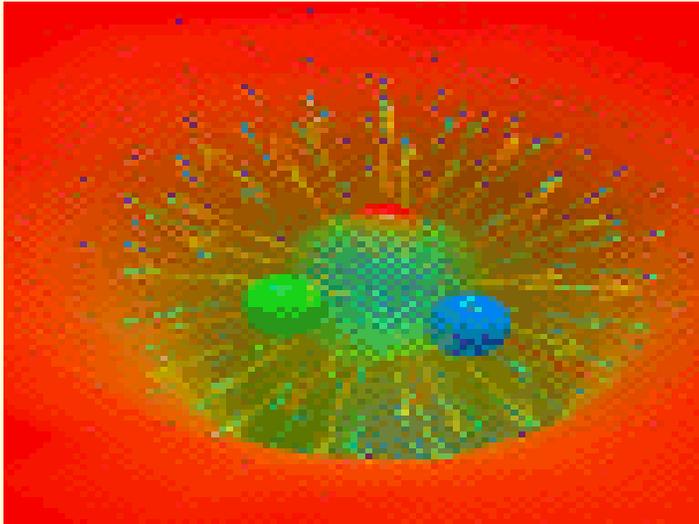


Some Physics Investigated by Giuliano Preparata

- QCD and the Vacuum Instability
- Macroscopic Quantum Field Coherence
- Properties of Water
- Cold Low Energy Nuclear Reactions
- Neutrino and Graviton Detection

Y.N. Srivastava { Physics Department & INFN University of Perugia }

Hadrons in a Color Magnetic Field and the Unstable Perturbation Theory Vacuum



Color Electric Field Lines Built out of the Glue Binding the Quarks

$$\mu = (\delta B / \delta H)$$

$$\text{Im } \mu^{-1}(-Q^2 + i0^+) < 0$$

**Glueon Magnetic
Field Lines Wound as
Tangled Strings or “Vermicelli”**



Y.N. Srivastava { Physics Department & INFN University of Perugia }

The Coherent Quantum Electrodynamic Field I

$$H_{field} = \frac{1}{8\pi} \int (|\mathbf{E}|^2 + |\mathbf{B}|^2) d^3\mathbf{r}$$
$$H_{molecule}(\mathbf{A}) = \sum_a \frac{1}{2M_a} \left(\mathbf{p}_a - \frac{z_a e}{c} \mathbf{A}_a(\mathbf{r}_a) \right)^2 + U(\mathbf{r}_1, \dots, \mathbf{r}_N)$$

Dicke Model

1. Truncate the Field Hamiltonian to One Mode.
2. Truncate the Molecular States Down to Two Energy Levels.
3. Make the Truncations Manifestly Gauge Invariant.

Step 3 is required for a *proper* treatment of the f-sum rule.

$$H = \frac{1}{8\pi} \int (|\mathbf{E}|^2 + |\mathbf{B}|^2) d^3\mathbf{r} + H'(\mathbf{E})$$
$$H'(\mathbf{E}) = \sum_a \frac{p_a^2}{2M_a} + U(\mathbf{r}_1, \dots, \mathbf{r}_N) - e \left(\sum_a z_a \mathbf{r}_a \right) \cdot \mathbf{E}$$

Y.N. Srivastava { Physics Department & INFN University of Perugia }

The Coherent Quantum Electrodynamic Field II

$$H_{Dicke} = H_{field} + H_{molecules} + H_{int}$$

$$H_{field} = \frac{1}{2} (P^2 + \omega_\infty^2 Q^2)$$

$$H_{molecules} = -\varepsilon \sum_j S_{jz}$$

$$H_{int} = -\lambda Q \sum_j S_{jx}$$

**Hepp and Lieb
Rigorous Solution of
This Dicke Model
Leads to a Phase
Transition Which is
the Basis of the
Preparata-del Giudice
Radiation Domains**

Y.N. Srivastava { Physics Department & INFN University of Perugia }

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Radiation Domains in Water



Y.N. Srivastava { Physics Department & INFN University of Perugia }

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Domains in Water I

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PHYSICAL REVIEW LETTERS

29 AUGUST 1988

Water as a Free Electric Dipole Laser

Emilio Del Giudice

Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Milano, Italy

Giuliano Preparata

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Sezione di Milano,
Istituto Nazionale di Fisica Nucleare, Milano, Italy*

and

Giuseppe Vitiello

*Dipartimento di Fisica, Università di Salerno, Salerno, Italy, and
Sezione di Napoli, Istituto Nazionale di Fisica Nucleare, Napoli, Italy*
(Received 23 May 1988)

