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Lattice Heat-Capacity of Crystals – A Q-Oscillator Debye Model

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Abstract – Tile theory manages a few uses of q-misshapening and quantum bunch thoughts to issues in consolidated issue material science. They are disfigurements of traditional gatherings and their structure is considerably more unpredictable than that of Lie gatherings, they sum up our recognizable ideas of balances to the 'domain of non-commutative geometry. The q-disfigurement of numbers was presented by Heine in 1878. The q-differential math which is a speculation of ord. inary differential math was additionally created in the nineteenth century, recently, there has been a lot of enthusiasm for the investigation of quantum gatherings and quantum algebras. The portrayal hypothesis of quantum algebras with a solitary twisting parameter q, has prompted the advancement of tile presently surely understood q-disfigured symphonious oscillator variable based math. Yet, 'Ne realize that in genuine physical frameworks one CaUI1()t expel the job of anharmonicity.

The way that the vitality levels of the q-oscillator are not similarly divided and the accomplishment of the q-oscillator model in representing the estimations on the infra-red range of a number of atoms, show that q-distortion can deal with anharmonicity impacts somewhat.

Key Words: Non-Commutative, Advancement, Q-Oscillator

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INTRODUCTION

Tile q-harmonic oscillator polynomial math examined in detail in the subsequent part, is a very much considered subject. In genuine physical frameworks, one can't expel the job of anharmouicity. For instance, the suspicion of sub-atomic and crystalline vibrations to be of symphonious kind is a romanticizing and test perceptions demonstrate deviations from the expectations dependent on consonant estimation. The disparity between hypothetical forecasts and test results, to a limited degree, can be expelled by expecting that the vibrations are of enharmonic type. In this section, we present the investigation of q-misshapenings of an enharmonic oscillator with quartic collaboration in first request bother hypothesis. The vitality range and measurable mechanics of q-Anharrnonic Oscillators (q-AO) are examined.

Anharmonic oscillator and its vitality range

We consider the anharmonic oscillator portrayed by tile Hamiltonian

$$H = \frac{p^2}{2m} + \frac{1}{2} m\omega^2 x^2 + \frac{\lambda}{4!} x^4 \quad \ldots 1.1$$

where ,\ is positive and assumed to l>e very small. In the Fock-space representation, H takes the form (56]

$$H = \hbar\omega(N + \frac{1}{2}) + \frac{\lambda}{4!} (\frac{\hbar}{2m\omega})^2 (6N^2 + 6N + 3) \quad 1\ldots2$$

where N is the number administrator having eigenvalues 0, 1, 2, ... 00. The second articulation on the RHS of eq. bodes well just for low-lying le•vels

Vitality range of q-AO

Tile Hamiltonian of the q-analogue of the anharmonic oscillator is take

$$\bar{H} = \frac{\bar{p}^2}{2m} + \frac{1}{2} m\omega^2 \bar{x}^2 + \frac{\lambda}{4!} \bar{x}^4 \quad \ldots 1.3$$

The q-position cperator X and the q-force administrator p of the q-,£L\O are identified with the q-boson administrators uq and aqt similarly as on account of q-disfigured symphonious oscillators (see eqs. WA work in the boson acknowledgment in which Nq = N = at an and the eigenstates are those of the typical consonant oscillator. From now on we drop tile addition q for q-twisted administrators and q-numbers for comfort. TI1US

$$\bar{x} = \sqrt{\frac{\hbar}{2m\omega}}\,(a + a^{\dagger})$$
$$\bar{p} = i\sqrt{\frac{\hbar m\omega}{2}}\,(a - a^{\dagger}) \quad ...1.4$$

where

$$[N, a^{\dagger}] = a^{\dagger};$$
$$[N, a] = -a;$$
$$a\,a^{\dagger} - q\,a^{\dagger}a = q^{-N} \quad ...1.5$$

TItle two fundamental 'test realities about the warmth limit of solids which any hypothesis J11l1St clarify are: (I) At room temperature, the warmth limit of most solids is near 3k B per particle so that for particles comprising of '71, molecules, the molar warmth limit is near 49 ~lnR where R is the all-inclusive gas steady. Precise estimations demonstrate temperature reliance of warmth limit sick this locale. (ii) At low temperatures, tile heat limits decline and disappear at T = O. Tile abatement goes as T 3. The Debye model for grid heat limit ofsolids has been strikingly fruitful in depicting the exploratory perceptions at low temperatures in numerous unadulterated crystalline solids. In the low temperature system, the Debye's hypothesis predicts (~\, ex 'T 3 in concurrence with trial results. In the high temperature district (T » en), the Debye model prompts the Dulong-Petit law: C; = 3R/g.atom, a steady for every monoatomic gem and is autonomous of temperature, This isn't in definite concurrence with exploratory perceptions which demonstrate an expansion of warmth limit with temperature.

