

molecule. Similar findings could be made for AID also,<sup>7</sup> where the numerical value of the increase is about  $190\text{ cm}^{-1}$  and for CaD, where an effect of about  $100\text{ cm}^{-1}$  is suspected. For HgD, however, no noticeable increase seems to exist.

During the course of the analysis of several CH bands, attention was paid to a peculiar group of lines around 4324A mentioned first (together with the corresponding "isolated line group" in CD) by Fagerholm.<sup>8</sup> When an acetylene-flame served as light source, this group developed as a band similar to the  ${}^2\Delta-{}^2\Pi$  bands of CH in this region and analysis rendered it quite certain that it is the (2, 2) band of this system. We were not successful in the analysis of the corresponding CD band and by searching for the reason, it became clear that it was a small, but still observable broadening of all CD lines, which prevented an exact evaluation of the true combination differences. This behavior of the CD lines is the more peculiar since the Doppler width for the CD lines must be smaller than for the CH lines. The satisfactory sharpness of foreign and CH lines on the same plates guarantees the reality of an actual broadening. This is confirmed also by the fact that the broadening and the fuzziness of the CD lines are more pronounced on the longer wave-length side, where the line broadening  $\Delta\lambda$  corresponding to a given  $\Delta\nu$  value is obviously larger. The broadening effect has the order of magnitude of a few tenths of a  $\text{cm}^{-1}$  unit.

<sup>1</sup> L. Gerö, Zeits. f. Physik **117**, 709 (1941).

<sup>2</sup> L. Gerö, Zeits. f. Physik **118** (1941).

<sup>3</sup> L. Gerö and R. Schmid, Zeits. f. Physik **118**, 210 (1941).

<sup>4</sup> L. Gerö and R. F. Schmid, Phys. Rev. **59**, 528 (1941).

<sup>5</sup> For comparing predissociation phenomena in isotopic molecules see L. Gerö and R. Schmid, Zeits. f. Physik **118**, 250 (1941).

<sup>6</sup> In the case of H<sub>2</sub>, HD and D<sub>2</sub> this has been established by I. Sandeman, Proc. Roy. Soc. Edinburgh **59**, 130 (1939).

<sup>7</sup> E. Olsson, Dissertation, Stockholm 1938. Concerning evaluation, see reference 5.

<sup>8</sup> E. Fagerholm, Naturwiss. **25**, 106 (1937).

### The Fe $K\beta'$ and $K\beta_5$ Lines of FeS<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub>

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**S.** YOSHIDA<sup>1</sup> has studied the Fe  $K$  absorption structure of a number of Fe compounds. In the same paper, he reports the wave-length of the Fe  $K\beta_5$  line of a few of the same compounds. The absorption spectra were photographed with a Johann focusing spectrograph. For the  $K\beta_5$  lines, he used fluorescence excitation with a Siegbahn spectrograph. Among other findings, he concludes that "in the cases of the semi-conducting compounds the energy distance between the  $K\beta_5$  and the beginning of the main absorption edge is smaller than in the cases of the ionic compounds," which is "roughly in agreement with the theory of electrical conductivity in solids."

His experimental findings are reinforced by work of the present author<sup>2,3</sup> with a Johansson focusing spectrograph, on the Fe  $K\beta_5$  lines of two of the same compounds Yoshida studied: FeS<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> (hematite). Table I presents the

combined results of the two researches. The separation of the edge from the line, in electron volts, was calculated with  $R_\infty = 1.097 \times 10^5\text{ cm}^{-1}$  equivalent to 13.54 ev. The values given have been recalculated from Yoshida's original data. Where only his data are involved, the results

TABLE I. Separation of the Fe  $K$  absorption edge, and the Fe  $K\beta_5$  line, in FeS<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub>.

	BEGINNING OF THE $K$ EDGE—x.u. (YOSHIDA)	$\lambda K\beta_5$ x.u.	$K-K\beta_5$ ev	AUTHOR
FeS <sub>2</sub>	1739.4	1741.1 1741.3 ± 1	6.9 7.7 ± 3	Yoshida McDonald
Fe <sub>2</sub> O <sub>3</sub> (hematite)	1739.4	1741.7 ± 1	9.3 ± 4	McDonald
FeCO <sub>3</sub>	1739.0	1741.2	9.3	Yoshida
Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	1737.5	1741.2	15.1	Yoshida

are close to the calculated values given in the original paper, but are not exactly the same. The present author has not been able to discover precisely how Yoshida carried out his calculations to get the values published by him.

Table I shows agreement between the two authors in the observed position of the line in FeS<sub>2</sub>. Presumably the limits of error were about the same in both studies. The separation of edge and line is less than in Fe<sub>2</sub>O<sub>3</sub> (hematite), which is semi-conducting, although less so than FeS<sub>2</sub> (mareasite or pyrites).<sup>4</sup> Yoshida also confirms the observation of the present author that mareasite and pyrites produce indistinguishable spectra.

Neither FeCO<sub>3</sub> in the pure state, nor Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, are conducting. It must be concluded that the FeCO<sub>3</sub> is impure. Probably the salt actually examined was the basic carbonate, which might well be of a conductive nature. If this is not so, the results on FeCO<sub>3</sub> are not consistent with those from the other compounds.

Ya. M. Fogel<sup>5</sup> has studied the  $K\beta_1$  and  $K\beta'$  lines of Fe in a number of Fe compounds. He finds that the  $K\beta'$  line is sharp in one group of compounds, including Fe<sub>2</sub>O<sub>3</sub>; whereas in Fe, Fe<sub>3</sub>C, and FeS<sub>2</sub>, it is broad. This same effect showed up in the previous work by the present author<sup>2,3</sup> as an increase in the limit of error from ±0.1 x.u. to ±0.2 x.u. Fogel confirms the previous determination of the position of the line in Fe<sub>2</sub>O<sub>3</sub> at 1756.9 x.u.

His mean wave-length for the Fe  $K\beta'$  in FeS<sub>2</sub> was calculated from the positions of the edges of the band as 1755.6 x.u. In the work of the present author, the position of the line was measured as  $1756.6 \pm 2$  x.u., by setting directly on the line with the crosshair of the microscope in a measuring engine. Both researches were carried out with focusing spectrographs and fluorescent radiation.

The conclusion may be drawn that the Fe  $K\beta'$  line in FeS<sub>2</sub> is quite asymmetrical with the peak toward the long wave-length edge.

<sup>1</sup> S. Yoshida, Sci. Pap. Inst. of Phys. Chem. Res., Tokyo **38**, 272 (1941).

<sup>2</sup> J. C. McDonald, Phys. Rev. **50**, 694 (1936).

<sup>3</sup> J. C. McDonald, Phys. Rev. **50**, 782 (1936).

<sup>4</sup> International Critical Tables, **6**, 154.

<sup>5</sup> Ya. M. Fogel, J. Exper. Theoret. Phys. (USSR) **10**, 1455 (1940).