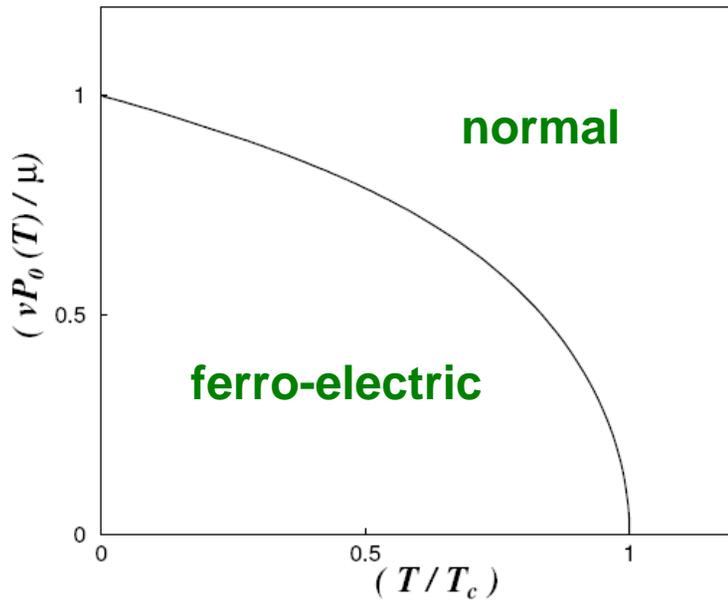
We show that the usually neglected interaction between the electric dipole of the water molecule and the quantized electromagnetic radiation field can be treated in the context of a recent quantum field theoretical formulation of collective dynamics. We find the emergence of collective modes and the appearance of permanent electric polarization around any electrically polarized impurity.

PACS numbers: 42.55.Tb, 03.70.+k

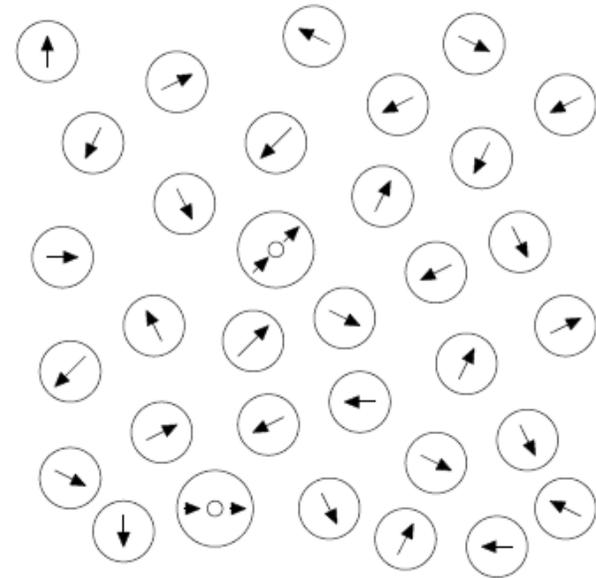
Y.N. Srivastava { Physics Department & INFN University of Perugia }

