AL'TSHULER, S.A.; BASHKIROV, Sh.Sh.; ZARIPOV, M.M.

Paramagnetic resonance and spin-lattice relaxation of Ti^{3+} ions in corundum. Fiz.tver.tela 4 no.12:3367-3372 D '62. (MIRA 15:12)

1. Kazanskiy gosudarstvennyy universitet im. V.I.Ul'yanova-Lenina.

(Paramagnetic resonance and relaxation)
(Titanium) (Corundum)

L 05063-67 EWT(d)/EWT(l)/EWP(v)/EWP(k)/EWP(h)/EWP(l)

ACC NR: AM6016003 Monograph UR/

Kulikovskiy, Longin Frantsevich; Zaripov, Nadiyar Fakhritdinovich 13 13+1

Inductive migration converters with distributed parameters (Induktivnyye preobrazovateli peremeshcheniy s raspredelennymi parametrami) (Moscow), Izd-vo "Energiya," 1966. 111 p. illus., biblio. 8000 copies printed. Series note: Biblioteka po avtomatike, vyp. 156

TOPIC TAGS: inductive converter, inductive displacement converter, information system

PURPOSE AND COVERAGE: This book is intended for a wide circle of engineers and technicians concerned with the problems of designing information and measuring systems. It may also be used by students and aspirants of related specialties. The book describes inductive converters with distributed magnetic and electrical parameters. The theoretical fundamentals of basic converter types are given; calculation methods of these devices are discussed; and examples of their use are given. No personalities are mentioned. There are 30 references, all Soviet.

Card 1/4 UDC: 621.3.081.8

L 05063-67
ACC NR: AM6016003

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ZARIPOV, M.

"Installing a Magic Eye in the Record Receiver," Radio, No. 3, 1949.

Samarkand, -c1949-.

LETOKHOV, V.S.; VATSURA, V.V.; PUKHLIK, Yu.A.; FEDOTOV, D.I.; KOSOZHIKHIN, A.S.; ZHABOTINSKIY, M.Ye.; DASHEVSKAYA, Ye.I.; KOZLOV, A.N.; RUVINSKIY, L.G.; VASIN, V.A.; YURGENEV, L.S.; NOVOMIROVA, I.Z.; PETROVA, G.N.; SHCHEDROVITSKIY, S.S.; BELYAYEVA, A.A.; BRYKINA, L.I.; GLEBOV, V.M.; DRONOV, M.I.; KONOVALOV, M.D.; TARAPIN, V.N.; MIKHAYLOVSKIY, S.S.; ZHEGALIN, V.G.; ZHABIN, A.I.; GRIBOV, V.S.; MAL'KOV, A.P.; CHERNOV, V.N.; RATNOVSKIY, V.Ya.; VOROB'YEVA, L.M.; MILOVANOVA, M.M.; ZARIPOV, M.F.; KULIKOVSKIY, L.F.; GONCHARSKIY, L.A.; TYAN KHAK SU

Inventions. Avtom. i prib. no.1:78-80 Ja-Mr '65. (MIRA 18:8)

VINOKUROV, V.M.; ZARIPOV, M.N.; KROMTOV, V.S.; STEPANOV, V.G.

Electron paramagnetic resonance of Mn^{2+} ions in cordierite. Geokhimiia no. 12:1486-1487 D '65 (MIRA 19:1)

1. Kazanskiy gosudarstvennyy universitet. Submitted November 20, 1964.

GREZNEV, Yu.S.; ZARIPOV, M.M.; STEPANOV, V.G.

Electron paramagnetic resonance of terbium in CoCl$_2$. Fiz. tver. tela 7 no. 12:3644-3645 D '65 (MIRA 19:1)

1. Kazanskiy gosudarstvennyy universitet imeni Ul'yanova-Lenina.

L 15731-66 EWT(m)/T/EWP(t)/EWP(b) IJP(c) JD/JG

ACC NR: AP6000892 SOURCE CODE: UR/0181/65/007/012/3688/3688

AUTHORS: Dernov-Pegarev, V. F.; Stepanov, V. G.; Zaripov, M. M.; Samoylovich, M. I.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvenny universitet)

TITLE: Investigation of EPR of Mn^{2+} ions in single crystal $ZnMoO_4$

SOURCE: Fizika tverdogo tela, v. 7, no. 12, 1965, 3688

TOPIC TAGS: zinc compound, molybdenum compound, epr spectrum, angular distribution, paramagnetic ion, spectral line, single crystal

ABSTRACT: The $ZnMoO_4$ were grown by the hydrothermal synthesis method. Investigation of the EPR spectrum at room temperature with a video spectroscope at 8 mm wavelength, disclosed a spectrum due to the divalent manganese and weaker lines of Cr^{3+} ions. The Cr^{3+} spectrum could not be investigated in detail because its lines overlapped the

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L 15731-66

ACC NR: AP6000892

more intense lines of Mn^{2+}, which contaminated the crystals. The angular dependence of EPR spectrum indicates that the symmetry of the crystalline field acting on the Mn^{2+} ions is not higher than rhombic, so that the spectrum can be described with the spin Hamiltonian of the rhombic system, for which the constants are given. The orientation of the z axis of Mn^{2+} in $ZnMoO_4$ coincides with the orientation obtained for Mn^{2+} in $CdWO_4$. Authors thank Ye. A. Pobedimskaya for the goniometric measurements. Orig. art. has: 1 formula.

SUB CODE: 07/ SUBM DATE: 14Jul65/ OTH REF: 001

Card 2/2

EWT(d)/EWP(z)/EWP(1) Pq-4/Pe-4/Pz-4 IJP(c) BB/GG
UR/0286/65/000/009/0092/0093

AUTHOR: Zaripov, M. F.

[illegible] multiplication and division. 166 Class 42,

No. 170758

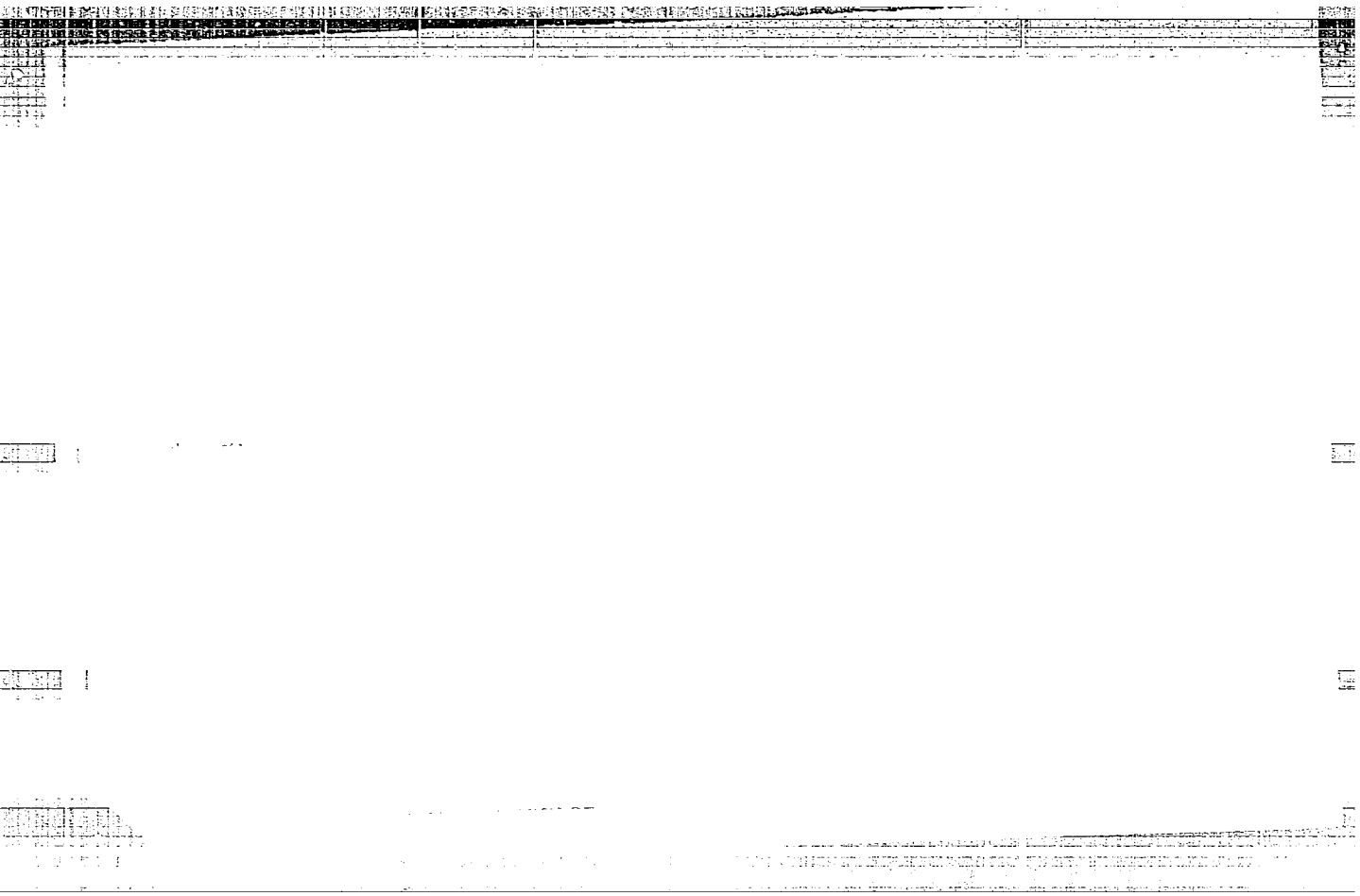
SOURCE: Byulleten' izobreteniy i tovarnykh znakov, no. 9, 1965, 92-93

TOPIC TAGS: electromechanical converter, calculator, electronic measurement

[illegible] based on electromechanical device for mul-

[illegible] is in the form of a rectangular core with a [illegible]
The other is in the form of an elongated letter P with differentially connected [illegible] coil loops. The measurement coil in this magnetic circuit is mounted on the short transverse portions of the [illegible]. The device also contains two short

Card 1/2



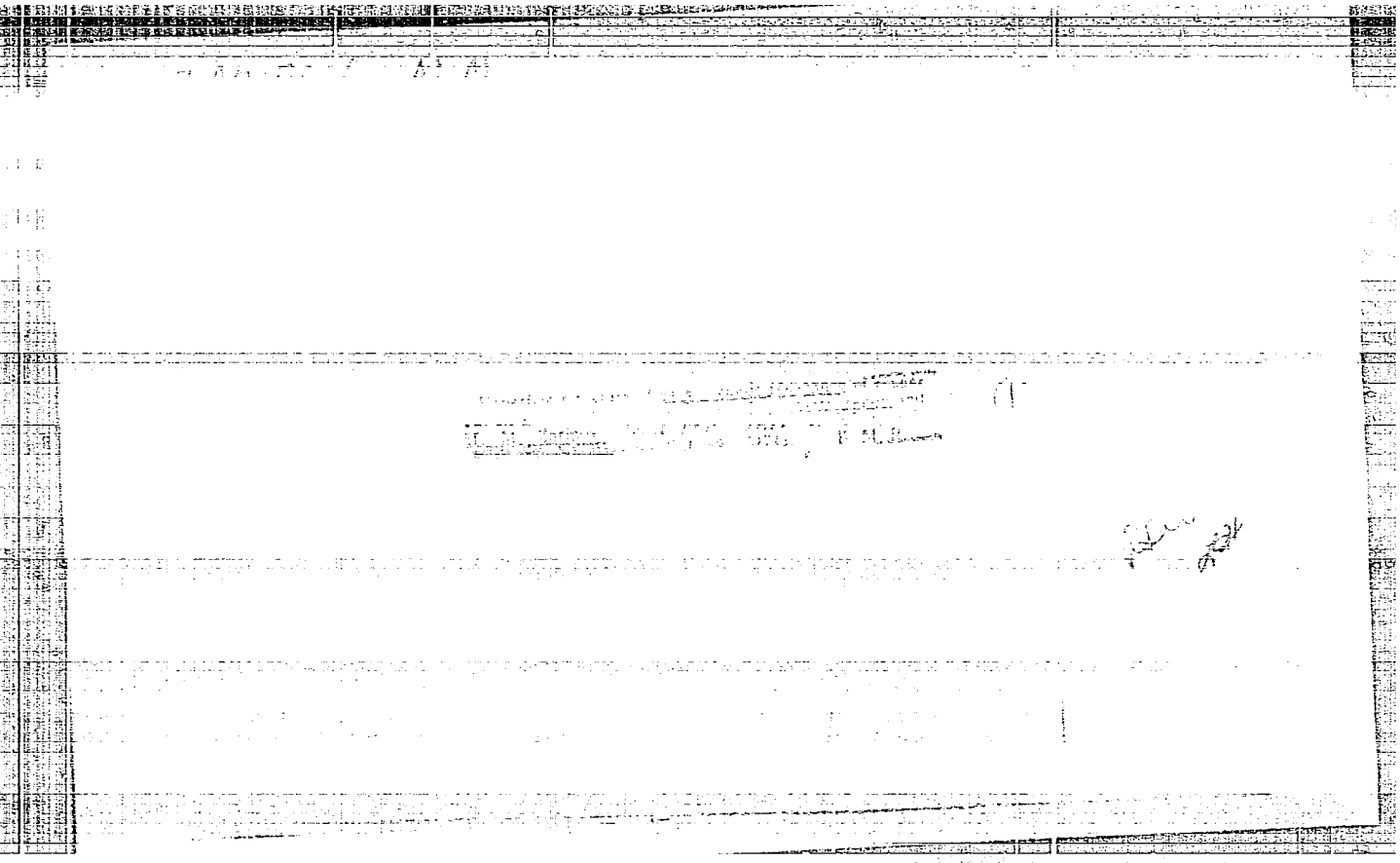
APPROVED FOR RELEASE: 09/19/2001 CIA-RDP86-00513R001963820017-4"

Card 2/3

ZARIPOV, M. M.

