-37th- The annual meeting of the society for the study of the origin and evolution of life
March 8, 2012. No.12. This article is translated from the original paper written in Japanese.

The systematic thermal motion on pair of hydrogen atoms in the water where helical structure is formed by intermolecular forces

Shinji Karasawa (Miyagi National College of Technology: Professor emeritus)

[Abstract]

This article reports examinations about existence of the cluster in which hydrogen atoms of water are arranged regularly, and also discusses about systematic thermal motion of hydrogen atoms. The molecule of water is arranged 3-dimensionally in liquid water as the tetrahedron unit. Electric dipoles of the molecule arranged along the electric axes of 3 directions, and there is penetrating holes along the optical axis of the helix that is perpendicular to the electric axes [1]. When each tetrahedron vibrates rotationally along the electric axes with keeping the bonds, the direction of rotation changes oppositely with the neighbor. The rotation in a cluster will be synchronized, because there are linkages of intermolecular force. In this case, the pair of hydrogen atom that is placed at near penetrating hole in the tetrahedron rotates the same direction, because the pair of hydrogen atoms is placed opposite side from the center of tetrahedron alternately. This rotation is able to exchange the position of hydrogen atom in the pair.

[Observation of Brownian movement of minute particles]

Brownian motion [2] on the fat balls of milk those are about 1μm(0.001mm) size was observed. The movement on fat particle in the movie captured high-speed frame rate (240 frame per second) becomes slow compared with photographing of standard frame rate (30 fps) [3]. The individual molecule of water could not cause the Brownian motion, because, the size of fat particle is larger than the diameter on molecule of water (3Å), i.e. ratio on the diameter is about (r)=3300, the ratio on the area is squared (i.e. 10 to 7th power), and the ratio of volume is cubed (i.e. 10 to10th power). Cluster of molecules is possible to cause the Brownian motion.

[Evidences on existence of linkages among atoms in liquid water]

Viscosity in liquid depends on the intermolecular force. The value of viscosity on liquid water decreases remarkably at increasing of temperature. The activation energy that obtained at the temperature from 0℃ to 100℃, decreases from 5kcal /mol to 3kcal/mol. The value corresponds to energy of hydrogen bond on dimer of water. On the other hand, the activation energy obtained from temperature dependency on saturated vapor pressure of water at high temperature is 10kcal /mol, the value corresponds to that of heat of vaporization. The value on heat of fusion on ice is 1.4kcal/mol. It is considered that the heat on fusion of ice is the activation energy for the rotation of a pair of hydrogen atoms along the electric axis. By the way, the viscosity of mercury is nearly equal to that of water at ℃. The viscosity on mercury decreases slightly with the temperature rise only. The value on molar heat capacity of liquid water 75.6J/(K･mol) is larger than that of monoatomic solid 25J/(K･mol).

[Regular arrangement of hydrogen atoms in the cluster of water]

The long-range force such as intermolecular-hydrogenbond and together with dipole-dipole interaction forms clusters in the liquid water. Hydrogen atoms in the cluster are arranged at regular position of helix by the intermolecular force, and also the force arranges thermal motion of hydrogen atoms. There are the helically linked thermal motions of hydrogen atoms in the cluster.

[Conclusions]

The atoms in liquid water are arranged partially regularly by intermolecular force. Each unit of molecule is arranged at helical structure in a network of helixes. The intermolecular forces have effects on the hydrogen atom and of it thermal motion. So, the synchronized activity of hydrogen atoms of the cluster in liquid water can play an important role in biochemical reaction.

[References]

[1] S.Karasawa, “Origin of Piezoelectricity in an α-Quartz”, J.J.A.P. Vol,13,No.5,799-803, 1974.
[2] T.Yonezawa, “Brownian motion”, Physics One Point-27, Kyouritu-pub. co. Jp, 1986
[3] S.Karasawa, “Movie on Brownian motion”, http://www.youtube.com/watch?v=3ar1bY2SP_c