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Domains in Water II



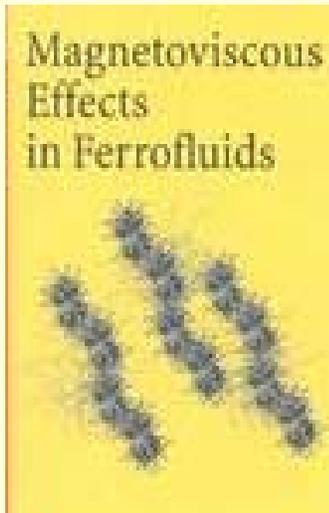
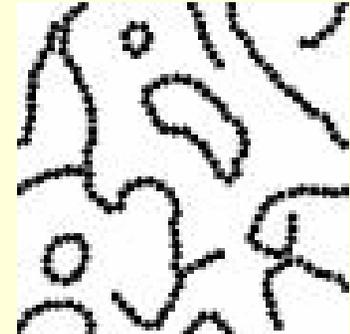
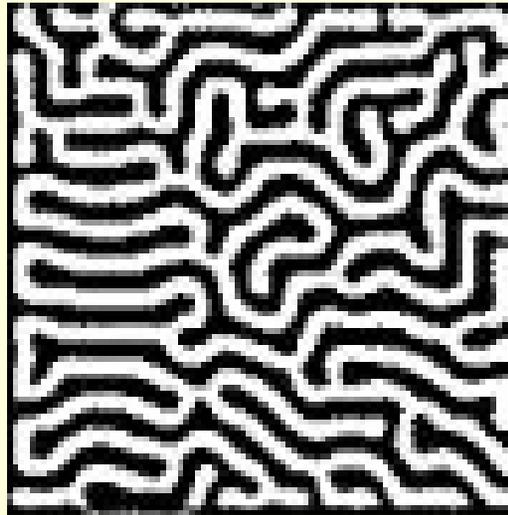
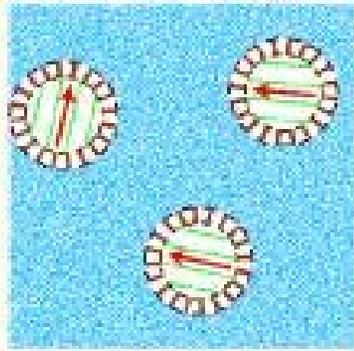
Phase Diagram



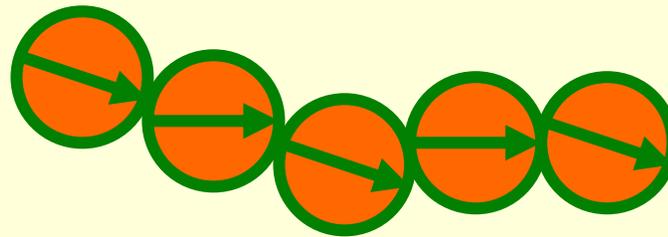
Polarized Domains in Water

Y.N. Srivastava { Physics Department & INFN University of Perugia }

Ferrofluid Domains and Strings



Small Magnets Immersed in Fluid Form Strings



Y.N. Srivastava { Physics Department & INFN University of Perugia }

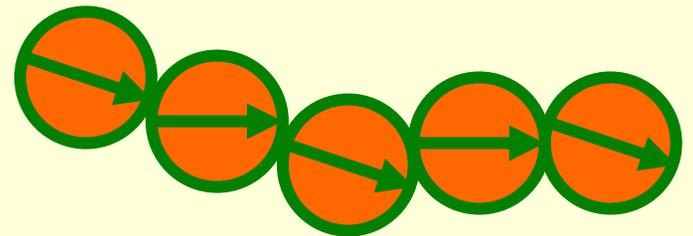
Domains in Water III

Preparata-del Giudice Two Fluid Model:

Water = “normal water” + “ordered water”



Will Small Electrically Polarized “Ordered Water” Immersed in a “Normal Fluid” Form Strings?



Y.N. Srivastava { Physics Department & INFN University of Perugia }

Magnetic Resonance Imaging of Directed Water Domains



$$\mathbf{B} = (0,0,B)$$

$$\omega = -\gamma_{\text{proton}} B$$

$$\mathbf{g} = \nabla \omega$$

$$M_{\perp} = M_x + iM_y$$

$$\frac{\partial M_{\perp}}{\partial t} = -i(\omega_0 + \mathbf{g} \cdot \mathbf{r})M_{\perp} + (\nabla_i D_{ij} \nabla_j)M_{\perp}$$

Nuclear magnetization \mathbf{M} of the Protons are in part described by the diffusion tensor \mathbf{D} .