ZARIPOV, M. M.--"The Theory of Fine and Superfine Structure of the Spectra of Paramagnetic Resonance." Min Higher Education USSR. Kazan' State U imeni V. I. Ul'yanov-Lenin. Kazan', 1955. (Dissertation for the Degree of Candidate of Physicomathematical Sciences).

SO: Knizhnaya Letopis' No. 27, 2 July 1955



APPROVED FOR RELEASE: 09/19/2001 CIA-RDP86-00513R001963820017-4"

FD-2217

ZARIPOV, M.M.

USSR/Physics - Paramagnetic resonance

Card 1/2 Pub 146-22/25

Author : Garif'yanov, N. S., and Zaripov, M. M.

Title : Hyperfine structure of the paramagnetic resonance of Tutton copper salt in intermediate fields

Periodical : Zhur. eksp. i teor. fiz. 28, 629-630, May 1955

Abstract : Up to the present time the hyperfine structure of the paramagnetic resonance of compounds of ferric elements has been investigated at high frequencies of the order ten billion cycles, in which region the resonance conditions for elements of the ferric group are fulfilled in strong magnetic fields, such fields permitting the splittings due to the interactions of the moments of the nuclei with the electrons. The authors note that at lower frequencies, in the decimeter and meter range, conditions are created that correspond to the Zeeman effect in intermediate and weak fields (S. A. Al'tshuler, B. M. Kozyrev, and S. G. Salikhov, DAN SSSR, 71, 1950; B. M. Kozyrev, Izv. AN SSSR, ser. fiz. 16, 1952), these investigations at low frequencies being used to verify the general theory of paramagnetic resonance absorption in crystals and also to determine precisely the constants of the hyperfine structure. In the present

work the authors study the paramagnetic resonance in single-crystals of $CuK_2(SO)_2 \cdot 6H_2O$ diluted 1:200 by isomorphous zinc salt at frequency 526.74 million cycles at temperature of liquid air. Eight references: e.g. Ye. K. Zavoyskiy, Dissertation, Physics Institute, Acad. Sci. USSR, Moscow, '44.

Institution : Physicotechnical Institute of Kazan Affiliate, Academy of Sciences USSR. Kazan State University

Submitted : November 30, 1954

ZARIPOV, M. M. (Kazan)

"Hyperfine splitting of the Simple Electron levels of Paramagnetics," paper presented at the International Conference on Physics of Magnetic Phenomena, Sverdlovsk, USSR, 23-31 May 1956

AUTHOR : Zaripov, M.M.

TITLE : Hyperfine Splitting of Singlet Electronic Levels of Paramagnetics (Sverkhtonkoye rasshchepleniye prostykh elektronnykh urovney paramagnetikov)

PERIODICAL : Izvestiya Akademii Nauk, V XX, # 11, 1220-1223, Nov 1956, (USSR), Seriya fizicheskaya

ABSTRACT : A theory of paramagnetic resonance caused by transitions between hyperfine sublevels of singlet electronic levels of paramagnetic ions is proposed.

The effect under consideration is intermediate between the phenomena of electronic and nuclear paramagnetic resonance, both in the position of resonance lines and their intensities.

The Hamiltonian of the problem is composed on the basis of the general theory of paramagnetic resonance spectra in crystals (3).

A table in the article contains the values computed for the coefficients of the spin Hamiltonian and the relative values of probabilities for magnetic dipole transitions.

Card 1/2

Zaripov, M.M

AUTHORS: Zaripov, M.M. and Shamonin, Yu.Ya.

TITLE: Electronic Paramagnetic Resonance in Natural Beryls (Elektronnyy paramagnitnyy rezonans v yestestvennykh berillakh)

PERIODICAL: Izvestiya Akademii Nauk, V. XX, # 11, 1224-1225, Nov 1956, (USSR), Seriya fizicheskaya

ABSTRACT: A spectrum of paramagnetic resonance absorption in 5 natural monocrystals of beryl was discovered during an investigation of paramagnetic resonance at a frequency of 9,655 megacycles. A curve in the article shows the general view of the spectrum. The table shows resonance values of the constant magnetic field (in oersteds).

Since the monocrystals of pure beryl do not contain paramagnetic atoms, the appearance of a paramagnetic resonance absorption spectrum is caused by paramagnetic admixtures in the beryl lattice. This admixture may be Fe^{+++} ions, which can substitute in an isomorphic way Al^{+++} ions in the beryl lattice. The optical spectrum analysis has confirmed the presence of iron. The results of this research show that a qualitative analysis of

Card 1/2

ZARIPOV, M.M.

USSR/Magnetism - Magnetic Radiospectroscopy, F-6

Abst Journal: Referat Zhur - Fizika, No 12, 1956, 34977

Author: Zaripov, M. M., Shamonin, Yu. Ya.

Institution: Kazan' University, USSR

Title: Paramagnetic Resonance in Synthetic Rubies

Original Periodical: Zh. eksperim. i teor. fiziki, 1956, 30, No 2, 291-295

Abstract: Experiments were made at room temperature and at a frequency of 9,580 Mc. Investigation was made of monocrystals of artificial rubies, the general equation of which can be written in the form $(1-n)\ Al_2O_3 \cdot nCr_2O_3$, with n = 0.1 - 0.01%. The paramagnetic resonance is given by the Cr^{3+} ions. The observed spectra are well explained if one assumes that the electric field of the crystal has fundamentally a trigonal symmetry; this does not contradict the crystallographic data on rubies. The initial splitting of the ground level of Cr^{3+} is found to be 0.38 cm^{-1} and the g-factors entering into the usual spin Hamiltonian is found to be $g_{\parallel} \approx g_{\perp} = 0.98$.

Card 1/1

48-6-12/23

TITLE: Resonance Paramagnetic Absorption of Ultrasound in Some Salts of Rare Earth Elements (Rezonansnoye paramagnitnoye pogloshchen-iye ul'trazvuka v nekotorykh solyakh redkozemel'nykh elementov)

the formula

$$\mathcal{F}_{\alpha\beta} = \sum r^2 \left(\frac{\partial U}{\partial x}\right)_{\alpha\beta}$$

where U - is the interaction energy with a neighboring particle of the magnetic atom under consideration

r - is the separation between the given particles, and

x - is the r-projection on the direction of sound propagation.

Ultrasonic absorption coefficients for longitudinal waves were calculated by the above formulae for Pr^{3+}, Eu^{3+}, Tb^{3+}, Ho^{3+} and Tm^{3+}, and it was established that the maximum absorption must occur in europium in an excited state.

The phenomenon of paramagnetic resonance absorption, caused by transitions between sub-levels of hyperfine structure, will be intermediate in its magnitude between the phenomena of electronic and nuclear paramagnetic resonance.

Frequencies of the order of 10^7 cycles can be used for the experimental discovery of the absorption effect, if ultrasound is

Card 2/3

ZARIPOV, M M

20-6-15/59

AUTHOR GARIF'YANOV, N.S., ZARIPOV, M.M., KOZYREV, B.M.,

TITLE On the Value of the Spin of the Fe^{57} Nucleus.
(O znachenii spina yadra Fe^{57} - Russian).

PERIODICAL Doklady Akademii Nauk SSSR, 1957, Vol 113, Nr 6, pp 1243-1243 (U.S.S.R.)

ABSTRACT The authors of the paper under review conducted measurements of the paramagnetic resonance in a congealed vitreous solution of borax, this solution contained iron. The cylindrical samples were obtained by melting together 5 mg of $FeCl_3.6H_2O$ and 4 g of borax. Sample # I contained an iron which had been enriched with the isotope Fe^{57} up to a concentration of 71.91%, whereas the analogous sample # II contained the common mixture of isotopes that had not been enriched. The measurements were conducted at 77° K at the frequencies of 115, 240 and 430 megacycles, and they were carried out with the aid of the method of the grid current, with the constant magnetic field H being modulated. The amount of the effective g-factor, the asymmetrical shape of the curves $\chi''(H)$, and the widening of these curves at frequency multiplication (all these phenomena can be observed in sample # II) permit to draw the following conclusion: The ion Fe^{+++} is under conditions that are analogous to the conditions in the derivatives of haemoglobin. It is probable that also in the case considered in the paper under review the lowest Kramers doublet ($M_s = \pm 1/2$) is in a considerable distance from the other sublevels. In such a case, taking into account the low frequencies employed in this investigation, one has to expect that the maximum of the absorption corresponds to the effective g-factors ~4, as a matter of fact, this was also observed in the experiments car-

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24.2000

77111
SOV/70-4-6-12/31

AUTHORS: Vinokurov, V. M., Zaripov, M. M.

TITLE: Magnetic Properties of Tourmaline

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 6, pp 873-877 (USSR)

ABSTRACT: Magnetic properties of tourmalines depending on their chemical composition and color were studied. Previous works in this field are briefly reviewed. Measurements of the specific mass magnetic susceptibilities (χ_m) of green, black, and pink tourmalines were taken on the radio frequency unit described previously (V. M. Vinokurov, Kristallografiya, 3,5, 600, 1958). Results of the measurements of specific mass magnetic susceptibilities of black tourmalines (schorls) are given in Table 1, those of the green tourmalines in Table 2, and those of the pink tourmalines in Table 3.

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The following conclusions, from the data obtained, were made. The high susceptibility and considerable anistropy of the black tourmalines is due to the presence of Fe^{++} ion ($^5D_4$). Introduction of Fe^{+++} ions ($^6S_{5/2}$) and Mn^{++} ions ($^6S_{5/2}$) into crystal lattice of black tourmaline increases susceptibility and decreases anisotropy of the crystal. In the authors' opinion, the difference in the anisotropy of magnetic susceptibility of the green tourmalines is determined by the ratio of Fe^{++} to Fe^{+++}. This is contrary to M. Leela, who attributed the differences to the presence of Cr^{++} ions ($^5D_0$). According to the spectral analyses of the investigated tourmalines, made by A. L. Stolov on the author's request, and also literature data, the tourmalines in question contain no Cr. In the authors' opinion the pink color of

tourmalines is not determined by the presence of Mn^{+++} ions, as was suggested by S. V. Grum-Grzhimaylo and M. M. Slivko, since the presence of Mn^{+++} would cause a higher anisotropy, which is not the case (see Table 3). The low susceptibility and some anistropy of the pink tourmalines are determined by the presence of small quantities of Mn^{++} and Fe^{++} ions, and also by the diamagnetism. There are 3 tables; and 14 references, 2 U.K., 2 German, 2 Indian, 8 Soviet. The U.K. references are: Wilson, Proc. Roy. Soc. A., 96, 429, 1920; J. E. S. Bradley, O. Bradley. Mineral. Mag., 30, 220, 1953.

