PARAMETERS OF CRYSTALLINE FIELD OF TETRAGONAL CENTERS IN CRYSTALS WITH SCHEELITE STRUCTURE

L. Ya. Shekun
Kazan' State University
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In crystals of the homological Scheelite series ($CaWO_4$) the rare-earth ions easily form centers with symmetry S_4. Analyzing the optical spectra and the EPR of these centers, we have found that the effect of the crystalline field on the trivalent rare-earth ion can be described by a potential

$$V = B_2^0 V_2^0 + B_4^0 V_4^0 + B_6^0 V_6^0 + B_4^4 V_4^4 + B_6^4 V_6^4 , \qquad (1)$$

where $B_n^m = A_n^m \langle r^n \rangle$ and V_n^m are dimensionless harmonic polynomials. For all the rare-earth ions B_2^0 should be positive, and B_4^0, B_4^4, and B_6^4 negative. The dominating constants are B_4^4 and B_6^4 with $|B_4^4| > |B_6^4|$. Estimates of the order of magnitude of the B_n^m yields the set

$$B_2^0 = +260 \text{ cm}^{-1}, \quad B_4^0 = -75 \text{ cm}^{-1}, \quad B_6^0 = 0, \quad B_4^4 = -800 \text{ cm}^{-1}, \quad B_6^4 = -380 \text{ cm}^{-1}, \qquad (2)$$

which duplicates, within ±10 cm^{-1}, the Stark structure of Yb^{3+} in $CaWO_4$ [1], and within ±20 cm^{-1} the structure of the levels $^4I_{9/2}$ and $^4I_{11/2,13/2}$ of Nd^{3+} in $PbMoO_4$ [2]. Without changing the constants (2), we can obtain, with 15% accuracy, the g-factors of the principal doublets of Ce^{3+} [3], Nd^{3+} [4], Sm^{3+} [5], Tb^{3+} [6], and Yb^{3+} [7] in $CaWO_4$. For large J ($^4I_{15/2}$ of Nd^{3+} and Er^{3+}), the agreement with experiment is poorer. The potential (1) can be subdivided into pure-cubic and axial parts:

	B_2^0	B_4^0	B_6^0	B_4^4	B_6^4
Cubic	0	-160	+18	-800	-380
Axial	+260	+ 85	-18	0	0
Sum	+260	- 75	0	-800	-380

We see therefore that the principal role is played in the potential by the cubic part. This fact can be used for rough calculations.

A detailed justification of our conclusions, illustrated with results of calculations for the individual ions, will be published soon.

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SIMPLE HIGH-ENERGY SCATTERING MODEL

V. V. Anisovich
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Attempts have been made recently to consider high-energy scattering in the framework of SU(6) [1] or SU(3) symmetry together with some additional assumptions concerning the character of the interaction process [2] (in [2] the small-angle scattering of particles is connected only with single quark-quark and quark-antiquark collisions). The relations between the cross sections of the different reactions, obtained in these papers, agree well with experiment. It is of interest to consider other variants of the interaction process at high energies and to compare them with the experimental data. We consider below a model in which elastic forward scattering is only via single quark-antiquark or three-quark scattering. This model is similar to the model of Levin and Frankfurt [2], but it is assumed here that the only essential quark interactions are those leading to bound states (mesons and baryons), and the remaining interactions are small. Further, we shall assume, as in [1], that SU(6) symmetry obtains. It was noted in [3] that the relations that follow from SU(6) symmetry are not satisfied in nucleon-antinucleon annihilation into two mesons, but it is perfectly possible that SU(6) symmetry is valid not for large t (annihilation process), but in the interval $t \sim 4\mu^2$.

We must also note the following circumstance: It follows from the experimental data that at energies larger than 15 BeV the different SU(6)-invariant amplitudes for quark-quark scattering are equal to one another in this model. This means that the SU(6) symmetry is in essence not employed at such energies.

Under the foregoing assumptions, the meson-baryon forward-scattering amplitudes are expressed in terms of two SU(6)-invariant quark-antiquark scattering amplitudes (synplet and 35-plet) and in terms of two three-quark scattering amplitudes (56-plet and 70-plet). This leads to the following relations between the cross sections

$$\sigma_{\pi^+p} - \sigma_{\pi^-p} = \sigma_{K^+n} - \sigma_{K^-n} = (1/2)(\sigma_{K^+p} - \sigma_{K^-p}), \quad (1)$$

$$\sigma_{K^-p} + \sigma_{K^+p} = \sigma_{K^-n} + \sigma_{\pi^+p} . \quad (2)$$

Relation (1) is the Johnson-Treiman equation [1], while (2) is that of Levin and Frankfurt [2]. Relation (2) at energies 6 - 20 BeV is satisfied with ~15% accuracy. It is natural to assume that to obtain more exact relations between the cross sections it is necessary to take into account the breaking of SU(6) symmetry. It can be assumed, for example, that at high energies the SU(6)-invariance is violated only in interactions where a third quark