$$\mathbf{D} \cdot \mathbf{e}_i = D_i \mathbf{e}_i$$

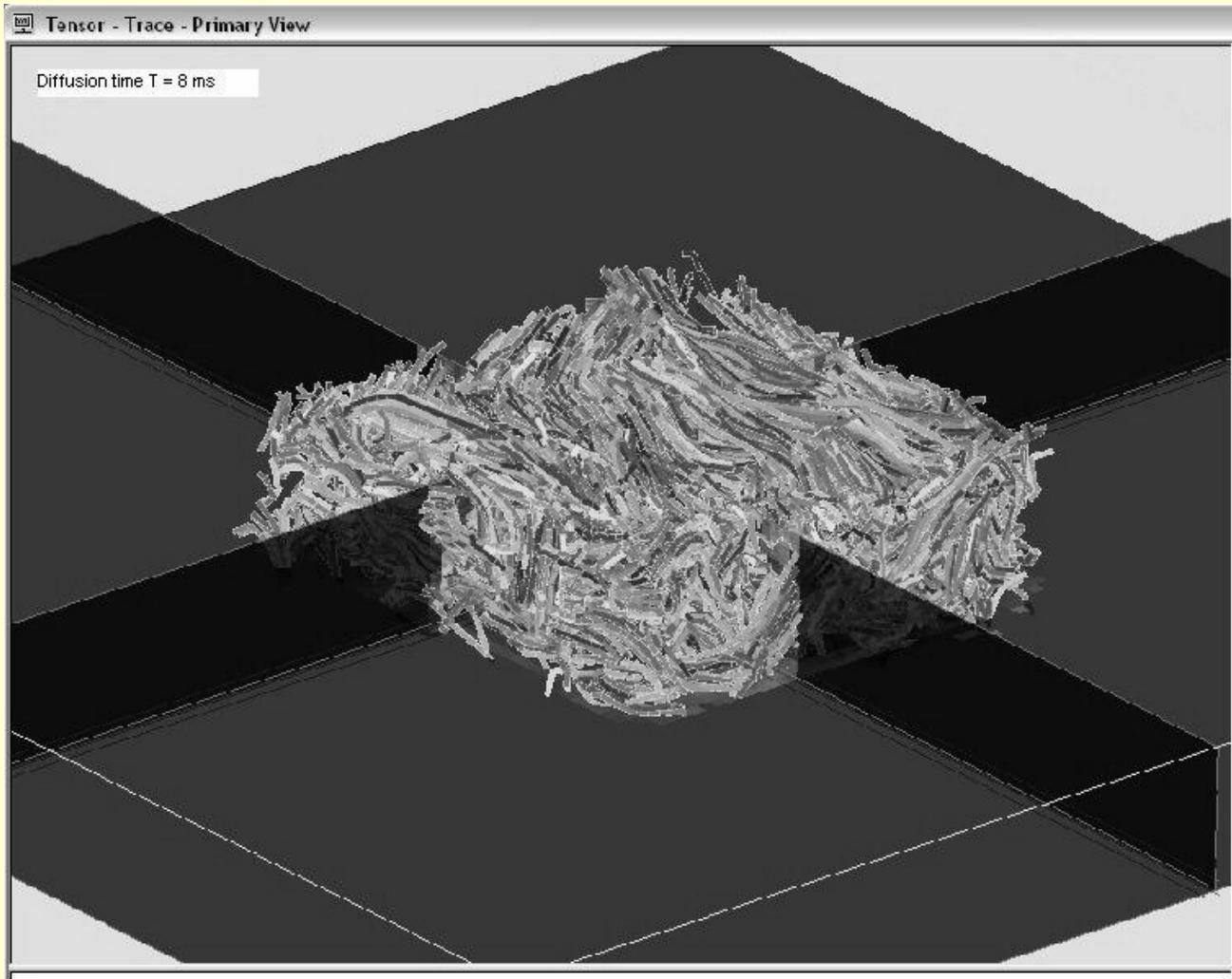
$(\mathbf{e}_1, \mathbf{e}_2, \mathbf{e}_3)$ principle directions

D_1, D_2, D_3 Diffusion eigenvalues

The picture scan establishes directed line along the largest diffusion eigenstate.