ASSOCIATION: Kazan' State University (Kazanskiy gosudarstvennyy universitet)

SUBMITTED: March 16, 1959

24 (7)

AUTHORS: Vinokurov, V. M., Zaripov, M. M., Yafayev, N. R.

SOV/56-37-1-54/64

TITLE: The Fine Structure of the Paramagnetic Resonance Spectrum of Natural Sapphire (Tonkaya struktura spektra paramagnitnogo rezonansa yestestvennogo sapfira)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 1, pp 312 - 313 (USSR)

ABSTRACT: The authors investigated the paramagnetic resonance spectrum of some natural sapphire crystals at room temperature within the frequency range of 9600 - 9200 megacycles, and tell of the results obtained in the present "Letter to the Editor". The blackish-blue color of the sapphire was caused by Fe^{3+}- and Ti^{3+}-ions, which substituted the Al^{3+} amorphously in corundum. Because of the short spin-lattice relaxation times, the Ti^{3+}-ions give no effect at room temperature, for which reason it is assumed that such an effect is due to the Fe^{3+}-ions, which was confirmed by the present investigation. Korniyenko and Prokhorov (Ref 2) already carried out an investigation of the fine struc-

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The Fine Structure of the Paramagnetic Resonance Spectrum of Natural Sapphire SOV/56-37-1-54/64

ture of the paramagnetic electron resonance spectrum of Fe^{3+}-ions in the Al_2O_3-lattice, and showed that the spectrum observed is possible as a result of the here given Hamiltonian (1). By basing upon these and using other results of reference 2, the authors theoretically investigated the paramagnetic resonance spectrum of sapphire and numerically computed the constants of the Hamiltonian (1), g, |D|, |a-F| and |a|; they found it to agree within the error limits with those of the Fe^{3+}-ions (Ref 2) introduced artificially into Al_2O_3. Also the splitting up of Fe^{3}-resonance lines found in reference 3 was likewise found in the sapphire crystals. There are 2 figures and 2 Soviet references.

ASSOCIATION: Kazanskiy gosudarstvennyy universitet (Kazan' State University)

SUBMITTED: March 28, 1959

Card 2/2

S/058/61/000/010/049/100
A001/A101

24,7900

AUTHORS: Baru, V.G., Zaripov, M.M.

TITLE: Calculation of times of spin-lattice paramagnetic relaxation in hydrated cobalt salts

PERIODICAL: Referativnyy zhurnal.Fizika, no.10, 1961, 164-165, abstract 10V366 (V sb. "Paramagnitn. rezonans", Kazan', Kazansk, un-t, 1960, 68-74)

TEXT: In the framework of Van Vleck's theory ("Phys. Rev.", 1940, v.57, 426) the authors calculated the spin-lattice paramagnetic relaxation time taking into account the contribution from spin-orbital coupling and crystalline fields of tetragonal and trigonal symmetries. In calculations were used constants obtained in the interpretation of the paramagnetic resonance spectrum of hydrated Co salts (Abrahams, A., Pryce, M.N.L., "Proc. Roy. Soc.", 1951, v. 206, 173). Direct processes and Raman processes of scattering of phonons on spins are considered. It is shown that the presence of a considerable admixture to the ground 4F-term of Co ion of an excited 4P-term does not cause any peculiarities in the form of dependence of relaxation time on temperature and constant magnetic field.

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Calculation of times ...

S/058/61/000/010/049/100
A001/A101

A quantitative comparison with experimental data (Bleaney, B., Ingram, D.J.E., "Nature", 1949, v. 164, 116) confirms the correctness of relaxation mechanism selected by the authors.

U. Kopvillem

[Abstracter's note: Complete translation]

Card 2/2

BIL'DYUKEVICH, A.L.; VINOKUROV, V.M.; ZARIPOV, M.M.; POL'SKIY, Yu.Ye.; STEPANOV, V.G.; CHIRKIN, G.K.; SHEKUN, L.Ya.

Electron paramagnetic resonance in andalusite. Zhur. eksp. i teor. fiz. 39 no. 6:1548-1551 D '60. (MIRA 14:1)

1. Kazanskiy gosudarstvennyy universitet.
(Paramagentic resonance and relaxation)
(Andalusite)

VINOKUROV, V.M.; ZARIPOV, M.M.; STEPANOV, V.G.

Paramagnetic resonance of Mn^{2+} in dolomite and magnesite. Zhur. eksp. i teor. fiz. 39 no. 6:1552-1153 D '60. (MIRA 14:1)

1. Kazanskiy gosudarstvennyy universitet.
(Paramagnetic resonance and relaxation)
(Manganese) (Dolomite) (Magnesite)

27299

S/181/61/003/008/029/034
B111/B102

24.7900

AUTHORS: Vinokurov, V. M., Zaripov, M. M., Stepanov, V. G., Pol'skiy, Yu. Ye., Chirkin, G. K., and Shekun, L. Ya.

TITLE: Electron paramagnetic resonance in natural chrysoberyl

PERIODICAL: Fizika tverdogo tela, v. 3, no. 8, 1961, 2475 - 2479

TEXT: The electron paramagnetic resonance spectrum of the Fe^{3+} ions which substituted isomorphically the Al^{3+} ions in Al_2BeO_4 was investigated. Measurements were made of triple, double, and single crystals at room temperature, at, $(7 - 51)\cdot10^9$ cps, and in magnetic fields of up to 20 kilogauss. Nuclear resonance of hydrogen, deuterium, and lithium was used to measure the field strength. The single crystals were placed in a cylindrical H_{111} resonator, and their natural faces (100) on its bottom. H could be changed by an angle of 360° in that plane. For studying the angular dependence of the e.p.r. spectrum between $10\cdot10^9$ and $20\cdot10^9$ cps a H_{011}

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resonator was used. The crystal in it could rotate around an axis perpendicular to the resonator's axis. The magnet rotated together with it by 360°. The measurements showed that the angular dependence of the e.p.r. spectrum was due to paramagnetic atoms substituting the Al^{3+} ions. The direction c was found to be one of the main directions of the electric field in the crystal acting on the paramagnetic ion. Whilst the existence of four magnetically nonequivalent, pairwise identical complexes was expected from X-ray diffraction studies, investigations of the e.p.r. spectra indicated the existence of only two identical complexes oriented in opposite directions. The orientations of the other two include an angle of about 70°. The authors attempt to explain this divergence by the assumption that the Al^{3+} ions are replaced by Fe^{3+} only in those complexes (II and IV in Fig. 1) in which the Al^{3+} ions are arranged symmetrically around the O^{2-} ions. If one considers only the neighborhood of the substituting Fe^{3+} ions, they seem to be subjected to an almost cubically symmetric electric field. It is, however, shown that the spectrum observed can be described by a Hamiltonian of lower (rhombical) symmetry. This fact is explained by the assumption that the atoms farther

Electron paramagnetic resonance...

from the Fe^{3+} ions which are arranged in rhombical symmetry have a significant influence upon the crystal field. Only in a few cases Al^{3+} ions in octahedral sites (I and III, Fig. 1) are substituted by Fe^{3+} ions. V. D. Kolomenskiy and V. G. Kuznetsov are thanked for having supplied specimens, D. Kh. Dinmukhametov and R. M. Mineyev for their assistance in calculations, and S. A. Al'tshuler for discussions. There are 3 figures and 4 references: 1 Soviet-bloc and 3 non-Soviet-bloc.

ASSOCIATION: Kazanskiy gosudarstvennyy universitet im. V. I. Ul'yanova-Lenina (Kazan' State University imeni V. I. Ul'yanov-Lenin)

SUBMITTED: April 5, 1961

09267

S/056/61/040/001/035/037
B102/B212

24.7900 (1147, 1158, 1160)

AUTHORS: Al'tshuler, S. A., Zaripov, M. M.

TITLE: Theory of the paramagnetic resonance of Ti and Co ions in corundum

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 1, 1961, 377-379

TEXT: Experimental investigations of paramagnetic resonance in Al_2O_3 crystals with different paramagnetic impurities has been interpreted to the effect that the Ti and Co ions in these crystals possess magnetic properties differing from other compounds. The authors of the present "Letter to the editor" examined this problem theoretically and showed that all experimental results concerning paramagnetic resonance spectra and spin-lattice relaxation time can be easily explained. For Ti in corundum an anomalously large anisotropic factor ($g_{\parallel} = 1.067$, $g_{\perp} < 0.1$) has been measured, and the spin-lattice relaxation time T_1 did increase from $T_1 = 5.10^{-8}$ to 0.1 sec in the

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S/056/61/040/001/035/037
B102/B212

Theory of the paramagnetic...

transition from 9 to 1.55°K. If it is assumed that the trigonal component of the crystal field has a much stronger spin-orbit interaction, and if the cubic and trigonal components are considered at the same time, and, moreover, if the constant of the trigonal field is taken to be negative, then it is possible to explain those data. The spin-orbit interaction splits the orbital ground level into two Kramers' spin doublets (interval $\delta = 70\ cm^{-1}$), and one obtains $g_\perp = 0$ and $g_\parallel = 1.07$. If the importance of the covalent coupling between the metal ion and the surrounding oxygen atoms is taken into account then one finds that $g_\perp$ for the Ti ion has to be somewhat different from zero. Considering the very strong spin-lattice interaction one obtains, due to the main role of two-phonon processes: $T_1 \sim T^{-1}$. Theoretical values for Co^{2+} ions agree with experimental results if the constants of the trigonal field are changed somewhat in the spin Hamiltonian

$$\mathcal{H} = D\left[S_z^2 - \frac{1}{3}S(S+1)\right] + g_\parallel H_z S_z + g_\perp \beta(H_x S_x + H_y S_y) + AI_z S_z + B(I_x S_x + I_y S_y),$$

the spin-orbit interaction in second perturbation theoretical approximation

Card 2/3

being taken into account, the change being such that the initial splitting of the spin quadruplet is $2D = 24\ cm^{-1}$; ($S = 3/2$). It has been established experimentally that the spin-lattice coupling of Co^{2+} ions is much stronger at $25^{\circ}K$ than that of Cr^{3+} ions; at helium temperatures, conversely, T_1 of Cr^{3+} ions was much shorter than T_1 of Co^{2+} ions. This can be also explained if we consider that at higher than helium temperatures the spin-lattice coupling will be strong and is governed by two-phonon processes, while at temperatures below helium temperature it will be governed by single-phonon processes which are related to transitions between spin-levels of the lower Kramers doublet. There are 4 references: 2 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Kazanskiy gosudarstvennyy universitet (Kazan' State University)

SUBMITTED: November 2, 1960

28756

S/056/61/041/003/009/020
B125/B102

24.2110 (1138, 1147, 1164)

AUTHORS: Valiyev, K. A., Zaripov, M. M.

