International Journal of Advanced Research in Physical Science (IJARPS)
Volume 5, Issue 1, 2018, PP 35-39
ISSN No. (Online) 2349-7882
www.arcjournals.org

Double Subtle Touch of Water Molecules Around Magnesium Cation

Janez Špringer

Cankarjeva cesta 2, 9250 Gornja Radgona, Slovenia, EU

Corresponding Author:** ***Janez Špringer, *Cankarjeva cesta 2, 9250 Gornja Radgona, Slovenia, EU*

Abstract: *Respecting the concept of subtle touch bonds the double subtle touch of water molecules around magnesium cation is proposed which should at the temperature of 29.10°C restrict the vibration of oxygen atoms around hydrogen-hydrogen subtle touched bond axis.*

Keywords: *subtle touch between hydrogen atoms, subtle touch between oxygen atoms, double subtle touch of water molecules, hydrogen octagon, oxygen square, magnesium cation, magnesium - water bond length, restricted vibration of oxygen atoms*

1. Theoretical Background

The length of the covalent bond formed between the oxygen and hydrogen atom in the water molecule, denoted OH, and the length of the subtle touch bond formed between hydrogen atoms in the same molecule, denoted HH_{subtle} are related through the HOH bond angle φ as follows [1]:

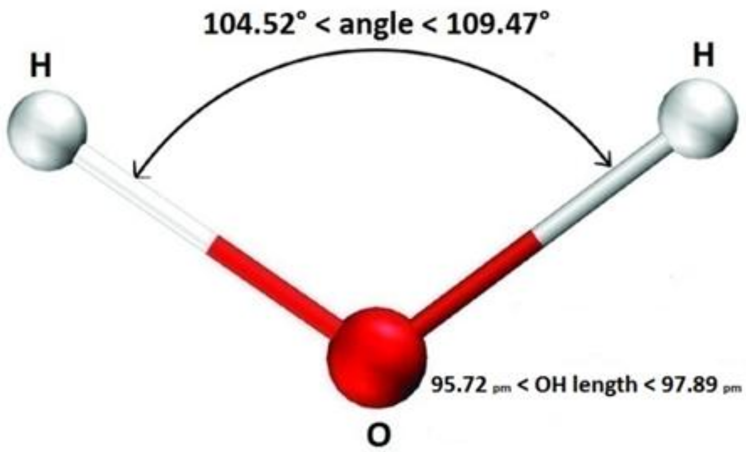

Figure1. *Geometry of water molecule from steam to ice*

$$HH_{subtle} = OH\ x \sqrt{2(1 - cos\ \varphi)}. \tag{1}$$

In the range between ice and steam the interpolated values of OH length and HOH angle are of the water temperature T dependent [1]:

$$\varphi(T) = 109.47° - \frac{109.47° - 104.52°}{100°C}\ x\ T = 109.47° - 0{,}0495°\ x\ \frac{T}{°C}. \tag{2}$$

$$OH(T) = 97.89\ pm - \frac{97{,}89pm - 95.72pm}{100°C}\ x\ T = 97.89\ pm - 0.0217\ pm\ x\ \frac{T}{°C}. \tag{3}$$

And so (of water temperature T dependent) is consequently the length of hydrogen subtle touch bond $HH_{subtle}(1)$.

2. The Proposal

Let us propose that the subtle touch between hydrogen atoms of the adjacent water molecules is possible, too. Such a bond can be formed, for instance, with the help of magnesium cation attracting water dipoles [2]:

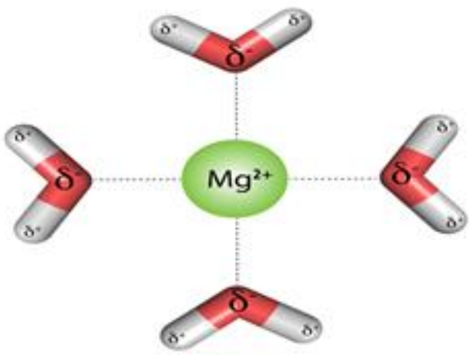

Figure2. *Water molecules spread around magnesium cation*

Four water molecules spread around magnesium cation $Mg^{++}$are able to form fixed hydrogen octagon and consequently changeable oxygen square attached to it as long as the vibration of oxygen atoms around HH_{subtle} bond axis is allowed. Let us examine the minimal and maximal oxygen square inside and partly outside the hydrogen octagon, respectively, to see how HH_{subtle} and OO distance are related through HOH angle, denoted φ.

