The rise and fall of melting temperatures

A.B. Belonoshko1*

1Dept. of Physics, Royal Institute of Technology (KTH), Stockholm, Sweden

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*e-mail: anatoly@kth.se

The path of science has never been straight. The same holds for high pressure studies that led not only to amazing discoveries but also to numerous confusions. I will analyze the history of high pressure studies on iron phase diagram and show, how insight into the physics of the related processes allows to resolve current controversies. I will report the latest theoretical data on some metallic phase diagrams. A particular emphasis will be on the stabilization of the high-PT body-centered cubic (bcc) Fe under conditions of the Earth Inner Core1 and how its stabilization interfere in the interpretation of iron melting curve and resolution of related enigmatic questions.

The mechanism of the high-PT bcc Fe phase stabilization is quite unique. The atoms in this structure move at times as in a liquid2. Therefore, the mean square displacement never saturates and the diffusion coefficient and the viscosity of the bcc Fe are similar to those in very viscous liquid3.

Recently, our theoretical prediction of the stability of high-PT bcc Fe phase1,4 was confirmed by diamond anvil cell experiments5. Interesting, that when a number of the experimental studies analyzed with the knowledge of the physics of the bcc Fe phase, those experiments confirm the stability of the new phase rather than contradict it.

I will show how the X-ray diffraction pattern of the bcc Fe looks like and discuss whether similar XRD patterns have already been observed in Fe high-PT melting experiments. I will demonstrate that the stabilization of the bcc phase was at times misinterpreted as melting.

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[2] https://www.youtube.com/watch?v=s5Rl7mtxiEY