TITLE: Theory of spin-lattice relaxation in liquid solutions of electrolytes

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 3(9), 1961, 756-761

TEXT: The spin-lattice relaxation of hydrated metal ions in aqueous solutions, caused by interaction of the ionic spin with the internal oscillations of the complex, has been studied by the methods of the theory of random processes. The energy of interaction of the spin $\vec{S}$ of the central ion of the complex with the oscillations Q_j can usually be represented as a series: $\mathcal{H} = \mathcal{H}^{(1)} + \mathcal{H}^{(2)} + \ldots = \sum_j P_j(\vec{S})Q_j + \sum_{ij} P_{ij}(\vec{S})Q_iQ_j + \ldots$ (1), where $P_j(\vec{S})$ and $P_{ij}(\vec{S})$ are quadratic functions of the components of the vector $\vec{S}(S_x, S_y, S_z)$. S. A. Al'tshuler and K. A. Valiyev (ZhETF, 35, 947, 1958) calculated the relaxation rate of the spin $\vec{S}$, which is due to the

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terms in the series expansion of the spin energy, which are linear with respect to Q_j. The terms in the expansion of $\mathcal{H}^{(2)}$, which are quadratic with respect to Q_j, excite a more efficient relaxation. Independently of the present authors, I. V. Aleksandrov and G. M. Zhidomirov arrived at the same conclusion (ZhETF, 41, 127, 1961). The relaxation-transition probability between sublevels of the spin energy is calculated from the perturbation-theoretical formula

$$w_{M,M'} = \hbar^{-2} \sum_{i,j} \overline{|\langle M|P_{ij}(S)|M'\rangle Q_i Q_j|^2} \rho_{ij}(\omega_{M,M'}) \qquad (2),$$

where $\rho_{ij}(\omega_{M,M'})$ is the spectral density of the perturbation energy $\mathcal{H}^{(2)}$ at the transition frequency $\omega_{M,M'}$. The bar denotes the average over the arguments of $\mathcal{H}^{(2)}_{M,M'}$. The densities $\rho_{ij}(\omega)$ and $\rho_{jj}(\omega)$ occurring in (2) are given by the expressions

$$\rho_{//}(\omega)=\frac{1}{2}\frac{\lambda_i+\lambda_j+\tau_r^{-1}}{(\omega_i+\omega_j-\omega)^2+(\lambda_i+\lambda_j+\tau_r^{-1})^2}+\frac{1}{2}\frac{\lambda_i+\lambda_j+\tau_r^{-1}}{(\omega_i+\omega_j+\omega)^2+(\lambda_i+\lambda_j+\tau_r^{-1})^2}+$$
$$+\frac{1}{2}\frac{\lambda_i+\lambda_j+\tau_r^{-1}}{(\omega_j-\omega_i-\omega)^2+(\lambda_i+\lambda_j+\tau_r^{-1})^2}+\frac{1}{2}\frac{\lambda_i+\lambda_j+\tau_r^{-1}}{(\omega_i-\omega_j+\omega)^2+(\lambda_i+\lambda_j+\tau_r^{-1})^2}, \quad (5)$$

$$\rho_{//}(\omega)=\frac{2}{3}\frac{\tau_r^{-1}}{\tau_r^{-2}+\omega^2}+\frac{2}{3}\frac{2\lambda_j+\tau_r^{-1}}{\omega^2+(2\lambda_j+\tau_r^{-1})^2}+$$
$$+\frac{2\lambda_j+\tau_r^{-1}}{(2\lambda_j+\tau_r^{-1})^2+(2\omega_j+\omega)^2}+\frac{2\lambda_j+\tau_r^{-1}}{(2\lambda_j+\tau_r^{-1})^2+(2\omega_j+\omega)^2}$$

The parameters λ_j occurring in (5) indicate the dissipation probabilities of the vibration energy of the complex. For $\omega_j\tau_c \gg 1$ one obtains $\lambda_j \sim \tau_c^{-1}$ and $\lambda_j \sim 10^{12}$ sec^{-1}. The frequencies ω_j amount to $\sim 10^2$ cm^{-1} from which it follows for $\omega_{M,M'} \ll \lambda_j$ that $\rho_{jj}(\omega) \approx 10^{-11}$ sec and $\rho_{ij}(\omega) \approx 10^{-13}$ sec. If the coordinates Q_i and Q_j are degenerate ($\omega_i = \omega_j$), one finds $\rho_{ij} = \rho_{jj}$. Relaxation in aqueous solutions of Cr^{3+} salts: The ^4F term of the free Cr^{3+}

ion in the cubic field produced by the six particles X_i is split up in such a way that the lower orbital level is single. The distance between the remaining orbital levels and the lower level is $\sim 10^{-4}$ cm^{-1}. The matrix element of the perturbation $\mathcal{H}^{(2)} + \lambda LS$, which connects the two spin levels M and M', occurs in third approximation. For the probability of the transition M, M+2 one obtains

$$w_{M,M+2} = (S_x^2)^*_{M,M+2}\hbar^{-2}\{e_1[\tfrac{6}{5}(\overline{Q_1^4}\rho_{22} + \overline{Q_3^4}\rho_{33}) + \tfrac{49}{5}\overline{Q_2^2}\,\overline{Q_3^2}\rho_{23} + \tfrac{961}{150}\overline{Q_2^4}\rho_{22} + \\ + \tfrac{19}{5}(\tfrac{\lambda\lambda}{\omega})^2(\overline{Q_5^4}\rho_{55} + \overline{Q_6^4}\rho_{66})] + \tfrac{16}{5}e_2^2[\overline{Q_4^2}\,\overline{Q_5^2}\rho_{45} + \overline{Q_5^2}\,\overline{Q_6^2}\rho_{56} + \overline{Q_4^2}\,\overline{Q_6^2}\rho_{46}]\}. \quad (12)$$

$$\overline{Q_j^2} = \frac{\hbar}{2\omega_j\mu_j}\operatorname{cth}\frac{\hbar\omega_j}{2kT}, \qquad \overline{Q_j^4} = \frac{3}{4}\frac{\hbar^2}{\omega_j^2\mu_j^2}\operatorname{cth}^2\frac{\hbar\omega_j}{2kT}. \quad (13)$$

where

$$\overline{|(S_x^2)_{M,M'}|^2} = \tfrac{2}{15}(S_xS_z)^*_{M,M+1}; \quad \tfrac{8}{15}(S_x^2)^*_{M,M+2},$$

$$\overline{|(S_x^2 - S_y^2)_{M,M'}|^2} = \tfrac{2}{15}(S_xS_z)^*_{M,M+1}; \quad \tfrac{16}{15}(S_x^2)^*_{M,M+2}, \quad (11)$$

$$\overline{|(S_\mu S_\nu)|^2} = \tfrac{2}{15}(S_xS_z)^*_{M,M+1}; \quad \tfrac{16}{15}(S_x^2)^*_{M,M+2}.$$

The braces denote the symmetric product $\{ab\} = ab + ba$. Similarly, one obtains the probability of the transitions M, M+1, which are of the same order of magnitude. $\varrho_{ij} \approx \varrho_{jj} \approx 10^{-11}$ sec is valid in (12). With $Q^4 = 1.5 \cdot 10^{-37}$ cm^4 the authors found the values $\varepsilon_1 = 1$, $\varepsilon_2 = 0.1$, and $w_{M,M+2} \approx 5 \cdot 10^7$ sec^{-1}, which is one order of magnitude smaller than the experimental value ($\sim 5 \cdot 10^8$ sec^{-1}). Eq. (12) gives a sufficient description of the temperature dependence of the resonance line width of Cr^{3+} ions in an aqueous solution of $Cr(NO_3)_3$, where ΔH_{exp} at 303, 323, 373, 423, and 473°K is 245, 190, 125, 107, and 105 oe, respectively. The authors found ΔH_{theor} 200, 137, 106, and 89 oe for 323, 373, 423, and 473°K at $w_j = 560$ cm^{-1} and $E/k = 1250$°K. In the case of an anisotropic g factor or Stark splitting of the ion sublevel ($S > 1/2$), another relaxation mechanism is possible, which leads to $T_1^{-1} \sim \coth^2 (\hbar\omega_j/2kT)\tau_r/(1+\omega^2_{M,M'}\tau_r^2)$. The resonance-line width of Cu^{2+} ions in aqueous solution: The orbital

levels are described by the wave functions $\psi_a = (\psi_2 + \psi_{-2})/\sqrt{2}$, $\psi_b = \psi_0$, $\psi_0 = (\psi_2 - \psi_{-2})/\sqrt{2}$, $\psi_d = (\psi_1 + \psi_{-1})/\sqrt{2}$, $\psi_e = (\psi_1 + \psi_{-1})/\sqrt{2}$. $\Delta \sim 10^4$ and $\delta \sim 10^3 cm^{-1}$. The width of the resonance line observed during the transitions $a, M = -1/2 \rightarrow a, M = +1/2$ is due to relaxation transitions between the orbital sublevels a and b which are excited under the action of $\mathcal{H}^{(2)}$ alone (without participation of the interaction $\lambda \vec{L}\vec{S}$). The direct transitions a→b are much more probable than transitions with spin re-orientation. The matrix element of a direct transition reads

$$\mathcal{H}^{(2)}_{a\rightarrow b} = a(Q_5^2 - Q_6^2) + bQ_2Q_3 + cQ_4Q_5;$$
$$a = \frac{9\sqrt{3}}{8}\left(\Lambda_1 - \frac{825}{8}\Lambda_2\right), \quad b = -18\left(\Lambda_1 - \frac{375}{16}\Lambda_2\right), \quad c = i\frac{45\sqrt{3}}{8}\Lambda_2; \quad (17)$$
$$\Lambda_1 = ee'\alpha\overline{r^2}R^{-5}, \quad \Lambda_2 = ee'\mu\overline{r^4}R^{-7}, \quad \alpha = -3\beta = 2/21.$$

and the probabilities of the transitions a→b read

$$w_{a,b} = \hbar^{-2}\left[a^2(\overline{Q_5^4}\rho_{55} + \overline{Q_6^4}\rho_{66}) + b^2\overline{Q_2^2}\,\overline{Q_3^2}\rho_{23} + c^2\overline{Q_4^2}\overline{Q_5^2}\rho_{45}\right] e^{-\delta/2kT} \quad (20).$$

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Theory of spin-lattice relaxation...

The temperature dependence of (20) is given by $w_{a,b} \sim \exp(-\delta/2kT)\,\mathrm{cth}^2(\hbar\omega_j/2kT)\lambda_j$, where $\lambda_j \sim \exp(-E/RT)$; the parameter E has the significance of a "viscosity barrier" of the liquid. The 1.8-fold broadening of the line in the same temperature range, observed by Kozyrev, is close to the calculated value. There are 1 figure and 12 references: 5 Soviet and 7 non-Soviet. The three most recent references to English-language publications read as follows: J. R. Senitzky. Phys. Rev., 119, 670, 1960; H. J. Mc Connell. J. Chem. Phys., 25, 709, 1956; B. R. Mc Garvey. J. Phys. Chem., 61, 1232, 1957.

ASSOCIATION: Kazanskiy pedagogicheskiy institut (Kazan' Pedagogical Institute)

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VINOKUROV, V.M.; ZARIPOV, M.M.

Blue color of apatites. Dokl.AN SSSR 136 no.1:61-62 Ja '61.
(MIRA 14:5)

1. Kazanskiy gosudarstvennyy universitet im. V.I.Ul'yanova-Lenina.
Predstavleno akademikom I.V.Belovym.
(Apatite) (Color of minerals)

24.7900

S/181/62/004/003/012/045
B102/B104

AUTHORS: Vinokurov, V. M., Zaripov, M. M., Stepanov, V. G., Pol'skiy, Yu. Ye., Chirkin, G. K., and Shekun, L. Ya.

TITLE: Paramagnetic resonance of trivalent chromium in andalusite

PERIODICAL: Fizika tverdogo tela, v. 4, no. 3, 1962, 646 - 649

TEXT: In Al_2SiO_5 there are two magnetically non-equivalent types of Cr^{3+} ions: the z-axes of both lie in the ab plane but diverge by an angle of 77°, the y-axes lie in the same plane, the x-axes coincide with the direction of the c-axis of the crystal. The z-axes of the Fe^{3+} ions diverge by 57.8°, the angle between the z-axes of the first types of Fe^{3+} and Cr^{3+} ions is 22.6°. The Cr^{3+} electron paramagnetic resonance in Al_2SiO_5 was measured at 9431 Mcps. The angular dependence of the resonance field was determined for the transition M = -3/2 → -1/2 (M - magnetic quantum number). For $\vec{H} \parallel z$, $g_{eff} \approx 2$, for $\vec{H} \parallel x$ and $\vec{H} \parallel y$, $g_{eff} \approx 4$, i. e. the initial splitting

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δ of the spin quadruplet of $Cr^{3+} > 10^{10}$ cps. The resonance values of H do not coincide for $\vec{H} \parallel x$ and $\vec{H} \parallel y$. The spin Hamiltonian is

$$\mathcal{H} = D\left[S_z^2 - \frac{1}{3}S(S+1)\right] + E(S_x^2 - S_y^2) + \beta(g_x H_x S_x + g_y H_y S_y + g_z H_z S_z) \quad (1);$$

its constants are: S=3/2, $g_{\parallel} = 1.976$, $g_{\perp} = 1.985$, $D = 15.95 \cdot 10^9$ cps, $E = 0.60 \cdot 10^9$ cps. The initial splitting δ is $(32.0 \pm 0.1) \cdot 10^9$ cps, which agrees well with the theoretical value ($\delta = 2\sqrt{D^2+3E^2} = 31.97 \cdot 10^9$ cps).

