

(a) see p. 2 (Corrected p. 034606-3 of Form

⑦ Vacuum fluctuation and interference; the Casimir effect

Nucleolar Superfluidity in general, and its incoherence in the case of a single Cooper pair like in  $^{11}\text{Li}$  in particular, are among the most quantum of all the phenomena displayed by the nucleolar many-body system. Even if the  $^{15}\text{S}_0, NV$  interaction was not operative, or was rendered subcritical by screening effects as in the case of  $^{11}\text{Li}$ , Cooper binding will still be close to the Fermi energy [Figs. I(III)(b), I(III)(d)–I(III)(g)], a direct consequence of the ZPF of the nuclear vacuum (ground state) [Figs. I(a) and I(c)].

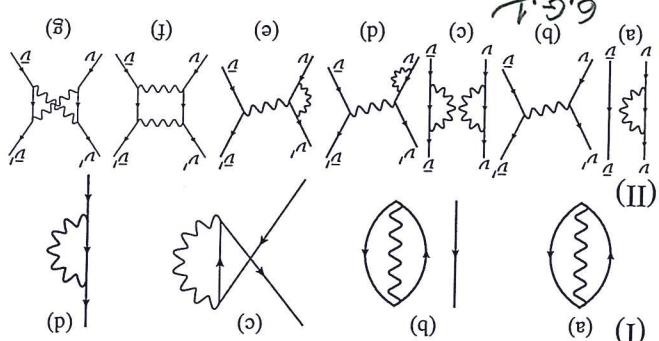
Within this context, and only so, one can posit that the order parameter  $\alpha_0$  does not depend on the presence or absence of the  $^{15}\text{S}_0, NV$  bare potential. Independence of  $\alpha_0$  from the presence or absence of the nucleolar superfluidity is intrinsically contained in the thus nuclear superfluidity is intrinsically contained in the fluctuations of the quantal nuclear vacuum. As such, it is a truly emergent many-body nuclear property, implying generalized rigidity in gauge space, with the associated pairing rotational bands being specifically excited through particle transfer [3,4,6,7]. The fingerprint of spontaneous symmetry breaking is a truly emergent many-body nuclear property, implying generalized rigidity in gauge space, with the associated pairing rotational bands being specifically excited through particle transfer [3,4,6,7].

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In what follows, we will show that there is a simple physical reason at the basis of the above parallelism, rooted in the fact that the atomic nucleus is a leptopidermous finite many-body quantum system. Virtual states, like those associated with zero-point fluctuations ( $ZPF$ ) of the nuclear vacuum ( $\text{ground state}$ ), in which a surface quantised vibration and an uncoupled particle-hole mode get virtually excited for a short period of time (Fig. 1(a)), are a basic characteristic feature of these systems (Fig. 1(b)). Adding a nucleon to it [odd system, Fig. 1(b)], through the particle-vibration coupling strength ( $V$ ; see, e.g., Ref. [21], Eq. (66)] to processes which contain the effect of the antisymmetry between the single particle explicitly considered and the particles out of which the whole group is built [Fig. 1(c)], Time ordering gives rise to the graph shown in Fig. 1(d). Processes I(c) and I(d), known as correlation (CO) and polarization (PO) contributions to the mass operators (see Refs. [22, 23]), and references therein], clothe the particles, leading to physical phenomena that book examples of quantum field theory phenomena. They describe the cloaking of nucleons is at the basis of the quantum field theory that the summing up, the processes shown in Fig. 1(d) are midings. Summing up, the processes with the experimental whose properties can be compared with the theoretical description that the cloaking of nucleons is at the basis of the quantum field theory phenomena.

