Dynamic fluctuation measured by sound wave as the origin of specific heat anomaly of ambient liquid water

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Liquid water near ambient conditions is known to exhibit many thermodynamic anomalies. A few scenarios have been proposed, of which the liquid-liquid phase transition (LLT) scenario is considered the most promising [1]: Critical fluctuation associated with the LLT in the supercooled region affect the thermodynamics, which is the cause of the anomalies. On the other hand, the significant change in density fluctuation observed by small-angle scattering (SAS) method is limited to the supercooled region [2], and the direct relationship with thermodynamic anomalies in real liquid above the melting temperature remains unclear.

As an alternative to SAS, we propose another fluctuation measurement method using the relaxation phenomenon of sound wave [3,4]. The application of this method to liquid water has revealed for the first time that the fluctuation exist over a very wide temperature and pressure ranges; The temperature and pressure changes of the strength of the fluctuation are linked to the changes in the isochoric specific heat, demonstrating that this fluctuation is the origin of the well-known specific heat anomaly in ambient liquid water [5]. While the fluctuation measured by SAS is static critical fluctuation, this fluctuation measured by sound wave can be recognized as dynamic critical fluctuation of LLT.

In this presentation, we will show the principle of the method and the results of its application to liquid water. On the other hand, in order to complete the above LLT scenario, it is necessary to focus on the difference between static and dynamic fluctuations. This will be discussed in a separate poster presentation [6].

REFERENCES

[1] review: P. Gallo et al., Chem. Rev. 116, 7463 (2016) [2] K. H. Kim et al., Science 358, 1589 (2017) [3] Y. Kajihara et al., J. Phys.: Condens. Matter 20, 494244 (2008) [4] Y. Kajihara, Rev. High Press. Sci. Tech. (in Japanese) 26, 288 (2016) [5] Y.Kajihara et al., Phys. Rev. Research 5, 013120 (2023) [6] Y. Kajihara, Poster presentation in this meeting