New Quadrupole and Forbidden Lines in the L-Emission Spectra of Ytterbium and Lutetium

A. N. Nigam, Q. S. Kapoor, and K. B. Garg

Physics Department, University of Rajasthan, Jaipur, India

(Z. Naturforschg. **22 a**, 572 [1967]; received 21 December 1966)

Coster [1], Wennerlöf [2], and Allais [3, 4] have studied the L-emission spectra of ytterbium and lutetium. However, there are several quadrupole and forbidden lines in these spectra that have not yet been observed. With a view to recording these lines, we have reinvestigated the L-spectra of ytterbium and lutetium. The preliminary measurements on the newly observed lines are reported in this paper.

The experimental set up used to record the spectra was similar to the one described elsewhere [5]. A 40-cm curved mica crystal spectrograph of transmission type was used. First order reflections from (100) and ($\bar{2}$01) planes giving a dispersion of about 12 X.U. per mm were employed. The exposure times ranged from 2 to 30 hours with the demountable X-ray tube operating at 20 – 30 kV (full wave rectified), 2.5 – 4 mA. The ytterbium and lutetium anticathode were prepared by embedding spec-pure ytterbium oxide and lutetium oxide powders respectively (supplied by Johnson Matthey and Co., London) into properly machined grooves on one of the four faces of the massive copper anticathode.

Transition	Notation	Nature	Wavelength in X.U.	(ν/R) Obs.	(ν/R) Calc. [6]
$L_IN_{IV,V}$	γ_{11}	quadrupole	1202.5	758.0	757.85
$L_{III}N_{III}$	–	quadrupole	1439.3	633.3	633.26
$L_{III}M_{III}$	s	quadrupole	1769.8	515.1	514.96
L_IN_I	–	forbidden	1237.4	736.7	736.5

Table 1. Data for the new diagram lines in the L-spectrum of ytterbium.

The present investigation has revealed, for the first time, the presence of four new diagram lines at 1202.5, 1439.3, 1769.8, and 1237.4 X.U. in the L-spectrum of ytterbium (Table 1). The first three lines correspond to the quadrupole transitions $L_IN_{IV,V}$ (γ_{11}), $L_{III}N_{III}$ and $L_{III}M_{III}$ (s) respectively. The fourth line has been assigned to the forbidden transition L_IN_I. Also for the first time, the presence of five new diagram lines at 1715.3, 1237.9, 1247.2, 1193.2, and 1144.8 X.U. (Table 2) in the L-spectrum of lutetium has been revealed by the present investigation. The first two lines correspond to the quadrupole transitions $L_{III}M_{III}$ (s) and $L_{II}N_{III}$ respectively. The last three lines have been assigned to the forbidden transitions $L_{II}N_{II}$, L_IN_I and L_IO_I respectively. Our measured values of the wavelengths are in fair agreement with those calculated from energy levels [6] and give nice fit with the Moseley plots. However, great accuracy in our measurements of wavelengths is not claimed because suitable reference lines were not recorded on the spectrograms. Various interferences with the newly observed lines have been taken into account. The presence of these lines in the L-spectra of ytterbium and lutetium can, therefore, be taken to have been conclusively established.

Transition	Notation	Nature	Wavelength in X.U.	(ν/R) Obs.	(ν/R) Calc. [6]
$L_{III}M_{III}$	s	quadrupole	1715.3	531.5	531.61
$L_{II}N_{III}$	–	quadrupole	1239.9	736.4	735.74
$L_{II}N_{II}$	–	forbidden	1247.2	731.0	731.74
L_IN_I	–	forbidden	1193.2	764.2	763.4
L_IO_I	–	forbidden	1144.8	796.2	796.6

Table 2. Data for the new diagram lines in the L-spectrum of lutetium.

[1] D. Coster, Phil. Mag. **44**, 546 [1922].
[2] I. Wennerlöf, Arkiv Mat. Ast. Fys. **22 A**, Nr. 8 [1930].
[3] M. Allais, C. R. Acad. Sci. Paris **212**, 123 [1941].
[4] M. Allais, Cahiers Phys. **7**, 13 [1942].
[5] A. N. Nigam, K. B. Garg, and Q. S. Kapoor, Proc. Phys. Soc. London, to be published.
[6] A. E. Sandström, Handbuch der Physik **30**, 224 [1957].