(8) can, schematically, be written as

HIGW/(i) (a) ZPF associated with (particle-hole) surface vibrations, (b) odd system, (c) the antisymmetric metatization between the particles in ions, (d) considered explicitly and those involved in the vibration; and (d) time ordering of panel (c). Diagrams (c) and (d) lead to the coupling of single-particle motion in lowest order in the particle-vibration vertex. (II) A dressed nucleon moving in a state  $v$  in the presence of (a) a bare nucleon moving in the time-reversed state  $\bar{v}$  and another dressed nucleon. Exchange of vibrational excitation in panel (a) leads to (b) the NFT lowest-order contribution in the particle-vibration coupling vertex of the induced pairing interaction (Appendix D). Exchange of vibrational excitations in panel (c) leads to (d) self-energy, (e) vertex correction of the induced pairing interaction (Appendix E), and (f) ladder diagram contributing to the induced pairing interaction (Appendix F). In panel (g), the bosons displayed in panel (c) is shown.



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in the interior of the liquid.

Summing up, one can posit that there are no fundamental forces in the sense of bare forces, but that all forces are, with varied degrees of complexity and strength, renormalized by many-body effects in the field generated Coulomb interaction, the responsible force of charges and of bio-physics was told us, this is such a subject.

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Quantum mechanical, such an effect is known as the Casimir effect. Two conducting, neutral plates at very small distances, of the order of the micron ( $1\mu = 10^{-6}$  cm), attract each other, due to the imbalance in electromagnetic field pressure exerted by the bombarding electrons and positrons, arising from the ZPF of the electromagnetic field (see Fig. 12). Of notice that the Casimir effect, namely the attraction between two metallic, uncharged, plates (which have been drawn in Fig. 12) as plane surface but which could, in principle have any shape) is not so different from that experienced by Leptodermic systems, that is, systems which display a surface tension. Setting two of such systems in contact "destroys" part of their surface moving the systems away from each other. But this is associated with "recreating" the surface section associated with the overlap. In other words the two Leptodermic systems attract each other with a potential energy proportional to the surface tension of the system (see Fig. 13). Now, this quantity is a measure of the force that must be applied to surface molecules so that they experience the same force as a molecule

Only waves with wavelength smaller than the separation of the ships can exist between them. In the region of sea extending away from the ships to the horizon, waves of any wavelength can exist (see Fig. 11(b)). This fact results into an imbalance between the forces exerted by the internal (between ships) waves, in favour of that exerted by the external waves, leading to a net attraction.

that a quantitative understanding of the phenomenon (based on knowledge of similar quantum effects) was achieved, providing evidence that the old tale was true.

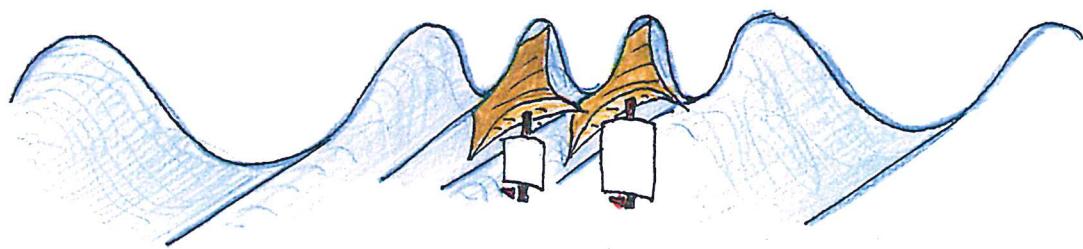
1

At sea, on a windless day in which the water surface can resemble a mirror, free floating ships single or in groups do not do much, just stay put. The situation is quite different in a strong swell, still on a windless situation. In this case, single, isolated ships end up lying parallel to the wave crests (see Fig. II(a)) and start rolling heavily. In the days of the clipper ships it was believed that under those circumstances, two vessels at close distance, attracted each other. This in keeping with the fact that the rigs of the rolling ships became entangled leading to disaster. It was not until quite recently (Boersma 1996), A maritime analogy of the Casimir effect, American Journal of Physics 64:539).

