Explanation of Variation of potential energy in Crystals by Doppler Effect

N.Ramakumar[1]

Department of Physics, Dadi Institute of Engineering and Technology,
Anakapalle, Visakhapatnam, Andhra Pradesh, India.
[1]ramakumar@diet.edu.in

Abstract: The one of the greatest phenomena of Doppler Effect was interestingly well applicable in all aspects of science and technology. Staring with particles size minute to maximum and distances of nano meters to infinite Doppler Effect phenomenon is applicable. In solids group of atoms are situated with appropriated distances and their binding energy.i.e, cohesive energy is can be estimated with help of Doppler Effect. The greatest laws of forces like coulomb's and Lorentz are highly influencing these binding energies of the atoms in solids and these laws elaborated in very comprehensive manner. Care has been taken to explain the variation of potential energy in solids with interatomic distances with help of Doppler Effect.

Key words: Doppler Effect, interatomic distances, cohesive energy, apparent frequency, Doppler shift.

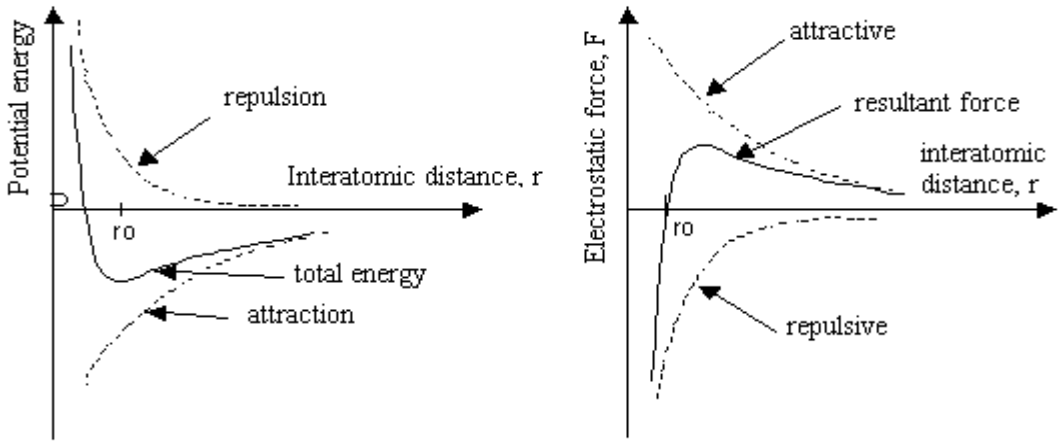
Introduction

The forces existed in this universe are many including electrostatic forces and nuclear forces which are very important in building blocks of crystals internally. Depending upon the atomic arrangements in the crystalline materials, their interatomic distances and cohesive energies are varies. The physical, chemical and other properties of crystals are decided by these atomic arrangements in the crystals. As from basic nature of crystal, the attractive force exits between the oppositely charged particles or ions, so they can be taken as a negative and it is inversely proportional to some power of the distance between the atoms. Similarly, the repulsive forces exist between the identical charged particles or ions and they can taken as positive and is inversely proportional to some power of the distance between the atoms.

General Background

The solid structures are formed due to the binding forces between the atoms in a molecule and the same binding forces are responsible for formation of crystal structures. Instead of magnetic and gravitational forces the electrical forces plays the vital role for binding the atoms as well as molecules. Generally crystals perform its stability more when they are in the form of individual atoms. The attractive interatomic forces exist which holds the atoms together. These interatomic forces are responsible for formation of crystals [4][5]. The atoms in the crystals experiences two kind of forces, one is attractive and other is repulsive which brings the atoms into closer to their vicinities until they achieve equilibrium state. The materials potential energy is sum of the individual energies of the atoms plus their internal interaction energy. When atoms all are infinitely apart so they don't interact with each other to form a solid. Then the potential energy between them is zero. It's potential inversely proportional to some power of the distance of separation. The potential energy due to the attraction is negative, since the atoms do the work of attraction. The repulsive energy is positive since external work must be done to bring the atoms together and it is inversely proportional to some power of the interaction separation " r ". The net potential is sum of the both terms.

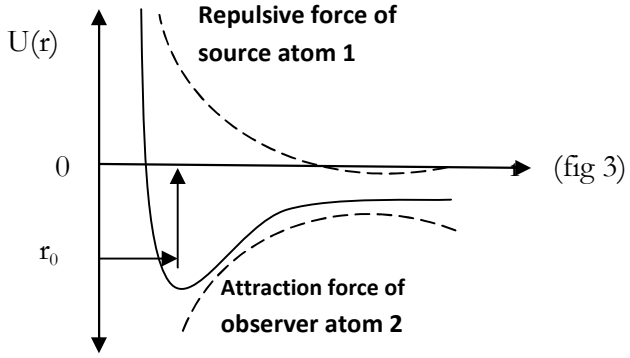
Suppose the two atoms A and B exerts attractive and repulsive forces and the bond forces, F will be act on the atoms $\boldsymbol{F(r) = -\frac{A}{r^M} + \frac{B}{r^N}}$, which N > M. Where, r is the center spacing between atoms, additionally A, B, M and N are constants characteristics of molecule [6]. The first term represents attractive force the second term represents repulsive force and both terms in a single equation reveals the relation between them, equilibrium state ultimately.



From fig, (right side), we can notice the variation of the electrostatic forces with the function of the interatomic distance and r_0 equilibrium state also shown. Similarly this condition can be applicable for the variation of potential energy according to their interatomic distances fig (left side). The potential energy with function of interatomic distance is mathematically expressed $\boldsymbol{U(r) = -\frac{a}{r^m} + \frac{b}{r^n}}$ which m > n.

Potential energy variation according to Doppler Effect:

The variation of the potential energy between the atoms of the crystals will be explained by Doppler Effect phenomenon. The apparent change in frequency of a sound wave due to the relative motion between the source and observer is known as Doppler Effect. If the frequency is replaced by potential energy and source and observer are replaced by two reference atoms in a crystal of different lattice points [3]. Firstly, in molten state the atoms in the solid moves in different directions and attractions and repulsions takes places during their motion. In order to get equilibrium state there is a potential energy variation takes place according interatomic distances. The apparent potential change takes place when the atoms displacements from their atomic scale.



If the relative motion between the observer and the source brings them closer, the apparent potential experienced greater than the actual frequency.

If the relative motion between them is separated with interatomic distance, the apparent potential lower than the actual frequency. The shift in the potential is known as Doppler shift in potential [1][2]. From fig 3., When source atom is moving away and observer atom at rest or source atom is at rest and observer atom is moving away then the potential energy with function of interactomic distances is decreases gradually. When the source or observer atom moves close with each other or both the atoms are moves opposite each other then potential energy increases gradually and at particular point i.e., equilibrium state potential energy becomes zero.

Conclusion

Here, I want to conclude that the variation of potential energy between atoms or ions or molecules of solids with help of interatomic distances was explained precisely earlier. The potential energy is taken as a main parameter which compared with distances and I assumed that the relative variation of potential can be estimated with help of Doppler Effect. The variation of potential energy explained with most familiar graphs and the same graphs has been taken as reference to explain Doppler Effect. Doppler Effect and its conditions will be applicable for explaining the variation potential in the crystals in all possible aspects. I consider Doppler Effect is the one of the easiest way to understand the physical, chemical, thermal and other properties of solids.

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