3. THE MINIMAL OXYGEN SQUARE

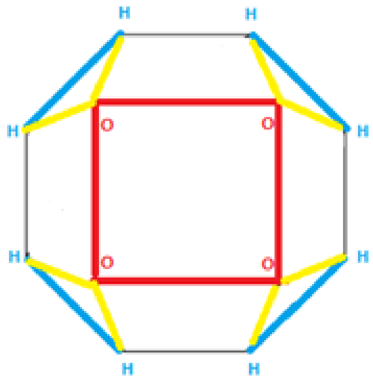

Figure3. *Minimal oxygen square inside hydrogen octagon*

According to section 5 at the minimal oxygen square the next relation between oxygen-oxygen and hydrogen-hydrogen distance is valid:

$$OO_{minimal} = HH_{subtle}\left(1+\frac{\sqrt{2}}{2}-\frac{cos\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right). \quad (4)$$

4. THE MAXIMAL OXYGEN SQUARE

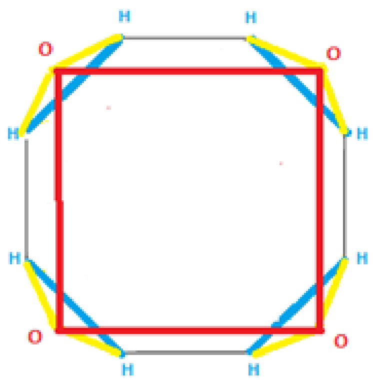

Figure4. *Maximal oxygen square inside hydrogen octagon*

And at the maximal oxygen square holds the next relation between oxygen-oxygen and hydrogen-hydrogen distance:

$$OO_{maximal} = HH_{subtle}\left(1 + \frac{\sqrt{2}}{2} + \frac{\cos\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right). \quad (5)$$

5. THE NEEDED FORMULA DERIVATION

Applying the magnesium-water geometry the formulas (4) and (5) can be derived on the next way:

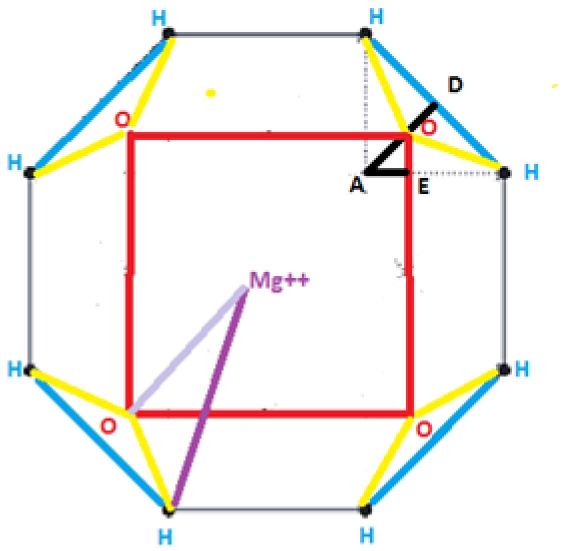

Figure5. *Magnesium-water geometry*

$$OD = OH\ x\cos\frac{\varphi}{2}. \quad (6)$$

$$AD = \frac{HH}{2}. \quad (7)$$

$$AO = AD \mp OD = \frac{HH}{2} \mp OH\ x\ cos\frac{\varphi}{2}. \quad (8)$$

$$AE = \frac{AO}{\sqrt{2}} = \frac{\frac{HH}{2} \mp OH\ x\ cos\frac{\varphi}{2}}{\sqrt{2}}. \quad (9)$$

$$OO = HH + 2x\ AE = HH + 2x\ \frac{\frac{HH}{2} \mp OH\ x\ cos\frac{\varphi}{2}}{\sqrt{2}} = HH + 2x\ \frac{\frac{HH}{2} \mp \frac{HH}{\sqrt{2(1-\cos\varphi)}}\ x\ cos\frac{\varphi}{2}}{\sqrt{2}}$$
$$= HH\left(1 + \frac{\sqrt{2}}{2} \mp \frac{cos\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right). \quad (10)$$

As previously mentioned the hydrogen subtle touch bond length $HH_{subtle}(1)$ is of the water temperature dependent (2),(3) and so is consequently(10) the oxygen distance $OO(4), (5)$.

6. THE SUBTLE TOUCH BETWEEN OXYGEN ATOMS OF ADJACENT WATER MOLECULES

The subtle touch orbit length of oxygen non-bound valence electrons in water molecule $s_{O-subtle}$ is twice longer than the original orbit length $s_{O-original}$ [1]. And the corresponding subtle touch bond length OO_{subtle} between oxygen atoms of adjacent water molecules is $\pi - times$ shorter[1]:

$$OO_{subtle} = \frac{2\ x\ s_{O-original}}{\pi}. \quad (11)$$

For $s_{O-original}^{solid\ H_2O} = 121.031\ 518\ \lambda_e$ and $s_{O-original}^{gas\ H_2O} = 123.089\ 913\ \lambda_e$ [1] we have:

$$OO_{subtle}^{solid\ H_2O} = 186.949\ 769\ pm. \quad (12)$$

$$OO_{subtle}^{gas\ H_2O} = 190.129\ 243\ pm. \quad (13)$$

Respecting interpolated values between (12)) and (13) the subtle touch bond length OO_{subtle} is of the water temperature T dependent as follows:

$$OO_{subtle} = 186.949\,769\,pm + \frac{190.129\,243\,pm - 186.949\,769\,pm}{100°C}\,x\,T$$
$$= 186.949\,769\,pm + 0{,}031\,795\,pm\,x\,\frac{T}{°C}. \quad (14)$$