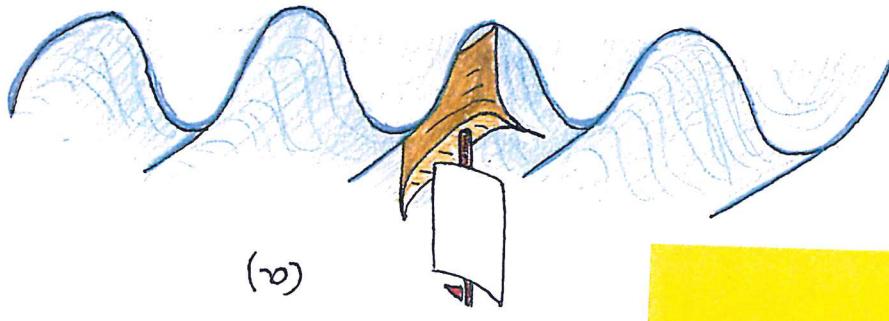
Schematic representation of the behaviour of an isolated ship at sea in a situation of no wind but of strong swell (a), and of two ships close by in similar conditions (b).

Caption to Fig. A  
6.6.2

Figure II.



(b)



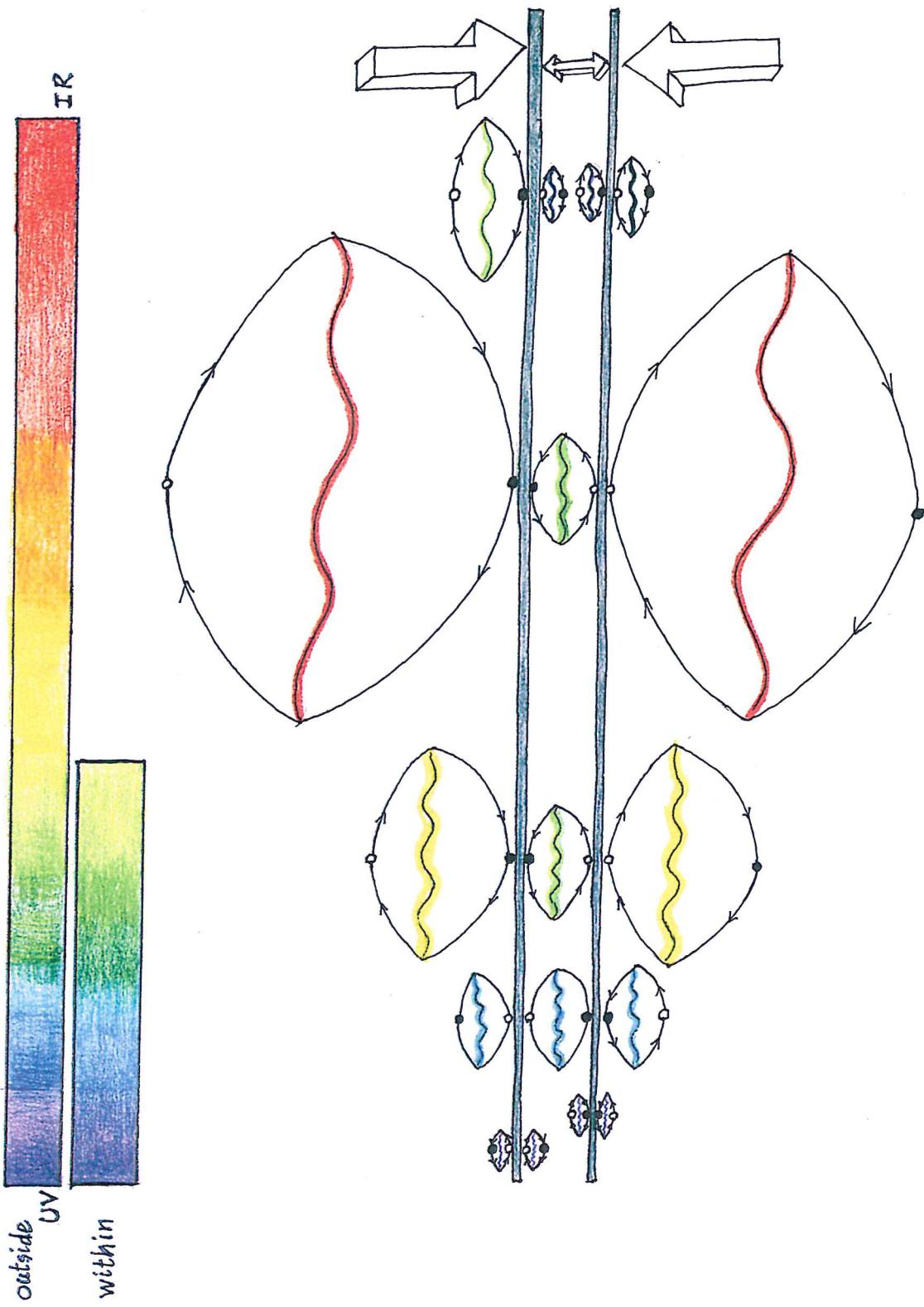
(a)

