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The Crystal Structure of Potassium Triiodidomercurate(II) Monohydrate, $KHgI_3H_2O$

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The crystal structure of $KHgI_3H_2O$ has been determined by single crystal X-ray methods, using three-dimensional diffractometer data. The unit cell is orthorhombic, with $a = 8.625$, $b = 9.345$, and $c = 11.501$ Å. The space group is No. 33: $Pna2_1$. The structure can be described as built up from HgI_4 tetrahedra linked through common corners to infinite chains, running parallel to the a axis of the unit cell. The large differences in the Hg–I bond lengths (2.70_5 Å, 2.73_1 Å, 2.83_4 Å, and 2.90_4 Å) indicate deviations from a regular tetrahedral bonding arrangement around the Hg atom.

Mercury(II) can coordinate from one to four halide ions in solution.[1] All evidence points towards a tetrahedral structure for HgX_4^{2-} and a linear arrangement in HgX_2.[2–4] X-Ray scattering measurements on mercury(II) iodide solutions in *dimethylsulfoxide* (DMSO) have indicated a pyramidal structure for the HgI_3^- ion and have given no evidence for the formation of polynuclear complexes.[5] In corresponding mercury bromide solutions, however, polynuclear complexes appear to occur.[6] Preliminary X-ray scattering measurements on *aqueous* solutions containing bromide or iodide do not indicate polynuclear complex formation, and even here it seems possible to interpret the results by assuming a pyramidal structure for the HgX_3^- ion.[7] Other X-ray measurements, however, have been interpreted as indicating the presence of polynuclear complexes in aqueous solutions with less than four iodide ions per mercury ion.[8]

In connection with the X-ray scattering measurements on aqueous solutions of mercury iodide complexes it was of interest to investigate the crystal structure of the compound $KHgI_3H_2O$, which crystallizes from such solutions, since a knowledge of the type of complexes present in the crystal and accurate values for the Hg–I bond lengths would be useful in the interpretation of the scattering data.

Crystals of this compound obtained by other authors [9] have been said to have the composition $KHgI_3$,[10] $KHgI_3H_2O$,[11,10] or $KHgI_3(H_2O)_{1.5}$.[12] According to Pernot,[11] the composition is $KHgI_3H_2O$. She obtained no evidence for the formula $KHgI_3$, and attributed the formula $KHgI_3(H_2O)_{1.5}$ to insufficiently dry crystals. The formula $KHgI_3H_2O$ is in agreement with the results of the present work.

EXPERIMENTAL

Preparation of crystals. Crystals were prepared by dissolving 9.74 g HgI_2 (Baker analyzed) and 6.26 g KI (E. Merck, Darmstadt, zur Analyse) in 4.0 ml of H_2O at about 60°C, to give a molar ratio of $KI:HgI_2 = 1.76$. The iodide content had to be kept high, otherwise a mixture of HgI_2 and $KHgI_3H_2O$ was obtained on cooling. The red mercury(II) iodide dissolved readily, yielding a heavy yellow solution which on cooling deposited yellow crystals of trapezoidal cross-section. The crystals were filtered off and dried over silica gel in a desiccator. They are very soluble in water and ethanol, but insoluble in benzene and carbon tetrachloride. They are decomposed slowly by light, but seem to be fairly stable if kept in a desiccator in the dark.

Analysis. The analysis was carried out according to the method described by Pernot.[11] A glass tube drawn out into two bulbs 2 cm apart was weighed empty, the crystals were inserted in the end bulb, and the tube was weighed again. The tube was then held horizontal, and the bulb carefully warmed to drive off the water of crystallization which condensed near the end of the tube. The bulb was then heated more strongly, until mercury(II) iodide sublimed into the second bulb. When the violet colour of liberated iodine was just perceptible in the end bulb, the heating was stopped. The tube was then dried and weighed, the water content being obtained from the loss in weight. The bulbs containing potassium iodide and mercury(II) iodide, respectively, were then separated, and the separate pieces weighed, cleaned and reweighed to obtain the amounts of potassium iodide and mercury(II) iodide present. The results indicated, however, that the separation of KI and HgI_2 by this method was not complete, and the potassium content was therefore determined separately by atomic absorption spectroscopy, using a Perkin Elmer 303. Crystals of known weight were dissolved in a known amount of water. In contact with water, the crystals decomposed and red mercury(II) iodide precipitated. An aliquot was taken from the clear solution and diluted so as to give a potassium content of approximately 4 ppm. Potassium chloride was used as standard, and the range of measurement was 2 – 6 ppm K.