7. THE SUBJECT OF INTEREST

At some temperature the oxygen-oxygen distance OO could equal the subtle touch bond length OO_{subtle} between oxygen atoms of adjacent water molecules. This fact should restrict the oxygen vibration around HH_{subtle} bond axis which is proposed to be present in the hydrogen octagon formed around magnesium cation Mg^{++}. The subject of interest of this paper is to find that temperature. Briefly, to examine the equality:

$$OO = OO_{subtle}. \quad (15)$$

8. THE SUBTLE TOUCH BETWEEN OXYGEN ATOMS OF ADJACENT WATER MOLECULES IN HYDROGEN OCTAGON

The subtle touch between oxygen atoms of adjacent water molecules spread in hydrogen octagon is achieved when the oxygen-oxygen distance OO equals the oxygen subtle touch bond length OO_{subtle}(15):

The searched equality is found when:

$$OO_{minimal} = OO_{subtle}. \quad (16)$$

Applying the equations (4) and (14) holds:

$$HH_{subtle}\left(1 + \frac{\sqrt{2}}{2} - \frac{cos\,\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right) = 186.949\,769\,pm + 0.031\,795\,pm\,x\,\frac{T}{°C}. \quad (17)$$

Including the equation (1) we have:

$$OH\,x\,\sqrt{2(1-cos\,\varphi)}\left(1 + \frac{\sqrt{2}}{2} - \frac{cos\,\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right)$$
$$= 186.949\,769\,pm + 0.031\,795\,pm\,x\,\frac{T}{°C}. \quad (18)$$

And with the help of equation (3) the next explicit relation is given:

$$\left(97.89\,pm - 0.0217\,pm\,x\,\frac{T}{°C}\right)x\,\sqrt{2(1-cos\,\varphi)}\left(1 + \frac{\sqrt{2}}{2} - \frac{cos\,\frac{\varphi}{2}}{\sqrt{(1-\cos\varphi)}}\right)$$
$$= 186.949\,769\,pm + 0{,}031\,795\,pm\,x\,\frac{T}{°C}. \quad (19)$$

The temperature $T = 29.10$°C satisfies the above equality.

No temperature can satisfy the equality $OO_{maximal} = OO_{subtle}$.

9. THE BOND LENGTHS OF WATER AROUND MAGNESIUM CATION AT T=29.10°C

Following the double subtle touch concept the bond lengths of water molecules spread around magnesium cation at 29.10°C are calculated step by step.

In the first step using the equation (2):

$$\varphi(29.10\,°C) = 109.47° - 0{,}0495°\,x\,\frac{29.10\,°C}{°C} = 108.03° \quad (20)$$

Second step using the equation (3):

$$OH(29.10\,°C) = 97.89\,pm - 0.0217\,pm\,x\,\frac{29.10\,°C}{°C} = 97.26\,pm. \quad (21)$$

Third step using the equation (1) and (2):

$$HH\ (29.10\ ℃) = OH\ x\ \sqrt{2(1-\cos\varphi)} = 97.26\ pm\ x\ \sqrt{2(1-\cos 108.03°} = 157.40\ pm. \tag{22}$$

Fourth step using the equation (14):

$$OO\ (29.10\ ℃) = 186.95\ pm + 0{,}0318\ pm\ x\ \frac{29.10\ ℃}{℃} = 187.88\ pm. \tag{23}$$

And in the fifth step with the help of octagon and square geometry ($section$ 5):

$$Mg^{++}H\ (29.10\ ℃) = \frac{\frac{HH}{2}}{\sin\frac{360}{2\ x\ 8}} = 205.65\ pm. \tag{24}$$

The concerned bonds are collected in Table1.

Table1. *Bond lengths of water spread around magnesium cation at 29.10°C*

T	φ = HOH	OH	HH	OO	$Mg^{++}H$
29.10°C	108.03°	97.26 pm	157.40 pm	187.88 pm	205.65 pm

The calculated magnesium –water bond length, denoted $Mg^{++}H$, equals 206 pm what is in accordance with the data known from physical references where the mentioned bonds range from 206 to 215 pm [3].

10. Conclusions

The double subtle touch of water molecules achieved at water temperature of 29.10℃ should restrict the vibration of oxygen atoms around hydrogen-hydrogen bonds formed around magnesium cation. Since magnesium is essential for many crucial physiological functions this phenomenon could play a role in the case of hypothermia.

Dedication

This fragment was written on the Slovene cultural holiday, 8th February 2018. It is dedicated to all friends since we think well in our hearts (ker dobro v srcu mislimo)

References

[1] J. Špringer, "Zero Water Molecule Enthalpy of Transformation", International Journal of Advanced Research in Physical Science (IJARPS), vol. 4, no. 9, pp. 9-13, 2017.

[2] Loren Dean Williams, Molecular Interactions (Noncovalent Interactions) illustrated by biochemical systems, Georgia Tech, 2017

[3] Richard C. Ropp, Encyclopedia of the Alkaline Earth Compounds, Elsevier, 2013, pp 101.

Citation: *J. Špringer, "Double Subtle Touch of Water Molecules Around Magnesium Cation", International Journal of Advanced Research in Physical Science (IJARPS), vol. 5, no. 1, pp. 35-39, 2018.*