4  
33



6.6.3

Figure 12:



to

(5)

Within this context one could view Dirac's vacuum as a semiconductor with a band gap  $2m_e c^2$ , that is roughly 1 MeV. However, the vacuum is  $n$ -type. It is doped with positive charges. Like holes in an  $n$ -type germanium or silicon, positrons can survive for some time in the  $n$ -world. An excitation corresponds to the electron-positron pair (see H.B.G. Casimir, Haphazard Reality, half a century of Science, Harper Books, New York (1983)).

18

Long wavelength  
Quanta of pressure

Casimir effect. Two metallic isolated, conducting plates (very vertical sections) in vacuum attract each other when they are placed at very small distances (of the order of micron). This is known as the Casimir effect (H.B.G. Casimir, Proc. K. Ned. Akad. Wet., 60, 793 (1948)). The origin of such a force are, in this work, traced back to quantum zero point fluctuations (ZPF) of the electromagnetic vacuum. In the figure a cartoon of such processes is given. Virtual electrons ( $e^-$ , solid dots) and positrons ( $e^+$ , open dots) pop up of the vacuum together with a photon, travel for short distances on timescales of the order of  $\hbar/1\text{MeV} \approx 10^{-23}\text{s}$  (1 MeV being approximately equal to the summed mass  $m_e$  of  $e^-$  and  $e^+$ ). In their way, some of them hit the plates. The different wavelengths of the visible photons (and thus the associate momenta of the fermions), are displayed with the standard color coding of the rainbow. Of course, the spectrum extends beyond such limit (from UV to IR). Because the colors (wavelengths) allowed between the plates is smaller than the full spectrum (see colored spectra to the far right of the figure), allowed for the photons associated with the ZPF in the right and left unlitited halves, more fermions will be knockeding the plates from outside that from the in between region, thus leading to an imbalance of the "quantal" pressure and consequently to an effective attractive force.

Caption to Fig. 12  
6.5.3

⑥ 35

~~Two overlapping water droplets attract each other with a potential energy proportional to the surface tension and, making a spherical approximation, as far as the overlapping region is concerned, proportional also to reduced radius or better, to the inverse sum of the curvature. This is also true for two atomic nuclei.~~

Two overlapping water droplets attract each other with a potential energy proportional to the surface tension and, making a spherical approximation, as far as the overlapping region is concerned, proportional also to reduced radius or better, to the inverse sum of the curvature. This is also true for two atomic nuclei.

Caption to Fig. 18  
6.6.4



(7)

After these properties follow from

the structure of the water molecule  $H_2O$ .  
This, in turn, is connected with the directional, anisotropic structure of the valence, electronic distribution of oxygen in an open shell atom, having in its ground state only four electrons in the six paired orbitals which can host six H-atoms to dynamically become

( $1s^2 = 1s^2 > 1s^2 > 1s^4$ ). It can thus be seen that the electrons of the two atoms fit into the electron shells of the two H-atoms to the present case. This is in keeping

with the requirement simple to fulfill - the electronic configuration, Fig. 6.6.5(c), a closed shell system (a noble gas

H-atoms to dynamically become

meets at first the demand of the two

( $1s^2 = 1s^2 > 1s^2 > 1s^4$ ).