Y.N. Srivastava { Physics Department & INFN University of Perugia }

Domains in Water IV



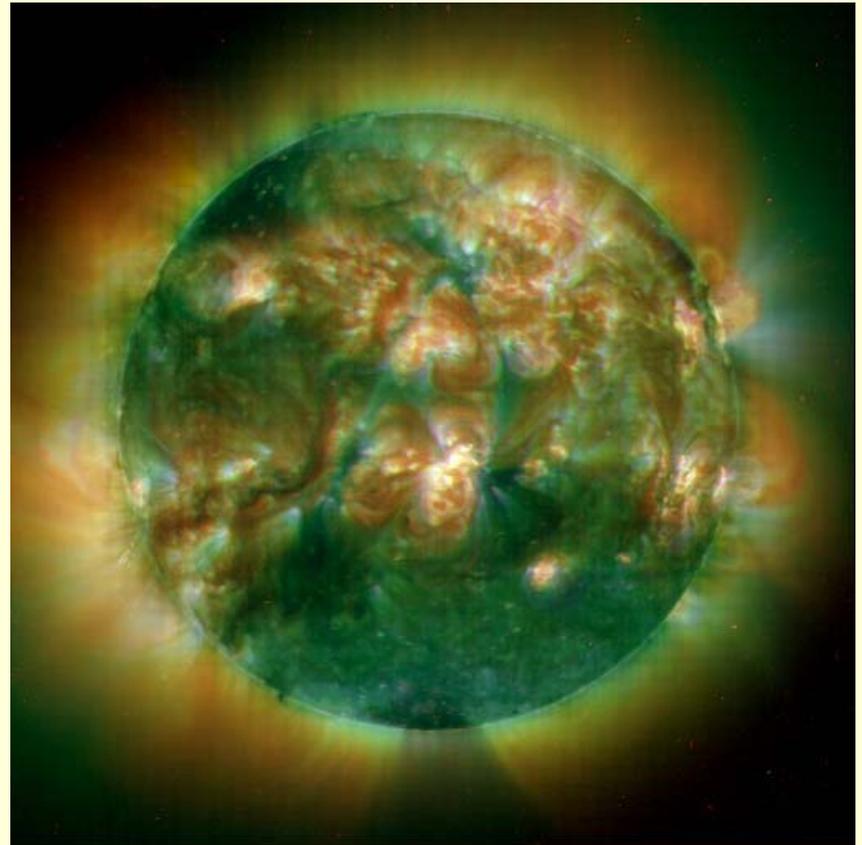
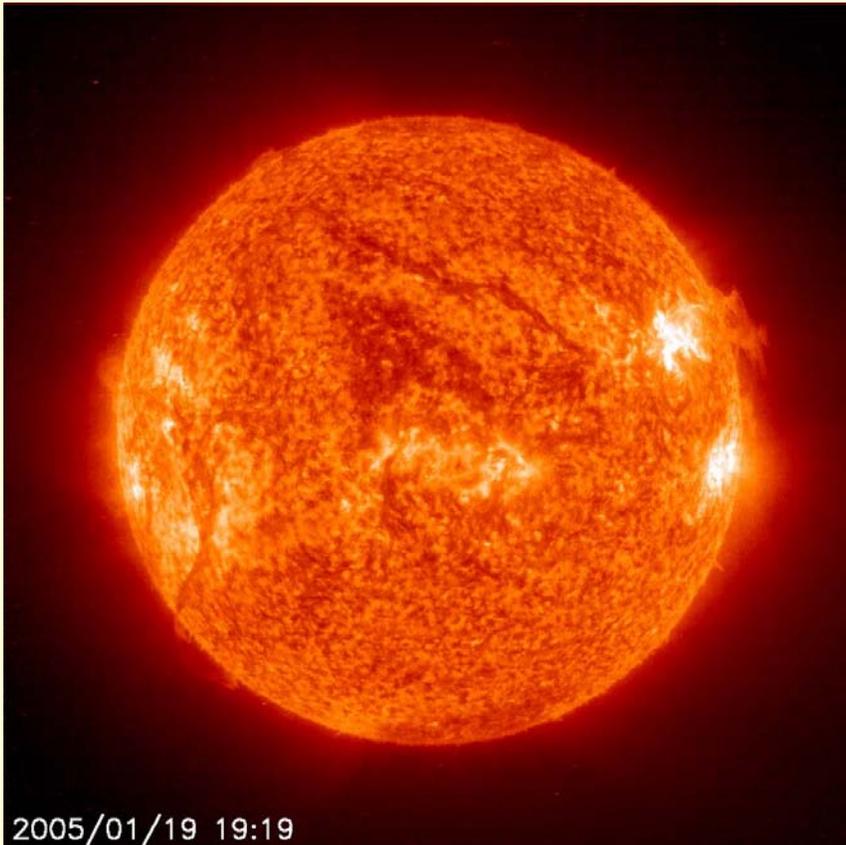
MRI Picture of Pure De-Ionized Water with Ordered Polarized Strings

B=3 Tesla and pulse times have to be of order of two to ten milliseconds.