O. I. Mar'yakhina is thanked for help and S. A. Al'tshuler for interest.

There are 3 figures and 3 references: 1 Soviet and 2 non-Soviet. The English-language references are: R. W. G. Wyckoff. Crystal Structure, II, 1951; A. Abragam M. H. L. Pryce. Proc. Roy. Soc. A205, 135, 1951.

ASSOCIATION: Kazanskiy gosudarstvennyy universitet imeni V. I. Ul'yanova-Lenina (Kazan' State University imeni V. I. Ul'yanov-Lenin)

SUBMITTED: October 16, 1961

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3647
S/056/62/042/002/031/055
B108/B104

54,9200 (1068, 1158, 1144)

AUTHORS: Valiyev, K. A., Zaripov, M. M.

TITLE: Effect of the shape of molecules on the magnetic relaxation rate in liquids

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 503 - 510

TEXT: The theory of magnetic relaxation is generalized to nonspherical molecules whose Brownian rotation is characterized by the diffusion tensor $D_{jk} = \frac{1}{2} kT(\beta^{-1}_{jk} + \beta^{-1}_{kj})$. β_{jk} is the viscosity tensor of the liquid in question. The rotational diffusion equation for arbitrary particles is $\partial w/\partial t = - \hat{M}_j D_{jk} \hat{M}_k w$, where $\hat{M}_j$ is the operator of rotation about the axis $j(x,y,z)$. The Green's function of the diffusion equation is expanded into a series of the eigenfunctions ψ_ν of the operator $\hat{M}_j D_{jk} \hat{M}_k$, $\hat{M}_j D_{jk} \hat{M}_k \psi_\nu = D_\nu \psi_\nu$. Thus, $G(t) = \sum_\nu \psi^*_\nu(\alpha^0, \beta^0, \gamma^0) \psi_\nu(\alpha,\beta,\gamma) \exp(-D_\nu |t|)$. The α's etc. are the

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Effect of the shape of molecules...

Euler angles (orientation) of the molecule at the times t = 0 and t, respectively. The ψ_ν in the equation for G(t) are the orthonormalized wave functions of a quantum mechanical rotator, the D_ν can be found from the eigenvalues of the rotator energy by substituting $D_{jk} \to (1/2)\hbar^2 J^{-1}_{jk}$ where J_{jk} is the tensor of inertia of the rotator. The D, ψ, and G are calculated for symmetrical and unsymmetrical rotators. For quadrupole interaction, the correlation function K and the transition probability A in nuclear spin relaxation are

$$K_{M,\,M-m}(t) = |\overline{\mathcal{H}'_{M,\,M-m}}|^2 \sum_{n=-2}^{2} \Omega_n \exp(-D^{(2)}_{mn}|t|),$$

$$A_{M,\,M-m} = \frac{2\pi}{\hbar^2} |\overline{\mathcal{H}'_{M,\,M-m}}|^2 \sum_n \Omega_n \rho(D^{(2)}_{mn}),$$

$$\Omega^2_{\pm 2} = \tfrac{3}{2} g_\varphi^{-2} |\varphi'_{\pm 2}|^2 = \tfrac{3}{2} g_\varphi^{-2} [\varphi^2_{\xi\eta} + \tfrac{1}{4}(\varphi_{\xi\xi} - \varphi_{\eta\eta})^2],$$

$$\Omega^2_{\pm 1} = \tfrac{3}{2} g_\varphi^{-2} |\varphi'_{\pm 1}|^2 = \tfrac{3}{2} g_\varphi^{-2} [\varphi^2_{\xi\zeta} + \varphi^2_{\eta\zeta}]^2, \qquad \Omega^2_0 = \tfrac{3}{8} g_\varphi^{-2} \varphi_0^2 = \tfrac{9}{4} g_\varphi^{-2} \varphi^2_{\zeta\zeta},$$

$$D^{(2)\,\prime}_{m,\pm 2} = 2D_1 + 4D_2, \qquad D^{(2)\,\prime}_{m,\pm 1} = 5D_1 + D_2, \qquad D^{(2)\,\prime}_{m,0} = 6D_1,$$

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Effect of the shape of molecules...

$$\Omega^a_{-2} = \frac{3}{4} g_\varphi^{-2} |\varphi'_2 - \varphi'_{-2}|^2 = 3g_\varphi^{-2}\varphi^2_{\xi\eta}, \quad \Omega^a_{-1} = \frac{3}{4} g_\varphi^{-2} |\varphi'_1 - \varphi'_{-1}|^2 = 3g_\varphi^{-2}\varphi^2_{\xi\zeta},$$

$$\Omega^a_{1,2} = \frac{3}{4} g_\varphi^{-2} \left| \sqrt{\frac{c_\pm}{4g_D}} (\varphi'_2 + \varphi'_{-2}) \mp \sqrt{\frac{c_\mp}{2g_D}} \varphi'_0 \right|^2 = \frac{3}{4} g_\varphi^{-2} \left| \sqrt{\frac{c_\pm}{4g_D}} (\varphi_{\xi\xi} - \varphi_{\eta\eta}) \mp \right.$$

$$\left. \mp \sqrt{\frac{3c_\mp}{4g_D}} \varphi_{\zeta\zeta} \right|^2, \quad \Omega^a_0 = \frac{3}{4} g_\varphi^{-2} |\varphi'_1 + \varphi'_{-1}|^2 = 3g_\varphi^{-2}\varphi^2_{\eta\zeta};$$

$$p(x) = (x/\pi)/(x^2 + \omega^2_{MM'}).$$

ξ, η, ζ are the coordinates of the system of the molecule. g_φ is the invariant of the tensor $\varphi_{ij} = \partial^2\varphi/\partial x_i \partial x_j$, where φ is the potential of the molecular electron shell. $\varphi_{\pm 2} = \frac{1}{2}(\varphi_{xx} - \varphi_{yy}) \pm i\varphi_{xy}$; $\varphi_{\pm 1} = \mp\varphi_{xz} - i\varphi_{yz}$; $\varphi_0 = \frac{\sqrt{6}}{2}\varphi_{zz}$. The perturbation $\mathcal{H}'$ which causes the transition between the stationary levels is due to the quadrupole moment of the nucleus in the charge shell of the molecule. The external field H_0 goes in the z direction. The superscripts s and a respectively refer to symmetric and unsymmetric rotators. A similar calculation is performed for the relaxation owing to intramolecular dipole-dipole interaction, where $\mathcal{H}' = \mathcal{H}_{jk}$

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Effect of the shape of molecules...

$$= \sum_{m=-2}^{2} \mathcal{H}^{m}_{jk} = P_{jk} \sum_{m} A_{-m} \{jk\}_{-m} Y_{2m}(\theta_{jk}, \varphi_{jk}) \text{ and}$$

$$\{jk\}_2 = \{jk\}^{*}_{-2} = \mathcal{J}^{+}_j \mathcal{J}^{+}_k, \quad \{jk\}_1 = \{jk\}^{*}_{-1} = \mathcal{J}^{+}_j \mathcal{J}_{kz} + \mathcal{J}_{jz} \mathcal{J}^{+}_k,$$
$$\{jk\}_0 = \mathcal{J}_{jz} \mathcal{J}_{kz} - \frac{1}{4}(\mathcal{J}^{+}_j \mathcal{J}^{-}_k + \mathcal{J}^{-}_j \mathcal{J}^{+}_k), \quad \mathcal{J}^{\pm} = \mathcal{J}_x \pm i\mathcal{J}_y,$$
$$A_2 = A_{-2} = A_1 = -A_{-1} = \sqrt{6\pi/5}, \quad A_0 = -\sqrt{16\pi/5}, \tag{26}$$
$$P_{jk} = g_{J_j} g_{J_k} \beta^2_N r^{-3}_{jk}.$$

The relaxation owing to anisotropy of the g-factor and of the hyperfine structure constant a_{ij} is calculated with the relations

$$\mathcal{H} = \mathcal{H}_0 + \mathcal{H}', \quad \mathcal{H}_0 = g^1 \beta S_z h_0 + a^1 S_z J_z, \quad g^1 = \tfrac{1}{3} g_{ll}, \quad a^1 = \tfrac{1}{3} a_{ll},$$
$$\mathcal{H}' = g^{11}_{ij} \beta h_i S_j + a^{11}_{ij} J_i S_j, \quad g^{11}_{ij} = g_{ij} - \delta_{ij} g^1, \quad a^{11}_{ij} = a_{ij} - \delta_{ij} a^1, \quad i, j = x, y, z. \tag{32}$$

The relaxation transition probabilities are then

$$A_{M_s, M_J; M_s - 1, M_J} = \frac{\pi}{15\hbar^2} (S + M_s)(S - M_s + 1) g^2_p \sum_n \Omega_{n\rho} (D^{(2)}_{m, n}), \tag{39.1}$$

$$A_{M_s, M_J; M_s, M_J - 1} = \frac{\pi}{15\hbar^2} (J + M_J)(J - M_J + 1) M^2_i g^2_a \sum_n \Omega_{n\rho} (D^{(2)}_{m, n}), \tag{39.2}$$

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Effect of the shape of molecules...

$$A_{M_s, M_J; M_s-1, M_J-1} = \frac{\pi}{15\hbar^2}(S+M_s)(S-M_s+1)(J+M_J)(J-M_J+1)\times$$
$$\times g_a^2 \sum_n \Omega_{np}(D^{(2)}_{m,n}). \qquad (39.3),$$

The so called secular broadening $(1/T_2')$ of the electron resonance line $M_S - 1$, $M_J \longrightarrow M_S$, M_J corresponding to the diagonal matrix element of the perturbation $\mathcal{H}'$ for nonspherical molecules is

$$(T_2')^{-2} = (32\pi/45)g_p^2 h^{-2}\sum_n \Omega_n \text{arc tan}(2/D^{(2)}_{m,n}T_2').$$

There are 10 references: 3 Soviet and 7 non-Soviet. The four most recent references to English-language publications read as follows: Y. Masuda. J. Phys, Soc. Japan, 11, 670, 1956; H. M. McConnell. J. Chem. Phys., 25, 709, 1956; L. D. Favro. Phys, Rev., 119, 53, 1960; S. Broersma. J. Chem. Phys., 32, 1626, 1632, 1960.

ASSOCIATION: Kazanskiy pedagogicheskiy institut (Kazan' Pedagogical Institute)

SUBMITTED: August 4, 1961

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ZARIPOV, M.M.; MURTAZIN, Sh.F.; STEPANOV, V.G.

Calculation of the paramagnetic resonance spectrum of Mn^{2+}. Opt. i spektr. 14 no.3:421-422 Mr '63. (MIRA 16:4)
(Paramagnetic resonance and relaxation) (Manganese—Spectra)

VINOKUROV, V.M.; ZARIPOV, M.M.; [illegible]; STEPANOV, V.G.; CHIRKIN, G.K.; SHEKUN, L.Ya.

Electron paramagnetic resonance of Gd^{+3} in CaF_2. Fiz. tver. tela 5 no.2:599-604 F '63. (MIRA 16:5)

1. Kazanskiy gosudarstvennyy universitet imeni V.I.Ul'yanova-Lenina.
(Paramagnetic resonance and relaxation) (Gadolinium)
(Calcium fluoride)

S/051/63/014/003/013/019
E039/E120

AUTHORS: Zaripov, M.M., Murtazin, Sh.F., and Stepanov, V.G.