The density of the crystals was estimated according to the method of Archimedes as described by Schrewelius.[20] The average of six determinations was 4.57 ± 3 g/cm³.

The results of the analysis, which are summarized in Table 1, support the conclusion reached by Pernot,[11] that the composition of the crystals is $KHgI_3H_2O$.

Table 1. Result of the analysis.

Substance	Observed (%)	Calculated (%) for $KHgI_3H_2O$
H_2O	2.65	2.823
$KI + HgI_2$	97.15	97.177
K	6.43	6.123
Density	4.57	4.574 ($z = 4$)

INTENSITY DATA

The crystals, which are acicular (needle-axis parallel to the crystallographic *a* axis), were cut to approximately cubic dimensions. The cube edge was, in all cases, approximately 0.1 mm. Single crystals were mounted about the *a* and *b* axes, and the layers $h0l-h6l$ (402 reflections) and $0kl-3kl$ (370 reflections) were recorded, using multiple film equi-inclination Weissenberg techniques and Ni-filtered CuK radiation. From a crystal mounted along a face diagonal ([011]) as rotation axis, 246 reflections were similarly recorded from the zero, second and fourth layers.

The relative intensities of the reflections were estimated visually by comparison with a scale prepared by making timed exposures of a selected reflection from the relevant crystal.

Although these data proved to be sufficient for the determination of the main features of the structure, they were not sufficient for an unambiguous location of the oxygen atoms. For the final refinement of the structure, a new set of intensity data was therefore recorded, using an automatic diffractometer (type Philips-Norelco PAILRED) with a scintillation counter and MoK radiation, monochromatized with a crystal of lithium fluoride. Half the sphere of reflection was explored ($0kl-10kl$), and a total of 1542 reflections were recorded. The crystal used had the dimensions 0.14 mm in the direction of the a axis, and 0.11 mm in the other two axial directions. The intensity values were corrected for absorption, assuming a linear absorption coefficient of 274 cm^{-1}.

All calculations were carried out on a CDC3600 or an IBM360/50 computer. The following programs were used:

DATAP2:	LP and absorption correction of Weissenberg and diffractometer data.[13]
DRF:	Structure factor calculations and Fourier summations.[14]
LALS:	Full matrix least squares refinement.[15]
DISTAN:	Calculation of interatomic distances and angles.[16]
POWDER:	Least squares refinement of unit cell parameters from powder photographs.[17]

UNIT CELL AND SPACE GROUP

From the Weissenberg photographs, the Laue symmetry was found to be *mmm*. Approximate unit cell dimensions were estimated from the rotation and Weissenberg photographs, and more accurate dimensions were obtained from a Guinier powder photograph taken with Cu$K\alpha$ radiation ($\lambda(\text{Cu}K\alpha_1) = 1.54051$ Å), using lead(II) nitrate ($a_0 = 7.8566$ Å) as an internal standard.[18] A least squares refinement led to the values $a = 8.6252$ (11), $b = 9.3445$ (11), $c = 11.5008$ (10), $V = 926.95$ Å^3. Observed and calculated $\sin^2\theta$ values are listed in Table 2.

Assuming four formula units in the unit cell, the calculated density is 4.574 g/cm^3, which is in agreement with the observed values of 4.57 g/cm^3 (Table 1).

Systematically absent reflections are $0kl$ with $k+l$ odd, and $h0l$ with h odd. This is in accordance with the orthorhombic space groups:[19] No. 33, $Pna2_1$, and No. 62, $Pnam$. All reflections hkl with $k+l$ odd are very weak, which indicates an approximate A-centering of the unit cell, at least with respect to the mercury and the iodine atoms.