REVIEW OF LITERATURE

The turn wave hypothesis has been amazingly effective in foreseeing the low temperature properties of ferromagnetisms [2013-2015]. The hypothesis is based upon the perfect model comprising of a grid or indistinguishable twists with cubic evenness and with isotropic trade coupling between closest neighbors, The idea of turn waves was presented by Bloch [2016&2018]. He demonstrated that low-lying excitations of a Spill framework with the previously mentioned properties are wave-like in. character. Tile vitality of a Spill wave is quantized and the quanta are known as magnons. Holstein and Primak off [2015] recommended the techniques for field hypothesis to turn waves and this offered ascend to the straight turn wave tb.eory where the magnon cooperation's are ignored 8,11(1 the Hamiltonian is communicated as an entirety of energies of uncoupled oscillators. The hypothesis yields a 1i reliance both for magnon heat limit and unconstrained polarization of a ferromagnet. The impact of turn wave cooperation on the vitality levels of the precious stone will be immaterial just if the all out number of turn waves is little. Numerous creators [2014-2015] have attempted to fuse magnon collaborations into che turn wave hypothesis. The most significant among them is the work due to Dyson [2012-2015].

He idealized the turn wave hypothesis by presenting magnon connections and demonstrated that at low temperatures, the impact of spin-wave association is slight. The most reduced request adjustment to the unconstrained polarization is corresponding to T 4, which for low temperatures is extremely little contrasted and the main Bloch 1i term. In this manner the turn wave hypothesis stays as an authentic technique for exploring the low temperature properties of materials with requested basic attractive minutes. In any case, the understanding between the turn wave hypothesis dependent on Hcisenberg trade model of ferromagnetism and exploratory perceptions isn't perfectiy agreeable. Numerous endeavors have been made to improve the model.

Tile work exhibited here is likewise one such endeavor. As of late, Bonechi etal.[2014] have researched the one dimensional Heisenberg ferromagnet by methods for quantum Galieli gathering and found that in this methodology, a portion of the outcomes given by the Bethe-ansatz strategy develop normally, It is as of now valued that q-disfigurement 67 call describe connection between different degrees of opportunity. For instance, Zhe Cbang and Hong Yan [46], in their depiction of turn vibration spectra of diatomic particles utilizing q-oscillator variable based math, have demonstrated that q-distortion portrays the pivot vibration association. Inspired by this reality and by the way that q-disfigurement brings sick non-straight impacts, we study the Heisenberg model of ferromagnetism utilizing q-distorted oscillator algebras. In the straight turn wave hypothesis of ferromagnetism [2014], the Heisenberg Hamiltonian is diagonalised by changing the turn administrators into boson administrators utilizing the Holstein-Primakoff transforma: particle ~73]. We build up a q-disfigured form of the turn wave hypothesis utilizing the q-distorted Holstcin-Primakoff change [2016] for the turn factors, treating the magnons as q-bosoru., The trade Hamiltonian in the closest neighbor estimation, is gotten. for little estimations of the twisting parameter TJ. The thermodynamic amounts sick the low temperature area are likewise assessed. It is discovered that the unconstrained polarization and m. agnetic commitment to explicit warmth limit have q-subordinate T terms sick expansion to the notable Bloch T term. In the point of confinement q 1, 011r outcomes match with the old style results. We have likewise made a similar investigation of the hypothetical outcomes with test information on account of the notable Heisenberg ferromagnets EuD and EuS. Before examining the q-disfigured model, we quickly review the fundamental ideas in direct turn wave hypothesis.