TITLE: On the calculation of the paramagnetic resonance spectrum of Mn^{2+}

PERIODICAL: Optika i spektroskopiya, v.14, no.3, 1963, 421-422

TEXT: The fine and hyperfine structure of the paramagnetic resonance spectrum of Mn^{2+} for natural single crystals of calcite $CaCO_3$ is described (F.K. Hurd, H. Sachs, W.D. Hershberger, Phys. Rev., v.93, 1954, 373) by a spin Hamiltonian of the following form:

$$\mathcal{H} = g_{\parallel}\beta H_z S_z + g_{\perp}\beta(H_x S_x + H_y S_y) + D\left[S_z^2 - \frac{1}{3}S(S+1)\right] +$$

$$+ \frac{F}{180}\left[35S_z^4 - 30S(S+1)S_z^2 + 25S_z^2 - 6S(S+1) + 3S^2(S+1)^2\right] +$$

$$+ AI_z S_z + B(S_x I_x + S_y I_y) \qquad (1)$$

where with $H \parallel z$ $D = 81 \pm 0.4$, $F = 61.632$, $A = 93.95 \pm 0.05$, $g_{\parallel} = 2.0022 \pm 0.0006$; with $H_{\perp}$ z $D = 79.4 \pm 0.4$, $F = 61.632$,

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B = 93.90 ± 0.05, g = 2.0014 ± 0.0006. D, F, A and B are in oersteds. It is shown that this form of spin Hamiltonian is not applicable for describing the Mn^{2+} EPR spectrum, hence the determination of Eq.(1) is repeated. The denominator of the terms in the second and fourth approximations must depend not only on the Zeeman energy, but on the coefficients D, F and A, which were not calculated by Hurd et al. In order to obtain an expression for $E_{M, m}$ in compact form the proper value of Eq.(1) is calculated by another method. The energy level is determined to the third approximation and the results are presented in the form:

With H || z,

$$E_{M,m}=g_0\beta HM+D\left[M^2-\frac{1}{3}S(S+1)\right]+f(M)+AMm+$$
$$+\frac{A^2}{2g_0\beta H}\left(M[I(I+1)-m^2]-m[S(S+1)-M^2]\right)+$$
$$+\frac{A^2}{(2g_0\beta H)^2}[S(S+1)-M(M+1)][I(I+1)-m(m-1)]\times$$
$$\times[D(2M+1)+f(M+1)-f(M)+A(m-M-1)]+ \qquad (2)$$
$$+\frac{A^2}{(2g_0\beta H)^2}[S(S+1)-M(M-1)][I(I+1)-m(m+1)]\times$$
$$\times[-D(2M-1)+f(M-1)-f(M)+A(-m+M-1)],$$

for $H \perp z$:

$$E_{M,m} = g_\perp \beta H M - \frac{D}{2}\left[M^2 - \frac{1}{3}S(S+1)\right] + \frac{3}{8}f(M) + BMm +$$
$$+ \frac{D^2}{2g_\perp \beta H}\left(M\left[2S(S+1) - 1\right] - 2M^3\right) + \frac{A^2}{2g_\perp \beta H}\left(M\left[l(l+1) - m\right.\right.$$
$$\left.\left. - m\left[S(S+1) - M^2\right]\right) + \frac{A^2}{(2g_\perp \beta H)^2}\left[S(S+1) - M(M+1)\right]\left[l(l+1) - m(m-1)\right]\times\right.$$
$$\times\left[-\frac{D}{2}(2M+1) + \frac{3}{8}f(M+1) - \frac{3}{8}f(M) + A(m - M - 1)\right] +$$
$$+ \frac{A^2}{(2g_\perp \beta H)^2}\left[S(S+1) - M(M-1)\right]\left[l(l+1) - m(m+1)\right]\times \qquad (2)$$
$$\times\left[\frac{D}{2}(2M-1) + \frac{3}{8}f(M-1) - \frac{3}{8}f(M) + A(-m + M - 1)\right] +$$
$$+ \frac{D^2}{(2g_\perp \beta H)^2}\left[S(S+1) - M(M-1)\right]\left[S(S+1) - (M-1)(M-2)\right]\times$$
$$\times\left[2D(M-1) + \frac{3}{8}f(M-2) - \frac{3}{8}f(M) - 2Am\right] +$$
$$+ \frac{D^2}{(2g_\perp \beta H)^2}\left[S(S+1) - M(M+1)\right]\left[S(S+1) - (M+1)(M+2)\right]\times$$
$$\times\left[-2D(M+1) + \frac{3}{8}f(M+2) - \frac{3}{8}f(M) + 2Am\right],$$

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On the calculation of the ... S/051/63/014/003/013/019
E039/E120

where $f(M) = \frac{F}{180}\left[35M^4 - 30M^2S(S+1) + 25M^2 - 6S(S+1) + 3S^2(S+1)^2\right]$;
M and m are magnetic quantum numbers corresponding to electron and nuclear spin. With calculations of the second and third approximation it is assumed that A = B. By the use of this expression the position of the absorption lines is calculated (determined from the resonance condition $E_{M,m} - E_{M-1,m} = h\nu$) and agree with the experimental results within the error of measurement if the following values for the constants are assumed:
For $H \parallel z$
D = 81, F = 7.704, A = 95.95, $g_{\parallel} = 2.0018$;
For $H \perp z$
, D = 81, F = 7.704, B = 94.40, $g_{\perp} = 2.0013$.
For determining these constants the results of measurements carried out by Hurd were used.
SUBMITTED: July 20, 1962

Card 4/4

L 10873-65 EWA(k)/EWT(l)/EWT(m)/EEC(k)-2/T/EEC(b)-2/EWP(k)/EWP(b)/EWA(m)-2 Po-4/

AUTHOR: Zaripov, M. M. B

SOURCE: Ref. zh. Fizika, Abs. 8D316

TITLE: Contribution to the theory of spin lattice relaxation of the ions of the rare earth group in liquid solutions

CITED SOURCE: Sb. Materialy* Nauchn. konferentsii. Kazanek. gos. ped. in-t, 1962. Kazan', 1963, 376-379

TOPIC TAGS: rare earth element, spin lattice relaxation, Brownian motion, liquid state, solvent action, phonon, paramagnetic material

TRANSLATION: In the case of ions of the rare-earth group, relaxation can be realized via a two-step process in which the excited state participates. Such a transition is possible because of energy exchange between the spin system and the lattice via the phonons. The

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L 10879-65
ACCESSION NR: AR4046536

possibility of these transitions for ions in liquid solutions is examined. The frequencies of the internal oscillations of paramagnetic complexes have as a result of the interaction with the Brown- [illegible] The excited [illegible] tions are possible. The calculations made for the ions Ce^{3+} and Pr^{3+} both in accordance with the usual relaxation theory where the matrix elements are expressed in terms of the Zeeman and orbit- [illegible] and in accordance with the theory of two-step transitions, give the following orders of magnitude: $\tau_s \sim 10^{-}$ sec for Ce^{3+} and $\tau_s \sim 10^{-14}$ sec for Pr^{3+} ($\delta \approx (10--100)$ cm^{-1}, $T = 350°$).

A. Smirnov.

SUB CODE: NP, GP ENCL: 00

Card 2/2

ACCESSION NR: AP4034943 S/0181/64/006/005/1545/1546

AUTHORS: Garif'yanov, N. S.; Zaripov, M. M.

TITLE: The study of glass by electron paramagnetic resonance at low frequencies

SOURCE: Fizika tverdogo tela, v. 6, no. 5, 1964, 1545-1546

TOPIC TAGS: glass, electron paramagnetic resonance, g factor, fine structure

ABSTRACT: The authors studied electron paramagnetic resonance in sulfate and borate glasses, (containing about 0.01 mole/liter of Cr and Gd) in the frequency range 100-600 megacycles and at 300 and 77K. The g factor in the sulfate glass at 77K and in Cr-bearing borate glass at 300 and 77K ranged between 3.00 and 2.95, depending on the frequency. An absorption line with g = 5.33, independent of frequency, was observed in Gd-bearing sulfate glass at 77K. A line with g = 4.70, independent of frequency and temperature, was observed in borate glass. A study of electron paramagnetic resonance spectra indicates the observed effects to be due to the Cr^{3+} and Gd^{3+} ions. It is noted that partially allowed fine structure was observed at frequencies of about 10 kilomegacycles in the EPR spectrum of Gd^{3+}-bearing borate glass; in low-temperature glasses a broad line with g = 1.99 was found.

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ACCESSION NR: AP4034943

Orig. art. has: 1 figure, 1 table, and 2 formulas.

ASSOCIATION: Kazanskiy fiziko-tekhnicheskiy institut AN SSSR (Kazan Physicotechnical Institute, AN SSSR); Kazanskiy gosudarstvenny*y universitet im. V. I. Ul'yanova-Lenina (Kazan State University)

SUBMITTED: 09Dec63 ENCL: 00

SUB CODE: MT NO REF SOV: 002 OTHER: 001

Card 2/2

ACCESSION NR: AP4039647 S/0181/64/006/006/1645/1648

AUTHORS: Zaripov, M. M.; Chirkin, G. K.

TITLE: Investigation of the electron paramagnetic resonance spectrum of Cu^{2+} in NH_4Cl

SOURCE: Fizika tverdogo tela, v. 6, no. 6, 1964, 1645-1648

TOPIC TAGS: electron paramagnetic resonance, unit cell, excess charge, g factor, spin orbit constant, crystal structure, crystal lattice, doublet, intercrystalline electric field, spin Hamiltonian

ABSTRACT: The authors investigated the electron paramagnetic resonance spectrum of Cu^{2+} in NH_4Cl at frequencies of the order of 40 kilomegacycles at a temperature of 77K. They observed the spectrum and studied its angular variation for single crystals grown from a parent solution having the proportion of Cu^{2+}: NH_4Cl = $1 : 10^4$. The studies showed the presence of three magnetically nonequivalent Cu^{2+} ions. The axis of the intercrystalline electric field was oriented along the cube

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ACCESSION NR: AP4039647

edge of the unit cell. From these studies the authors proposed a hypothesis for the mechanism of penetration of the Cu^{2+} ions into the NH_4Cl lattice and analyzed the g factor and the spin orbit interaction constant. Experimental values are given by the two sets of coefficients

$$\begin{array}{llll} c_1=0.7736, & c_2=0.0894, & c_3=0.6274; \\ c_1=0.7082, & c_2=0.7011, & c_3=0.0825, \end{array} \quad (1)$$

and g is given by

$$g_{\parallel}=2(3c_1^2-c_2^2-2c_3^2), \quad g_{\perp}=4c_1(c_2+c_3). \quad (2)$$

Orig. art. has: 7 formulas.

ASSOCIATION: Kazanskiy gosudarstvenny*y universitet im. V. I. Ul'yanova-Lenina (Kazan State University)

SUBMITTED: 09Dec63 DATE ACQ: 19Jun64 ENCL: 00

SUB CODE: IC NO REF SOV: 003 OTHER: 005

Card 2/2

ACCESSION NR: AP4041727 S/0181/64/006/007/2178/2178

AUTHOR: Antipin, A. A.; Vinokurov, V. M; Zaripov, M. M.

TITLE: Electron paramagnetic resonance of Co^{2+} in calcite

SOURCE: Fizika tverdogo tela, v. 6, no. 7, 1964, 2178

TOPIC TAGS: Co sup 2 plus paramagnetic resonance, paramagnetic resonance effect, electron paramagnetic resonance

ABSTRACT: The effect of paramagnetic resonance has been detected in synthetic single crystals of calcite containing a small impurity of cobalt atoms, at a frequency of about 9×10^9 cps. One group consisting of eight absorption lines was observed. Resonance magnitudes of a constant magnetic field for all eight lines simultaneously reach extreme values when the magnetic field H is perpendicular or parallel to the third-order axis (C_3) of the crystal. At room temperature and at 77K, no effect was observed. The measurement data for H parallel and perpendicular to C_3 and for some intermediate orientations shows that the spectrum can be described by a spin Hamiltonian. It can be assumed that the spectrum is due to Co^{2+} ions (Co^{59}, $I = \frac{7}{2}$),

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ACCESSION NR: AP4041727

isomorphically substituted for Ca^{2+} in calcite.

ASSOCIATION: Kazanskiy gosudarstvenny*y universitet im. V. I. Ul'yanova-Lenina (Kazan State University)

SUBMITTED: 21Jan64 ATD PRESS: 3048 ENCL: 00

SUB CODE: NP NO REF SOV: 000 OTHER: 000

Card 2/2

S/0051/65/018/002/0245/0250

ACCESSION NR: AP5000037

AUTHOR: Zorikov, M. M.

[illegible] internal vibrations of paramagnetic complexes on the rate of spin-lattice relaxation

SOURCE: Optika i spektroskopiya, v. 18, no. 2, 1965, 245-250

TOPIC TAGS: anharmonicity, internal oscillations, paramagnetic complex, spin lattice relaxation, relaxation rate

ABSTRACT: The author investigates the influence of anharmonicity of the internal [illegible] on the relaxation rate, within the framework of the spin-[illegible] solutions of paramagnetic salts proposed by [illegible]

[illegible] icity of the oscillations greatly improves the agreement between the theoretical and experimentally obtained dependence of the spin-lattice relaxation on the tem-

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ZARIPOV, M.M.; CHIRKIN, G.K.