Y.N. Srivastava { Physics Department & INFN University of Perugia }

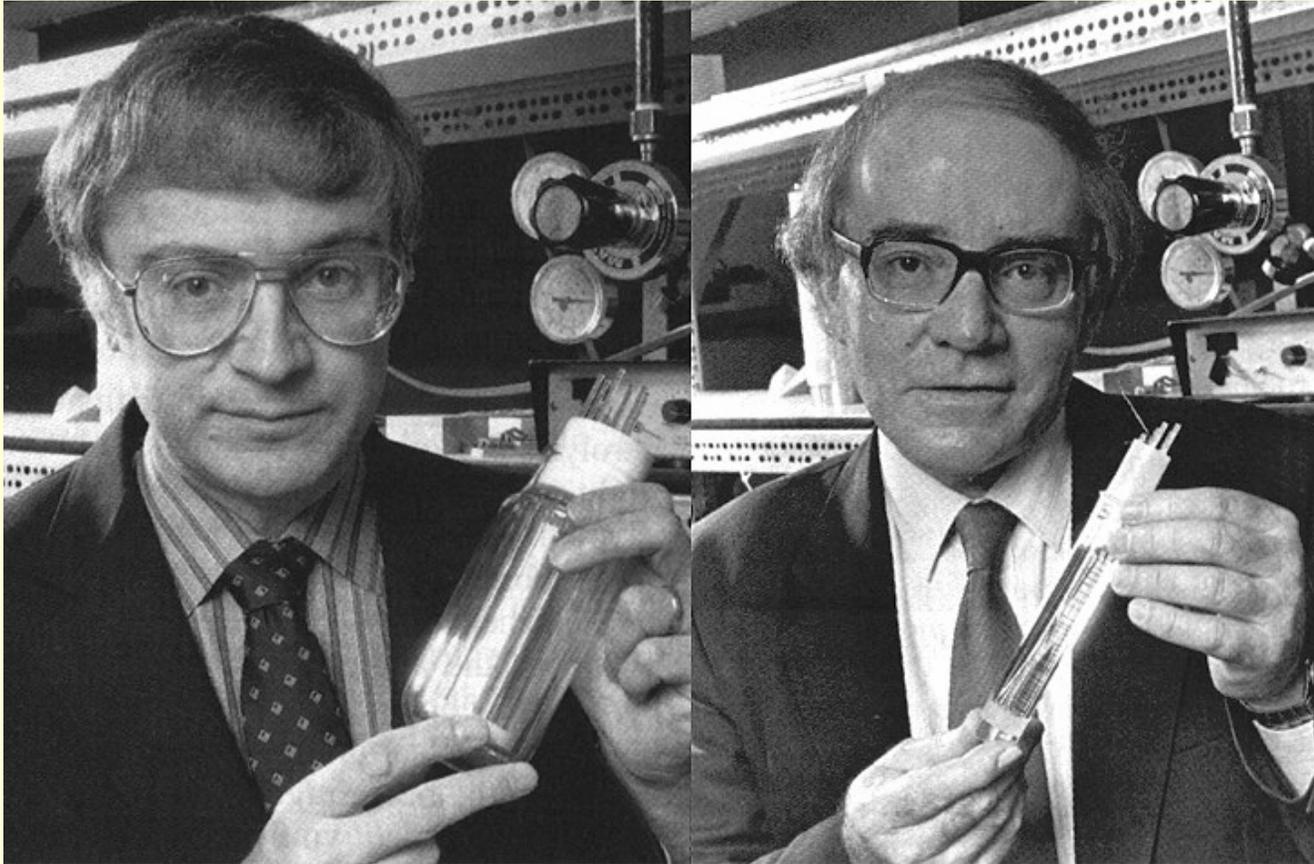
Hot Nuclear Reactions in the Sun



Y.N. Srivastava { Physics Department & INFN University of Perugia }