FERRORNAGNETIC MAGNONS-BASIC CONCEPTS

We consider tile basic instance of a limited cubic gem with intermittent limit condition. is and with N particles) every iota having z closest neighbors, To every molecule :I is atf.ached a turn vector sj of greatness s. At that point the Hamiltonian of the precious stone with isotropic closest neighbor exchan.ge connection can be composed as

$$\mathcal{H} = -J\sum_{j=1}^{N}\sum_{\delta=1}^{z}\vec{s}_j.\vec{s}_{j+\delta} - g\,\mu_B\,H\sum_{j} s_{jz}$$

The vectors LT associate particle j with its lfh closest neighbor on the bravais grid. .I is the trade vital bet\veen the J1hatom and its Y.h closest neighbor and for ferromagnets, J is sure. J-Ln is the Bohr magneton, 9 is the spectroscopic parting factor. The primary term in 'H is the Heisenberg trade vitality communicated in tC•"l.n~; of the nuclear turn administrators. The subsequent term is the Zeeman commitment which gives the cooperation vitality of each nuclear magnet with the outside attractive field HO whose course is taken as the positive z-heading. At the point when the framework is sick the ground express, the attractive minutes are arranged along the positive z-pivot. The dipole-dipole collaboration dry the communication of higher request attractive posts are dismissed here.

CONCLUSION

In this way the q-oscillator Debye model proposed here redresses the shortcoming of the first model sick the high temperature system. Tile disfigurement, however minor (1] rv lo-5)j produces brilliant understanding in the three cases considered over a wide scope of temperature. The examinations loan backing to the view that phonons in gems might be q-quantized excitations. Such phonons might be named q-phonons. The deviations saw at higher temperatures might be clarified considering quartic and higher request .cooperation’s potentially inside the system of a q-enharmonic oscillator model.

REFERENCE

1. S. L. Woronowicz (1987). Comm.Math.Phy~. 111, 613 (1987)

2. S. L. Woronowicz (1989). Invent. Math. 93, 35 (1988) [21] S L Woronowicz, Comm.Math.Phys. 122, 125.

3. I. J. D. Faddeev, N. Yu Reshetikhin and L. A. Takhtajan'I Quantisation of Lie 9'T'OUPS and Lie alqebras, LOMI Preprint E-14-87

4. J ~Ves.s and B Zumino (1991). Nucl.Phys.B Proc.Suppl. 18 B, 302, pp. 95

5. B. Zumi1 (1991). MOll.Pllys.Lett.A 6, pp. 1225.

6. S. Majid (1988). J. Classical atul Quant'l.L1Tl Gravity 5, pp. 1587.

7. F 1-1 Hoissen (1992). J.Ph,ys.A: lvla"th.Gen. 25, 1703.

8. Ya.Aref'eva I and Volorich I.:Preprint CERN-TH 6137/91 1

9. R. Chakrabarthi and R. Jagannathan (1991). J.Phys.A 24, 5683.

10. E. Heine, Hasulbucli der Kuqeljumkiionen, Vol.LReimer, Berlin (1878), reprinted by Physica-Verlag, Wurzburg (1961)

11. Exton, q-lujperqeometric !U7tCt1:0'118 and applications, Ellis Horwood, Chichester (1983)

12. F. Jackson (1908). Tran.s.R.Soc. 46, pp. 1253.

13. F. Jackson (1910). Q.J.Math. 41, pp. 193.

14. Jagannatb.an, R. Sridhar, R. Vasudevan, S. Chaturvedi, M. Krishnakumari, P. Shanta and Sreenivasan (1991). J.Phys.A. 25, 6429 (1992) [~~4] R Chakrabarti and R Jagannathan, .1.Phys.A: Matlt.Gen. 24, L711.

15. P. Raychev (1995). Q'uantum Groups: Application. to Nuclear and Molecular SpectT()SCOP'Y~ Advances ill Quantum Chemistry, Vo1.26, Academic Press.Inc.

16. C. Quesne and U. L. Bruxelles (1992). Rais-ing and Lowering operators for Uq(n), preprint PNT/1/92

17. H~on.g r'an~ c.l.Ph-:lJs.A: .i\la.th. Ge'IL 2iS, L 1155 (1990)

18. Kulish and E. V. Damakinsky (1990). J.Phys.A: Ma·th. Gen. 23, L 415 (1990) [a9] :H Ui and N Aizawa, ~fod.Plty~.Lett. A 5, 237.

19. P. Polychronakos (1990). lVlod.Phys.Lett. A 5, pp. 2325.

20. G. Vinod, K. Babu Joseph and V. C. Kuriakose (1994). Pramasia J.Phys. 42, pp. 299.

21. Chaichian, D. Ellinas and P. Kulish (1990). Phys. Rev. Lett. 65, 980.

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