Electron paramagnetic resonance spectra and the structure of the immediate environment of paramagnetic ions in NH_4Cl. Fiz. tver. tela 7 no.10:2947-2951 O '65. (MIRA 18:11)

1. Kazanskiy gosudarstvennyy universitet imeni Ul'yanova-Lenina.

L 8976-66 EWT(l)/EWT(m)/EPF(n)-2/EWP(t)/EWP(b) LIP(c) JD/WW/GG

ACC NR: AP5027425 SOURCE CODE: UR/0181/65/007/011/3409/3410

AUTHOR: Zaripov, M. M.; Chirkin, G. K.

ORG: Kazan State Institute im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Electron paramagnetic resonance and second order phase transitions in ammonium chloride

SOURCE: Fizika tverdogo tela, v. 7, no. 11, 1965, 3409-3410

TOPIC TAGS: EPR, ammonium compound, chloride, second order phase transition

ABSTRACT: The paramagnetic resonance spectra of NH_4Cl are studied as a function of temperature in the phase transition regions of -30.5 and 184.3°C since these transitions have a strong effect on the magnetic relaxation of hydrogen and chlorine nuclei. Bivalent ions of manganese and copper were used as paramagnetic centers. Effects of the lower phase transition were observed on curves for the resonance magnetic field, g-factors and constants of the hyperfine structure of the ions as functions of temperature. No effect attributable to the higher transition were observed, which indicates that rearrangement of the ammonium chloride crystal lattice at this point does not take place close to the paramagnetic center. The authors thank V. F. Koryagin and G. I. Novikova for assistance in the work. Orig. art. has: 2 figures.

SUB CODE: 07,20/ SUBM DATE: 11May65/ ORIG REF: 001/ OTH REF: 002

Card 1/1

L 11136-66 EWT(l)/EWT(m)/EWP(t)/EWP(b) IJP(c) JD/WW/JG/GO

ACC NR: AP6000870 SOURCE CODE: UR/0181/65/007/012/3644/3645

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet) 52 50

AUTHORS: Greznev, Yu. S.; Zaripov, M. M.; Stepanov, V. G.

TITLE: Electron paramagnetic resonance of terbium in CeO_2 21,44,55 27

SOURCE: Fizika tverdogo tela, v. 7, no. 12, 1965, 3644-3645

TOPIC TAGS: electron paramagnetic resonance, terbium, cerium compound, epr spectrum, hyperfine structure, line splitting

ABSTRACT: The authors observed paramagnetic resonance of Tb^{3+} and Tb^{4+} in single crystal CeO_2 doped with terbium at temperatures 4.2K and frequencies ~ 36 Gcs. It follows from the angular dependence of the EPR spectrum that there are four magnetically nonequivalent Tb^{3+} in the electric fields of trigonal symmetry. The EPR spectrum of Tb^{4+} is observed also at 77K, but not at room temperature. The

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angular dependence of the spectrum indicates that all the Tb^{4+} spectra are in electric fields of cubic fields. This shows that the substitution of Tb^{4+} for Ce^{4+} is isomorphic. When the magnetic field was parallel to the [100] axis, 11 groups were observed, with four lines each, in the range from 0.5 to 13 kG; the groups had different intensities. It is assumed that each group represents the fine structure of the EPR spectrum and the four components represent the hyperfine structure. The spectral analysis was based on the usual spin Hamiltonian. The values obtained for the initial splitting (~ 54 Gcs) and for the g factor (2.0136) are larger than those known for the ions Gd^{3+} and Eu^{2+} in electric fields of cubic symmetry. This suggests that the covalent nature of the bonds plays an important role. The results also indicate that the initial splitting increases monotonically with increasing unit-cell dimensions, unlike the Gd^{3+} ions. The data are insufficient to interpret this phenomenon. Authors thank V. A. Ioffe and Z. N. Zonn for supplying the CeO_2 crystals. Orig. art. has: 2 formulas.

SUB CODE: 20/ SUBM DATE: 03Jun65/ ORIG REF: 002/ OTH REF: 006

L 14129-66 EWT(1) LJP(c) WW/GG

ACC NR: AP6000880 SOURCE CODE: UR/0181/65/007/012/3666/3666

44
B

AUTHOR: Zaripov, M. M.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Concerning an article by V. K. Zakharov and D. M. Yudin 'Study of Glasses with Chromium by the EPR Method.'

SOURCE: Fizika tverdogo tela, v. 7, no. 12, 1965, 3666

TOPIC TAGS: epr spectrum, chromium, multiplet splitting, spin lattice relaxation, chromium, glass, paramagnetic ion

ABSTRACT: The article in question (FTT v. 7, 1571, 1965) contains a phenomenological interpretation of the EPR spectrum of chromium in glass, using a complete spin Hamiltonian of rhombic symmetry. The present note states that the deduction that the main spin quadruplet of Cr^{3+} is split into two doublets with interval ~ 300 cm^{-1} is physically unacceptable, because splitting of the spin quadruplet by

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L 11129-66

ACC NR: AP6000880

$300\ cm^{-1}$ can be due only to very large contributions of the upper orbital states of Cr^{3+} to the ground state. This leads to a sharp reduction in the spin-lattice relaxation time. The resultant situation should be similar to that observed for the Co^{2+} ion in an octahedral coordination, where there is no EPR effect not only at room temperature but also at nitrogen temperature.

SUB CODE: 20/ SUBM DATE: 03Jul65/ ORIG REF: 001/

Card 2/2

L 21400-66 EWT(m)/EWP(t) IJP(c) JD/JG
ACC NR: AP6003795 SOURCE CODE: UR/0181/66/008/001/0238/0239

AUTHORS: Zaripov, M. M.; Livanova, L. D.; Stepanov, V. G.; Falin, M. L.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Electron paramagnetic resonance of Gd^{3+} in double molybdate of yttrium and lanthanum

SOURCE: Fizika tverdogo tela, v. 8, no. 1, 1966, 238-239

TOPIC TAGS: yttrium compound, lanthanum compound, molybdenum containing alloy, gadolinium, epr spectrum, optic spectrum, rare earth element, line width, crystal symmetry, electron paramagnetic resonance

ABSTRACT: In view of the appreciable attention paid recently to the study of optical and EPR spectra of compounds of the type $M^{2+}M^{6+}O_4$ (M^{2+} = Ca, Sr, Ba, Pb; M^{6+} = Mo^{6+}, W^{6+}), alloyed with elements of the rare-earth group, the authors have grown and investigated by the

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L 21400-66

ACC NR: AP6003795

EPR method single crystals of $M^{+}Y(MoO_4)_2$ and $M^{+}La(MoO_4)_2$, where M^{+} = Na, Li, and K with add mixture of 0.1 atomic per cent gadolinium. The crystals were grown by solution in the melt, in a programmed oven whose temperature could be set accurate to 1C in the limit 600 -- 1200C. The crystal growth procedure is briefly described. In all the crystals, including $KY(MoO_4)_2$, very broad absorption lines were observed, with the lines of the transition 1/2 -- 1/2 ($g \approx 1.99$) having a width of 200 Oe even for the field parallel to the z axis. The widths of the lines remain constant if the gadolinium concentration remains constant. The large width is attributed to the scatter of the axes of the local electric field acting on the magnetic ions. A distinct spectrum of the Gd^{3+} ions was observed in the $KY(MoO_4)_2$ single crystals. From the angular distribution of the EPR spectrum it is deduced that the structure $TY(MoO_4)_2$ has either monoclinic or rhombic syngony. The constants of the spin Hamiltonian has been evaluated and it is concluded from the near-equality of some of the constants for Gd^{3+} in crystals with scheelite structure, that the

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L 21400-66
ACC NR: AP6003795

nearest surrounding of Gd^{3+} ions in the $KY(MoO_4)_2$ are similar in structure in all these crystals. Orig. art. has: 1 formula

SUB CODE: 20/ SUB DATE: 12Jul65/ OTH REF: 002

Card 3/3

L 21397-66 EWT(m)/T/EWP(t) IJP(c) JD/JG

ACC NR: AP6003799 SOURCE CODE: UR/0181/66/008/001/0247/0248

AUTHOR: Dernov-Pegarev, V. F.; Zaripov, M. M.; Samoylovich, M. I.; Stepanov, V. G.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: EPR of Gd^{3+} in $CdMoO_4$

SOURCE: Fizika tverdogo tela, v. 8. no. 1, 1966, 247-248

TOPIC TAGS: gadolinium, cadmium compound, molybdenum compound, electron paramagnetic resonance, single crystal, crystal lattice structure

ABSTRACT: The authors investigated the EPR spectrum of Gd^{3+} in single-crystal $CdMoO_4$ at a frequency ~37 Gcs and at room temperature. The single crystal was grown by the hydrothermal method and has a scheelite structure. One type of Gd^{3+} ions was observed, situated in electric fields of tetragonal symmetry (z axis parallel to the c axis of the crystal). This indicates isomorphic substitution of Gd^{3+} for Gd^{2+}. The parameters of the spin Hamiltonian are determined for this constant and are found to be in agreement with those obtained for other single crystals with scheelite structure ($CaWO_4$, $PbMoO_4$, and $SrMoO_4$). The authors thank O. I. Mar'yakhina for computer processing of the experimental data. Orig. art. has: 1 figure and 1 formula.

SUB CODE: 20/ SUBM DATE: 16Jul65/ ORIG REF: 002/ OTH REF: 001

Card 1/1 ULR

L 21218-66 EWT(m)/EWP(t) IJP(c) JD
ACC NR: AP6003807 SOURCE CODE: UR/0181/66/008/001/0262/0262

AUTHORS: Zaripov, M. M.; Manenkov, A. A.; Chirkin, G. K.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: EPR of Gd^{3+} in $SrWO_4$

SOURCE: Fizika tverdogo tela, v. 8, no. 1, 1966, 262

TOPIC TAGS: gadolinium, electron paramagnetic resonance, single crystal, strontium compound, crystal symmetry, spin lattice relaxation

ABSTRACT: The authors investigated the EPR spectrum of Gd^{3+} ions in single crystal $SrWO_4$ grown by the Verneuil method. The crystals contained ~0.1 atomic per cent paramagnetic ions. The authors found that the Gd^{3+} ions are in a crystalline field of tetragonal symmetry, the z axis of which coincides with the c axis of the crystal. This is evidence of isomorphic substitution of Gd^{3+} for

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L 21218-66
ACC NR: AP6003307

the Sr^{2+} ions. The parameters of the spin Hamiltonian of tetragonal symmetry are determined at room temperature and at wave lengths of 8 mm. The relaxation characteristics were measured at 9.4 Gcs by the pulse saturation method. The spin-lattice relaxation time at T = 4.2K was the same for all transitions (8 msec) with the field parallel to the z axis. Cross relaxation with a time constant 0.5 msec is observed for all lines. Orig. art. has: 1 formula.

SUB CODE: 20/ SUBM DATE: 29Jul65/

Card 2/2

L 26627-66 EWT(l)/EWP(m) I.P(c) JD/WW/GG

ACC NR: AP5025370 SOURCE CODE: UR/0181/65/007/010/2947/2951

AUTHOR: Zaripov, M. M.; Chirkin, G. K.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Electron paramagnetic resonance spectra of the nearest surroundings of paramagnetic ions in ammonium chloride

SOURCE: Fizika tverdogo tela, v. 7, no. 10, 1965, 2947-2951

TOPIC TAGS: EPR spectrum, paramagnetic ion, ammonium chloride, temperature dependence

ABSTRACT: A study was conducted of the temperature dependence of electron paramagnetic resonance spectrum of the "tetragonal" ions Mn^{2+} and Cu^{2+}. The temperature dependence of the fine b_2^0 structure constant for Mn^{2+} is qualitatively explained by the change of the lattice constant ammonium chloride. The negative sign of b_2^0, an analysis of g-factors of Cu^{2+}, Ni^{2+}, Co^{2+} and the hyperfine structure constant of Cu^{2+} indicate that the bivalent paramagnetic ions are located in the octahedral surroundings formed by the four Cl^- ions and the two

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ACC NR: AP5025370

H_2O molecules. They are arranged in the center of a common grain of adjacent unit cells of NH_4Cl in which the vacancies of NH^{4+} are replaced by water molecules. This model clarified the observation of the "rhombic" Cu^{2+} ions. The strong tetragonal component of the electrical field causes a great amount of spallation of the ground state of Mn^{2+} and Ni^{2+}, and also the observation of an electron paramagnetic resonance spectrum of Fe^{2+} at 77K. Orig. art. has: 2 fig., 3 tables, 1 formula.