Table 2. Powder photograph of $KHgI_3H_2O$. Cu$K\alpha_1$ radiation, $\lambda(CuK\alpha_1) = 1.54051$ Å. Internal standard lead(II) nitrate ($a_0 = 7.8566$ Å). $a = 8.6252$ Å, $b = 9.3445$ Å, $c = 11.5008$ Å, cell volume = 926.95 Å^3.

h k l	$10^5\sin^2\theta$ calc	$10^5\sin^2\theta$ obs	*I* obs	*h k l*	$10^5\sin^2\theta$ calc	$10^5\sin^2\theta$ obs	*I* obs
0 1 1	1129	1125	vs	3 3 2	15086	15086	s
0 0 2	1795	1791	m	2 1 5	15090		
1 1 1	1926	1923	m	0 0 6	16157	16145	w
0 2 0	2717	2714	m	3 2 4	17075	17067	w
2 0 0	3190	3188	m	4 2 2	17272	17261	m
1 2 0	3515	3505	vvw	0 3 5	17334	17341	m
2 1 1	4318	4309	s	3 3 3	17330	17341	m
0 2 2	4512	4505	s	3 4 0	18046	18024	w
2 0 2	4985	4978	vvs	0 4 4	18049		
1 2 2	5310	5304	s	0 2 6	18874	18859	vw
1 1 3	5516	5511	vs	3 1 5	19077	19075	vvw
2 2 0	5907	5894	w	4 3 1	19322	19337	vvw
0 3 1	6562	6557	s	2 0 6	19347		
0 0 4	7181	7177	s	3 4 2	19341	19838	w
1 3 1	7360	7352	w	2 5 1	20620	20633	vvw
2 1 3	7908	7907	s	0 5 3	21021	21024	vvw
3 1 1	8305	8297	m	5 2 0	22654	22653	vw
1 3 2	8706	8698	vvw	4 2 4	22658		
3 2 0	9894	9871	m	0 1 7	22671		
0 2 4	9898			3 5 1	24608	24626	w
0 3 3	10153	10138	w	5 1 3	24655		
2 0 4	10371	10358	w	4 1 5	24659		
1 2 4	10696	10681	vw	0 4 6	27026	27015	vvvw
1 3 3	10950	10945	m	1 4 6	27823	27819	vvw
1 4 0	11666	11662	s	2 6 2	29439	29454	vvw
3 1 3	11896	11892	s	5 3 3	30089	30084	w
0 1 5	11900			4 3 5	30093		
4 0 0	12759	12752	m	4 2 6	31634	31616	vvw
2 2 4	13038	13088	s	3 5 5	35379	35378	vvw
2 3 3	13343	13343	vs	6 3 3	38861	38855	vw
3 3 1	13739	13737	vw	2 1 9	40223	40195	vvvw
4 1 1	13887	13871	m				
4 0 2	14555	14552	w				

STRUCTURE DETERMINATION

The positions of the mercury and the iodine atoms were determined from the three-dimensional Patterson function. It was not possible to explain the observed peaks if the unit cell was assumed to have a center of symmetry. For the non-centrosymmetric space group $Pna2_1$, however, an arrangement of the 4 Hg and the 12 I atoms was found, which was consistent with the peaks in the Patterson function. The derived parameters, assuming the z parameter of the Hg atom to be 1/4, were:

4 Hg in 0.25 0.21 1/4
4 I(1) in 0.50 0.25 0.09
4 I(2) in 0.25 0.42 0.83
4 I(3) in 0.25 0.42 0.42

Table 3. Peaks in the three-dimensional Patterson function.