The last occupied ap-orbital which can host six

ground state only four electrons in the

oxygen is an open shell atom, having in its

the valence, electronic distribution of oxygen in an open shell atom, having in its

directional, anisotropic structure of

This, in turn, is connected with the di-

the structure of the water molecule  $H_2O$ .

After these properties follow from

due to its dipole moment.

aside from being a good solvent

temperature of ring of mass 1 degree Kelvin -

- the amount of heat needed to raise the

an exceptionally large specific heat,

highly water is heavier than ice, it has

water has three remarkable properties:

W. Greiner, Quantum Mechanics, Springer, Berlin (1998)

\*) see e.g. Greiner (1998)

of Cooper 10c

it takes 0.385 Joules of heat to raise 1 gram

1 degree Celsius (°C). For comparison sake,

temperature of one gram of water to increase

1\*) Water absorbs 4.184 Joules of heat for the

W. Greiner, Quantum Mechanics, Springer, Berlin (1998)

of Hydrogen bond

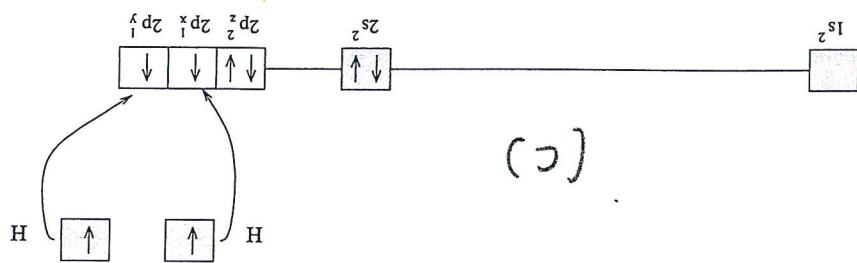
4.101200

P. ④

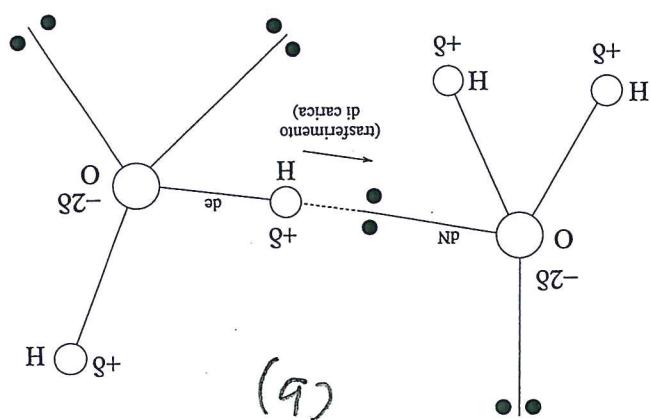
(a) To understand the behavior of water molecules, we have to realize that in the covalent bonds between the oxygen and the hydrogen atoms there is a complete electron sharing. The oxygen, which has six valence electrons, will attract the two electrons from each hydrogen atom. The two hydrogen atoms will share the two electrons with the oxygen atom. This means that a water molecule can form four hydrogen bonds; the molecule can be between a hydrogen atom and a lone pair. Oxygen has six valence electrons, so the hydrogen bond is a bond between an oxygen atom and a hydrogen atom. Thus, the oxygen atom is surrounded by two hydrogen atoms, which are shared by the two hydrogens. This sharing of electrons. Furthermore, the sharing of electrons. Furthermore, the oxygen atom is surrounded by two hydrogen atoms, which are shared by the two hydrogens. This sharing of electrons. Furthermore, the oxygen atom is surrounded by two hydrogen atoms, which are shared by the two hydrogens.

caption to Fig. 6.6.5

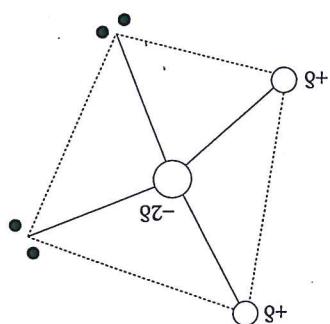
Fig. 6.6.5



(c)