SUB CODE: 20/ SUBM DATE: 05Apr65/ ORIG REF: 006/ OTH REF: 006

Card 2/2

L 29589-66 EWT(1) / IJP(c) [illegible]
ACC NR: AT6014765 SOURCE CODE: UR/0000/64/000/000/0005/0041

AUTHOR: Zaripov, M. M.; Shekun, L. Ya. 49

ORG: none B+1

TITLE: Electron paramagnetic resonance in crystals

SOURCE: Paramagnitnyy rezonans (Paramagnetic resonance); sbornik statey. Kazan, Izd-vo Kazanskogo univ., 1964, 5-41

TOPIC TAGS: electron paramagnetic resonance, Hamiltonian, EPR spectrum, ion

ABSTRACT: Ordinary spin Hamiltonians are used for describing electron paramagnetic resonance spectra in crystals. Expressions are given for the operators which describe the fine structure of the spectra for various types of electric field symmetry: cubic, hexagonal, triagonal, tetragonal, rhombic and purely axial. The procedures used for absorption line identification to find the constants of the spin Hamiltonian are discussed. Expressions are given for calculating the hyperfine structure due to interaction between the electron magnetic moment and the magnetic moment of the nucleus of the paramagnetic atom. Experimental research done at the Kazan University on electron paramagnetic resonance spectra in crystals is briefly reviewed. The data on ions with identical effective spins are grouped together. Ions with spins of 1/2, 3/2, 5/2 and 7/2 are considered. Orig. art. has: 25 figures, 30 tables, 30 formulas.

SUB CODE: 20/ SUBM DATE: 04Jun64/ ORIG REF: 014/ OTH REF: 017

Card 1/1 CC

L 32566-66 EWP(e)/EWT(m) WH/WW

ACC NR: AP5003792 SOURCE CODE: UR/0181/66/008/001/0231/0233

AUTHORS: Zaripov, M. M.; Kropotov, V. S.; Livanova, L. D.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Electron paramagnetic resonance of Mn^{2+} ions in MgF_2

SOURCE: Fizika tverdogo tela, v. 8, no. 1, 1966, 231-233

TOPIC TAGS: electron paramagnetic resonance, magnesium compound, manganese, paramagnetic ion, fluorine, hyperfine structure, line splitting, epr spectrum

ABSTRACT: To obtain information on the interaction between paramagnetic ions and their nearest surrounding atoms, the authors investigated crystals of magnesium fluoride doped with manganese (concentration 0.5 at. in the charge), grown in a graphite crucible by the Bridgman method at 10^{-4} mm Hg. The immediate environment of the Mg^{2+} ions consists of six fluorine ions and has a high symmetry (D_{2h}).

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L 32566-66

ACC NR: AP5003792

This symmetry could be observed on the plotted EPR spectrum of the Mn^{2+}, evidencing isomorphous replacement of the Mg^{2} ions by the Mn^{2+} ions. A super-hyperfine structure is observed for the spectrum in a magnetic field parallel to the c axis, wherein each line of the hyperfine structure of Mn^{2+} is split into 15 components. It is deduced that out of the six fluorine atoms surrounding the Mn^{2+} ions, four are at equal distance from the central ion, and two are at a different but likewise equal distance. A formula is written out for the spin Hamiltonian describing the observed spectrum. The constants of the fine and hyperfine structures are determined by the usual procedure. The results do not agree with those obtained by M. Tinkham (Proc. Roy. Soc. v. A236, 535, 1956), and the discrepancy is attributed to errors in Tinkham's paper. Orig. art. has: 1 figure and 3 formulas.

SUB CODE: 20/ SUBM DATE: 03Jun65/ ORIG REF: 001/ OTH REF: 003

Card 2/2

L 46834-66 EWT(l)/EWP(e)/EWT(m)/EWP(t)/ETI IJP(c) JD/WW/GG/WH

ACC NR: AR6013643 SOURCE CODE: UR/0058/65/000/010/D075/D075

AUTHOR: Garif'yanov, N. S.; Zaripov, M. M.

38
B

REF SOURCE: Sb. Itog. nauchn. konferentsiya Kazansk. un-ta za 1963 g. Sekts.: paramagnitn. rezonansa, spektroskopii i fiz. polimerov, radiofiz., astron., bion. Kazan, 1964, 6

TITLE: The study of EPR of Cr^{3+} and Gd^{3+} in glasses at low frequencies

SOURCE: Ref. zh. Fizika, Abs. 10D540

TOPIC TAGS: EPR, Hamiltonian

TRANSLATION: Experimental and theoretical studies of EPR of Cr^{3+} and Gd^{3+} in a number of different supercooled solutions and glasses were conducted at frequencies of 100 Mhz. It is shown that the weak field condition obtains at these frequencies. The theoretical interpretation is based on an assumption that the rhombic component of the spin Hamiltonian is large compared to the others. A good agreement between calculated values and experimental data was obtained.

SUB CODE: 20/ ~~SUBM DATE: none~~

Card 1/1 blg

ACC NR: AP6037021 (A,N) SOURCE CODE: UR/0181/66/008/011/3445/3445

AUTHOR: Zaripov, M. M.; Potkin, L. I.; Samoylovich, M. I.; Stepanov, V. G.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: Electronic paramagnetic resonance of gadolinium 3 ions in barium tungstate

SOURCE: Fizika tverdogo tela, v. 8, no. 11, 1966, 3445

TOPIC TAGS: crystal, growing, gadolinium, ~~gadolinium~~ ion, electronic paramagnetic resonance, ~~scheelite~~, ~~monocrystal~~, barium tungstate, compound, EPR spectrum, electric field

ABSTRACT: A study was made of the electron paramagnetic resonance spectrum in hydrothermally grown crystals containing $\sim$ 0.1% Gd^{3+} ions. In $BaWO_4$, as in earlier studied bases, one type of Gd^{3+} ions was found, occurring in an electrical field of tetragonal symmetry. Measurements of the spectrum were made at room temperature at $\lambda \sim 8$ мм. Approximate values of the parameters of hamiltonian spin, determined by the method of the perturbation theory, were

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ACC NR: AP6037021

verified on an electronic computer. It was found that at $g = 1.991$ $b_2^0 = 873$ gs, $b_4^0 = 13$ gs, $b_4^4 = -113$ gs, $b_6^0 = b_6^6 = 0$. For $H \parallel z$ the position of resonance lines is described to an accuracy of ± 3 gs, and for $H \perp z$ — ± 15 gs. This provides supplementary data on the splitting of the ground state of Gd^{3+} ions by an electric field in crystals of a homologous series of scheelite. [Translation of abstract] [SP]

SUB CODE: 20/SUBM DATE: 13Jun66/

Card 2/2

VINOKUROV, V.M.; ZARIPOV, M.M.; STEPANOV, V.G.

Electron paramagnetic resonance of Mn^{2+} in apatite. Fiz. tver. tela 6 no. 4:1125-1129 Ap '64.

Paramagnetic resonance of Mn^{2+} ions in diopside crystals. Ibid.:1130-1137 (MIRA 17:6)

1. Kazanskiy gosudarstvennyy universitet imeni V.I.Ul'yanova-Lenina.

VINOKUROV, V.M.; ZARIPOV, M.M.; STEPANOV, V.G.

Electron paramagnetic resonance of Mn^{2+} ions in gaylussite.
Geokhimiia no.12:1318-1319 D '64. (MIRA 18:8)

1. Kazanskiy gosudarstvennyy universitet.

TITLE: Electron paramagnetic resonance in [illegible]

[illegible] Kazan', Kazansk. un-t, 1964, 5-41

[illegible] University on electron paramagne-

TRANSLATION: A review of [illegible] of experimental data

Card 1/1

VINOKUROV, V.M.; ZARIPOV, M.M.; KROIGTOV, V.S.; STEPANOV, V.G.

Studying Mn^{2+} isomorphism in beryls by the method of electronic paramagnetic resonance. Geokhimiia no.1:104 Ja '65.
(MIRA 18:4)

1. Kazanskiy gosudarstvennyy universitet.

ZARIPOV, M.M.; CHIRKIN, G.K.

Electron paramagnetic resonance of ions of the iron group in NH_4Cl single crystals. Fiz. tver. tela 7 no.1:100-102 Ja '65.
(MIRA 18:3)

1. Kazanskiy gosudarstvennyy universitet imeni V.I'yanova-Lenina.

[illegible] spectra in crystals

[illegible] SOURCE: [illegible] nauchn. [illegible] Kazansk. un-ta za 1962 [illegible] Kazan', [illegible]

TOPIC TAGS: electron paramagnetic resonance, epr spectrum, crystal field symmetry

[illegible] crystals are [illegible]

spectrum of Gd^{3+} in CaF_2 is due to three types of Gd^{3+} ions, which are in fields

of cubic, tetragonal, and trigonal symmetry. The epr effect in BaF_2 [illegible]

non-equivalent Mn^{2+} ions in a field of axial symmetry. The results of calculations of the energy spectrum of a paramagnetic ion situated in a field of axial symmetry, carried out in the approximation of a strong magnetic field, are used

GARIL'YANOV, N.S.; ZARIPOV, M.M.

Studying glasses by the paramagnetic resonance method at low frequencies. Fiz. tver. tela 6 no.5:1545-1546 My '64. (MIRA 17:9)

1. Kazanskiy fiziko-tekhnicheskiy institut AN SSSR i Kazanskiy gosudarstvennyy universitet imeni Ul'yanova-Lenina.

ZARIPOV, M.M.; CHIRKIN, G.K.

Electron paramagnetic resonance spectrum of Cu^{2+} in NH_4Cl.
Fiz. tver. tela 6 no.6:1645-1648 Je '64. (MIRA 17:9)

1. Kazanskiy gosudarstvennyy universitet imeni Ul'yanova-Lenina.

ACC NR: AP7005879 SOURCE CODE: UR/0181/66/008/012/3680/3681

AUTHOR: Zaripov, M. M.; Kropotov, V. S.; Livanova, L. D.; Stolov, A. L.; Yakovleva, Zh. S.

ORG: Kazan' State University im. V. I. Ul'yanov-Lenin (Kazanskiy gosudarstvennyy universitet)

TITLE: EPR and optical spectrum of Cr^{3+} ions in MgF_2

SOURCE: Fizika tverdogo tela, v. 8, no. 12, 1966, 3680-3681

TOPIC TAGS: laser material, epr spectrum, luminescence spectrum, optic spectrum, magnesium compound, fluoride, activated crystal, chromium, crystal impurity, impurity center, impurity level

ABSTRACT: To check on the two types of EPR spectra observed in ZnF_2 activated with Cr^{3+}, the authors measured the luminescence spectrum of Cr^{3+} in single crystals of MgF_2 to which Li, Na, and Cu were introduced as additives. The crystals with lithium showed an EPR spectrum (at 9.3 GHz) with a line structure having 5, 7, and 3 components when the field was parallel to the z, x, and y axes, respectively. The luminescence spectrum of the same crystals had an intense band with maximum at 7860 Å, a weaker band at 6805 Å, and narrow lines at 7320 and 7620 Å. The levels corresponding to these lines are identified. In the case of the copper impurity, the same EPR and optical spectra were observed but with lower intensity. In addition, a more complicated EPR spectrum with new lines due to several centers is observed. In the crystals with Na impurity or those without any impurity, the EPR spectra observed in the

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ACC NR: AP7005879

crystals with lithium vanishes, and only the complicated EPR spectrum observed with copper is seen. The maximum at 6805 Å in the optical spectrum becomes stronger. The results do not lead to any unique conclusions other than that the excess Cr^{3+} charge is compensated by the Li, Na, or Cu in a nonlocal manner. Orig. art. has: 1 figure and 1 formula. [WA-14] [02]

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