Positions			Height	Assignment of vectors		
				Hg – Hg	Hg – I	I – I
0	0	0	100			
0	0.50	0.50	90	2+2		4+2+4+2
0.50	0.02	0	15			2(+2)
0.50	0.50	0.50	24			2+2
0.50	0.35	0	13			2+2
0.50	0.85	0.50	13			2+2
0.50	0.08	0	25	2		
0.50	0.58	0.50	22	1+1		
0	0.28	±0.08	13		1+1	
0	0.78	±0.58	12		1+1	
0	0.22	±0.16	13		1+1	
0	0.72	±0.66	14		1+1	
0	0.50	±0.09	13			2
0	0	±0.59	14			2
0.25	±0.49	±0.34	18		1+1	
0.25	±0.98	±0.84	17		1+1	
0.25	±0.17	±0.29	12			1+1+1+1
0.25	±0.67	±0.79	12			1+1+1+1
0.50	0.12	±0.43	13		1+1	
0.50	0.63	±0.93	13		1+1	
0.50	0.38	±0.34	14		1+1	
0.50	0.87	±0.84	14		1+1	
0.50	±0.16	±0.08	7			1+1
0.50	±0.66	±0.58	8			1+1

The assignment of vectors in the three-dimensional Patterson function is given in Table 3.

The derived parameter values correspond to a complete A-centering of the unit cell, and do not, therefore, explain the weak reflections *hkl* with $k+l$ odd. The first least squares refinement was carried out keeping the x parameters fixed, and including an isotropic temperature factor for each atom, which led to an R factor of 0.22 for the 554 observed reflections. The x parameters were then shifted slightly from their values of 1/4, and the refinement was continued. A number of cycles using different starting values for these shifts finally led to an optimum agreement, corresponding to an R value of 0.169 for all observed reflections. Of these, 123 belonged to reflections with $k+l$ odd, for which the corresponding R factor was 0.203 ($R=\sum||F_{\text{obs}}|-|F_{\text{calc}}||/\sum|F_{\text{obs}}|$).

A three-dimensional difference map, based on the parameters from the least squares refinement, was used for the location of the light atoms. The position of the potassium atom could be unambiguously determined as corresponding to the highest peak (13 el/Å^3) in the difference map. Several peaks were of a height expected for an oxygen atom, but geometrical reasoning showed that only one of these was plausible. A new least squares refinement with the potassium atom included led to an R factor of 0.156 for all observed reflections, and of 0.159 for those 123 with $k+l$ odd.

REFINEMENT OF THE STRUCTURE

For the final refinement of the structure, the intensity data recorded with the diffractometer were used. The atomic scattering factors were taken from Doyle and Turner,[21] and were corrected for the real part of the anomalous dispersion according to Cromer.[22] Hughes' weighting scheme [23] was used.

The least squares refinement was started with the previously obtained parameters for the Hg and the I atoms. After three cycles, the R factor was 0.15 for 1522 observed reflections, and 0.26 for those 392 reflections with $k+l$ odd. In a difference map, calculated using the refined parameter values, the two highest peaks occurred at the positions previously assigned to the potassium and the oxygen atoms.

With all atoms included, a new least squares refinement yielded an R value of 0.106 for all observed reflections, and 0.187 for those reflections with $k+l$ odd. When anisotropic temperature factors for each atom and the imaginary part of the anomalous dispersion correction were included, the R factor dropped to 0.089 for all observed reflections, and to 0.159 for the reflections with $k+l$ odd. If 32 weak reflections (19 of which had $k+l$ odd), which were given zero weight in the refinement, were excluded, the R factors were 0.081 and 0.131, respectively. In the final cycle of refinement, all parameter shifts were less than 10 % of the estimated standard deviations.

A three-dimensional electron density map, calculated using the final parameter values, showed peak heights of 350 el/Å^3 for the Hg atom, 210 – 250 el/Å^3 for the I atoms, 47 el/Å^3 for the K atom, and 17 el/Å^3 for the O atom. In the final difference map, all peaks were below 5 el/Å^3, with the exception of a peak close to the mercury position which was 8 el/Å^3. Observed and calculated F values are compared in Table 7.