New Energy Times Archives

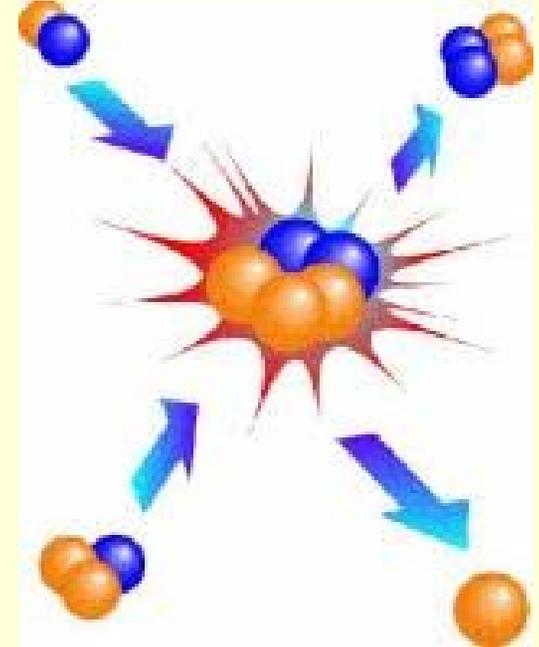
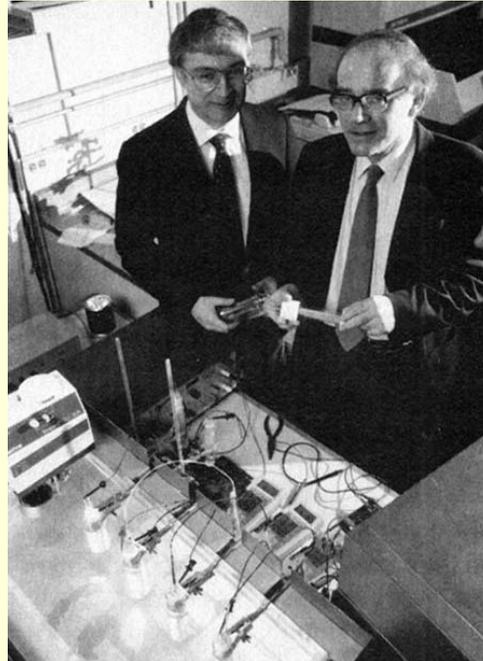
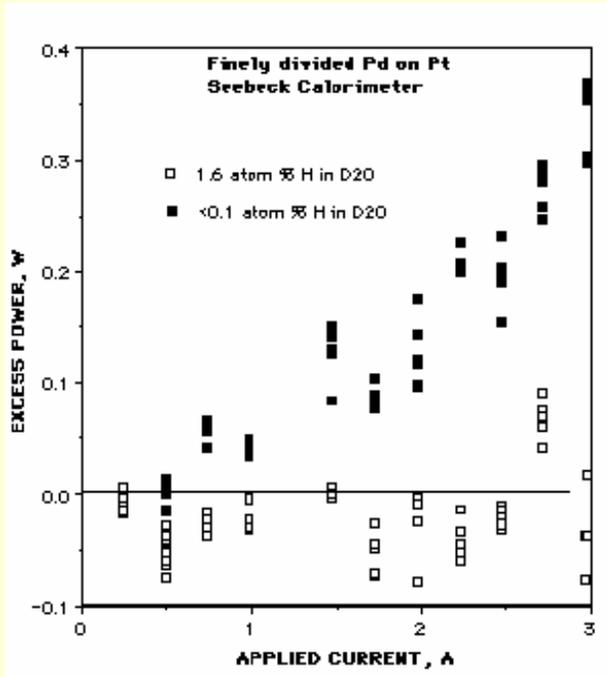
Cold Nuclear Reactions on the Desk Top I