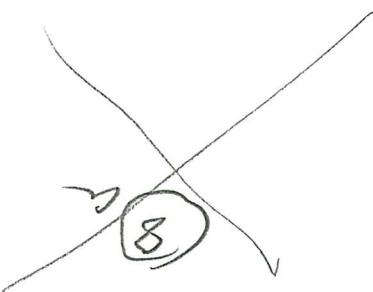
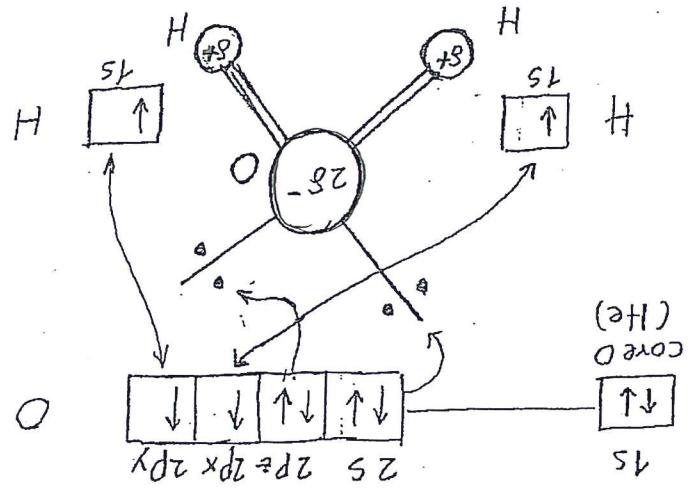
(b)



(a)

8

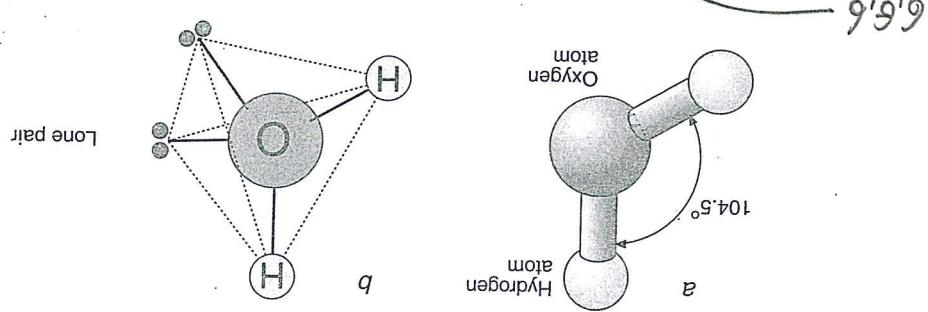
~~Fig. 6.G.5~~





$$\begin{aligned}
 & \textcircled{9} \quad E = 1.602 \times 10^{-19} C \\
 & \quad \boxed{\text{Direct measurement}} \quad A_6 = 0.529177 \times 10^{-16} \text{ m} \\
 & \quad \boxed{\text{of water.}} \\
 & 0.068 \times E \times A_6 = 0.068 \times 0.847742 \times 10^{-29} \text{ cm} \\
 & = 5.765 \times 10^{-2} \times 10^{-29} \text{ cm} \\
 & \approx 0.6 \times 10^{-29} \text{ cm}
 \end{aligned}$$

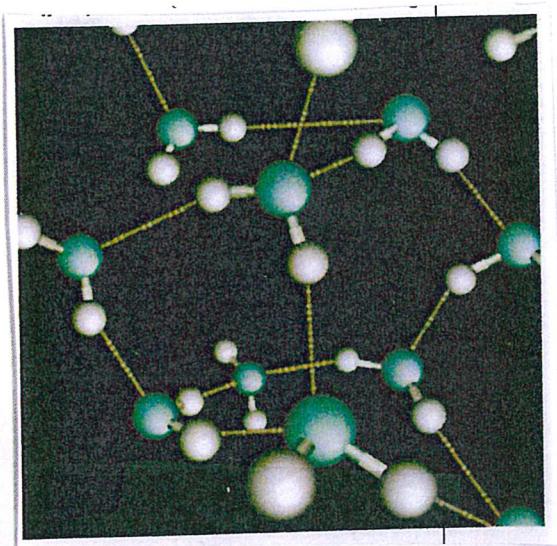
Fig. 6.6 The water molecule is bent, with the two bonds between oxygen and hydrogen spaled at an angle of  $104.5^\circ$  (a). To understand the structure of liquid water, we must also take into account the two lone pairs of electrons on the oxygen atom. The hydrogen atoms and the two lone pairs sit more or less at the corners of a tetrahedron (b). At the molecular scale, the structure of water is imprinted with this tetrahedral geometry.



