HYPERFINE-STRUCTURE ANOMALY, CROSSED-SECOND-ORDER EFFECTS IN ISOMER SHIFT, FIELD AND MASS SHIFTS IN EUROPIUM II

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With collinear-laser-ion-beam spectroscopy, hyperfine structure and isotope shifts for 17 different transitions between $Eu\,II$ $4f^7 5d$ and $4f^7 6p$ levels have been measured with an enhanced accuracy. The measurements in stable ^{151}Eu and ^{153}Eu were performed at the Marburg-University mass separator whereas those in radioactive isotopes with mass numbers $A = 145, 146, 147, 152$ were performed at the IRIS mass-separator in LNPI. The isomer shift between spectral lines of the ground state isotope ^{152g}Eu and its isomer ^{152m}Eu ($t_{1/2} = 9.3h$) was also measured. The isotope ^{152g}Eu and its isomer ^{152m}Eu were produced in the LNPI reactor while the other radioactive isotopes were produced with the help of the LNPI synchrocyclotron. The measured spectra were analyzed in respect to the isotope (isomer) shifts and the splitting factors A and B.

A noticeable hfs-anomaly Δ in splitting factors A was observed [1]. As a consequence of this the ratios of the nuclear g-values do not agree with the ratios of the A-values. The value of Δ depends on the quantum numbers L, S, J and on a factor $f(AA')$ which depends on nuclear magnetization. The factors $f(AA')$ were determined from the experimental data and then from the obtained ratios of the A-factors, corrected for Δ, g-values were derived.

As for the splitting B-factors, they show no anomaly. Hence, the ratios of B-factors are also the ratios of the Q-moments. The obtained values of nuclear magnetic moments μ and the ratios of B-factors are presented in Table.

Table

Nuclear magnetic moments and ratios of B-factors for Eu isotopes

A	μ/μ_n	B/B_{153}
145	3.999(3)	0.11684(87)
146	1.421(8)	-0.0743(20)
147	3.736(6)	0.2185(23)
151		0.39184(22)
152	-1.9401(8)	1.18220(49)
153	1.5324(3)	1

The ratio of B_{151}/B_{153} deviates significantly from that of muonic measurements, however it is in good agreement with the other atomic data in $Eu\ I$ and $Eu\ II$. Therefore we conclude [2] that the uncertainty of the muonic X-ray transition experiments may be larger than expected.

With the help of eight isomer-shift values between ^{152g}Eu and ^{152m}Eu and further six shifts for the radioactive ^{145}Eu, it was shown [3] that not only the field shift but also mass shift in ^9D multiplet of $Eu\ II$ $4f^7(^8S)5d$ is affected by crossed second order effects. Therefore

optical measurements alone are not sufficient to separate mass-effect and field effect, and independent second measurement (for example, muonic IS-measurement) is needed for this purpose.

REFERENCES

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