Y.N. Srivastava { Physics Department & INFN University of Perugia }

New Energy Times Archives

Cold Nuclear Reactions on the Desk Top II



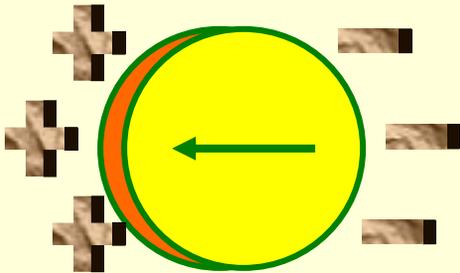
**Too Much Excess Heat
for Chemistry**

Chemical $eV \Rightarrow$ Nuclear MeV

Y.N. Srivastava { Physics Department & INFN University of Perugia }

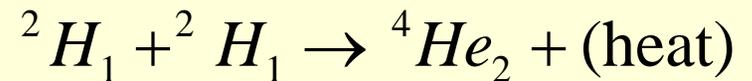
New Energy Times Archives

Preparata Domains in Metallic Hydrides



**Bulk Internal
Dynamic Oscillating
Polarization Domain**

**Domain Fields Supply the
Collective Energy Allowing
Coulomb Barrier Penetration
When Two Deuterons Combine
into an Alpha Particle**

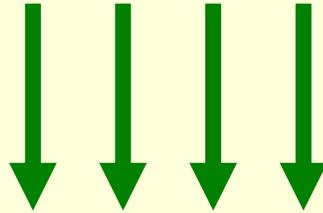


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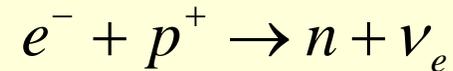
Recent Developments (Surface Domains)

Proton Flux



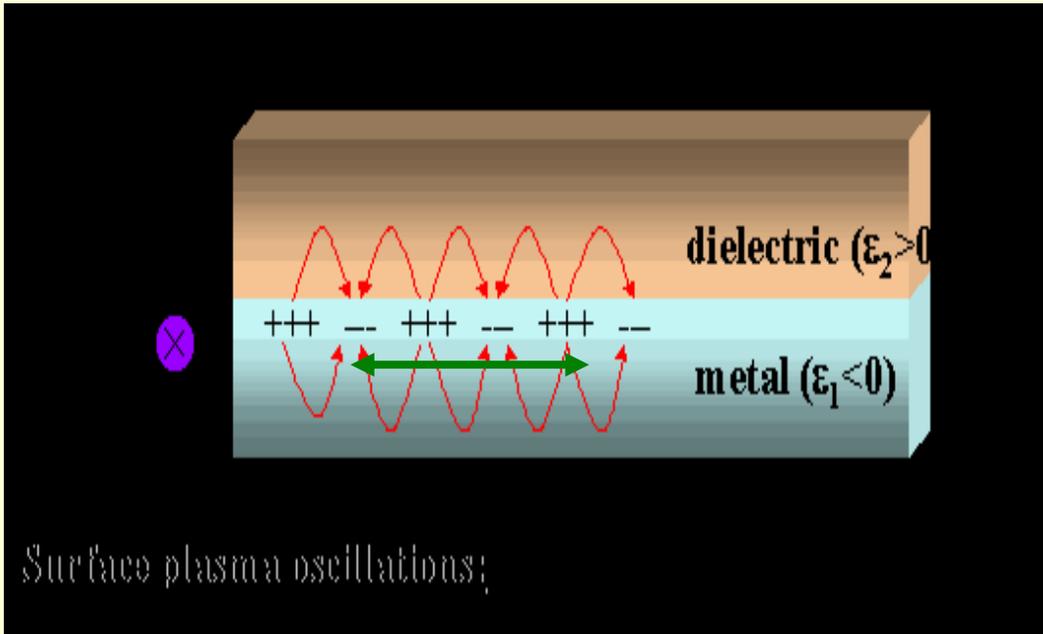
$$(m^*)^2 = m^2 + \frac{e^2}{c^4} \left\{ \langle A_\mu A^\mu \rangle_{\text{matter}} - \langle A_\mu A^\mu \rangle_{\text{vacuum}} \right\}$$

electronic mass renormalization



ultra-low momentum neutrons

Proton Oscillations



Y.N. Srivastava { Physics Department & INFN University of Perugia }

Conclusions

- QCD and the Vacuum Instability
- Macroscopic Quantum Field Coherence
- Properties of Water
- Cold Low Energy Nuclear Reactions

There is an ever increasing amount of work being done in the above areas of research. The spirit of the work involves collective modes of quantum coherence as originally discussed in the work of Giuliano Preparata.

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