(b)

The molecules have two hydrogen atoms which form two bonds with neighbouring oxygens, while the molecule's two hydrogens, <sup>5\*</sup> interact with their two <sup>5\*</sup> neighbours, <sup>6</sup> which are hydrogen bonding to one pair <sup>5\*</sup> (Fig. 6.6.6). The term <sup>6</sup> hydrogens (<sup>6</sup>) (<sup>6</sup> Fig. 6.6.6). The term <sup>6</sup> water (<sup>6</sup> Fig. 6.6.6) do not mix. The term <sup>6</sup> hydrophobic (water-fearing) is commonly used to describe substances that else do not mix (adhesive) with (<sup>6</sup> h) water all, although it may look as if water repels all, these two types of molecules actually attract each other, e.g. through the van der Waals interaction, but not really as strong as water attracts itself. Mixing enough <sup>6</sup> structures, scattering and structures, <sup>6</sup> Pohl and Mirsina; Springer, Berlin (2002)

in bulk water (after  
Doddrell (2002))  
light grey H) of a melt with a  
sticch and ball representation (blue O,  
Fig. 6, 6, 7



(10)

D. Chaudhury, Two facets of water, Nature 417, 491 (2002)

D. Chaudhury, Nature 437, 640 (2005)  
small and large length scales, J. Phys. Chem., B 103, 4570 (1999)  
K. Lum, D. Chaudhury, J. D. Wallen, Hydrophobicity at  
assembly, Nature 437, 640 (2005)

Lum et al. (1999) and refs. therein.  
6\*) See e.g. Chaudhury (2002), (2005) and

John Bush:  
at the water surface, but nothing else. That sharp is at the  
summit, just one rule: hands can grasp  
your up has just one rule: hands can grasp  
and you're H<sub>2</sub>O. The way that water molecules  
go. at the water, stretch out your arms -  
hydrogen atoms, your ankles are the lone pairs  
superimpose a water molecule. If your hands are  
of electrons of oxygen, stand leg apart... twist  
of electrons of oxygen, stand leg apart... twist  
at the water molecule. If your hands are  
your up has just one rule: hands can grasp  
and you're H<sub>2</sub>O. The way that water molecules  
go. at the water surface, but nothing else. That sharp is at the  
summit, just one rule: hands can grasp  
your up has just one rule: hands can grasp  
and you're H<sub>2</sub>O. The way that water molecules  
go. at the water, stretch out your arms -

continuation (footnote 5\*) p. 16 (Quoting from Ball (2003))

P. Ball H<sub>2</sub>O A biography of water, Phoenix, London (2003)

therefore leads to a reduction in force  
between water molecule, induce  
aggregation of NP molecule  
from water and results in an  
affectionate NP-NP (hydrophobic)  
attractions, also observed e.g. in  
molecules force measurements (6\*). For  
example, the loss of hydrogen bond nor  
the use extend hydrophobic surfaces  
hydrogen atoms, your ankles are the lone pairs  
superimpose a water molecule. If your hands are  
of electrons of oxygen, stand leg apart... twist  
of electrons of oxygen, stand leg apart... twist  
at the water molecule. If your hands are  
your up has just one rule: hands can grasp  
and you're H<sub>2</sub>O. The way that water molecules  
go. at the water, stretch out your arms -

11

(hydrophobic, ignore), with water  
(non polar (NP))

## \* Hydrophilic molecules do not hydrolyze

described in Fig. 6. G. X comes water to move away from those surfaces, producing their vapour layers. These vapour layers can stabilize and protect the interface film in the water. This interface film consists of two main parts: the aqueous phase and the oil phase. The aqueous phase contains water-soluble molecules that are attracted to water, while the oil phase contains oil-soluble molecules that are repelled by water. The interface film acts as a barrier between the aqueous and oil phases, preventing them from mixing.

Fig. D3 illustrates the effect of hydrophobicity on the interface film. In this diagram, the aqueous phase is represented by a blue circle containing a white cross, and the oil phase is represented by a red circle containing a white cross. The interface film is shown as a thin grey line separating the two phases. The hydrophobicity of the interface film is indicated by the angle between the interface film and the horizontal axis. A larger angle indicates higher hydrophobicity, while a smaller angle indicates lower hydrophobicity.

The hydrophobicity of the interface film is determined by the properties of the molecules that make up the film. For example, if the molecules have a strong affinity for water, they will be attracted to the aqueous phase and repelled by the oil phase, resulting in a low hydrophobicity angle. Conversely, if the molecules have a strong affinity for oil, they will be attracted to the oil phase and repelled by the aqueous phase, resulting in a high hydrophobicity angle.

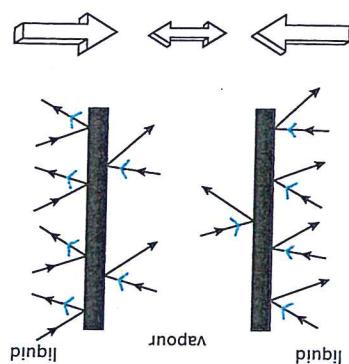
The hydrophobicity of the interface film also depends on the concentration of the molecules in the aqueous phase. At low concentrations, the molecules are more likely to form a stable interface film. As the concentration increases, the molecules begin to compete for the same binding sites, leading to a decrease in the hydrophobicity of the interface film.

The hydrophobicity of the interface film is also affected by the presence of surfactants. Surfactants are molecules that have a hydrophilic head and a hydrophobic tail. They are attracted to the aqueous phase and repelled by the oil phase, which helps to stabilize the interface film. The presence of surfactants can also change the properties of the interface film, such as its thickness and its ability to withstand shear forces.

The hydrophobicity of the interface film is an important factor in many industrial processes, such as emulsion formation, oil-water separation, and oil recovery. By understanding the factors that affect the hydrophobicity of the interface film, it is possible to optimize these processes and improve their efficiency.

plates (after K. A. Lin et al (1999))  
 of two large parallel hydrodynamic  
 (square) surfaces from the outer space (vapour)  
 outside (as shown in the figure)  
 molecule (assisted by also blue  
 schematic illustration of water

Fig. 6.6, 8



(12)

Within this context, small in hosting cells the bacterium plays a critical role in the formation and destruction of proteins, one can specify that water at physiological conditions -  $300\text{K}$ ,  $\text{pH} = 7$ , etc - can be reduced as the occurrence of the most common enzymes involved in metabolism, and this one of the two enzymes of life is esterase:

What the many-body basis of hydrophobicity cannot be discussed (Fig. 6.5.7)

The parallel until the zero-body contribution (6.5.3) can hardly be avoided. But nevertheless the molecular processes do not result in Fig. 6.6.1 nor will those

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④

described in sets 3.A.2 and 3.A.3 in connection with superconductivity in metals. Within this same, one could also observe a (generalized) Nambu-tumbling effect, namely due to the basis of hydrogen bonding water.

proteins...metabolism, see first the difference in the ZPT energy between hydrogen bonds and water. Can hydrogen bonds feel when in presence of some other oxygen molecule, closely associated with structural configuration?

must push the water molecules away from the protein.

The basis for a possible explanation of these observations is the fact that, if a segment of a protein adopts a native-like conformation as an isolated peptide, it may inhibit protein refolding if this segment of the protein is involved in folding in an early stage of the refolding process. Inhibition would result from competition of the exogenous peptides with its counterpart in the protein for interacting with complementary regions of the refolding protein (cf. ref. [37], see also [83]).

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