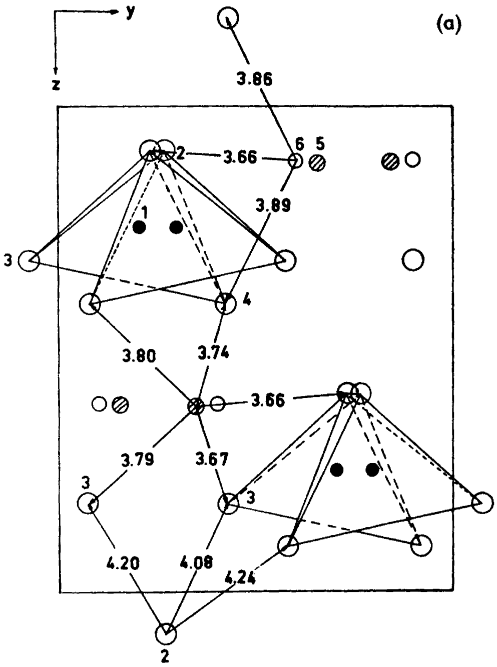
DISCUSSION OF THE STRUCTURE

The final parameter values are given in Table 4, and interatomic distances and angles in Table 5. Projections of the structure along the three axes of the unit cell are shown in Fig. 1.

ble 4. Final atomic fractional coordinates and thermal parameters. Space group No. 33, $Pna2_1$.[a] Standard deviations within brackets. The temperature factor was calculated as $\exp 2\pi^2(-h^2a^{*2}U_{11}-k^2b^{*2}U_{22}-l^2c^{*2}U_{33}-hka^*b^*U_{12}-hla^*c^*U_{13}-klb^*c^*U_{23})$

om	x	y	z	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
g	0.2559 (3)	0.2032 (2)	$\frac{1}{4}$	0.044 (1)	0.043 (1)	0.045 (1)	–0.009 (2)	0.023 (2)	–0.008 (2)
1)	0.4964 (4)	0.2686 (3)	0.0908 (3)	0.026 (1)	0.039 (1)	0.031 (1)	–0.003 (2)	–0.010 (3)	–0.012 (3)
2)	0.2442 (6)	0.4266 (3)	0.8193 (3)	0.052 (2)	0.048 (1)	0.043 (1)	–0.002 (4)	–0.012 (4)	–0.027 (2)
3)	0.2400 (6)	0.4214 (3)	0.4075 (3)	0.057 (2)	0.055 (2)	0.043 (1)	0.015 (4)	0.027 (5)	0.028 (3)
	0.0607 (15)	0.1552 (13)	0.6173 (19)	0.049 (6)	0.055 (6)	0.121 (14)	–0.018 (10)	0.006 (18)	–0.013 (17)
	0.3655 (37)	0.1002 (34)	0.6126 (53)	0.040 (17)	0.057 (20)	0.127 (42)	0.051 (30)	–0.103 (56)	0.012 (54)

[a] The atomic positions are 4(a) (x,y,z), $(\bar{x},\bar{y},\frac{1}{2}+z)$, $(\frac{1}{2}-x,\frac{1}{2}+y,\frac{1}{2}+z)$, $(\frac{1}{2}+x,\frac{1}{2}-y,z)$.


y
z
(a)
3.86
2
3.66
6 5
3.89
1
3
4
3.80
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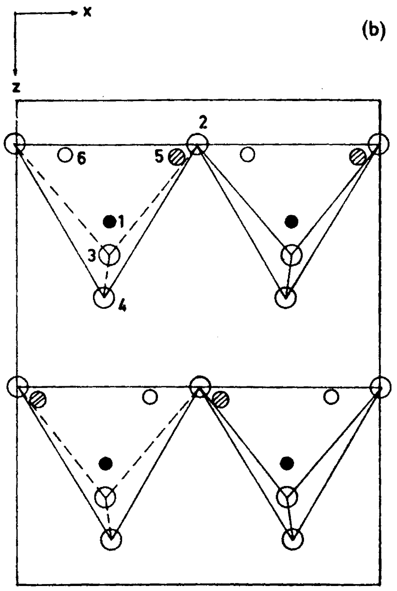
3
3
4.20
4.08
4.24
2



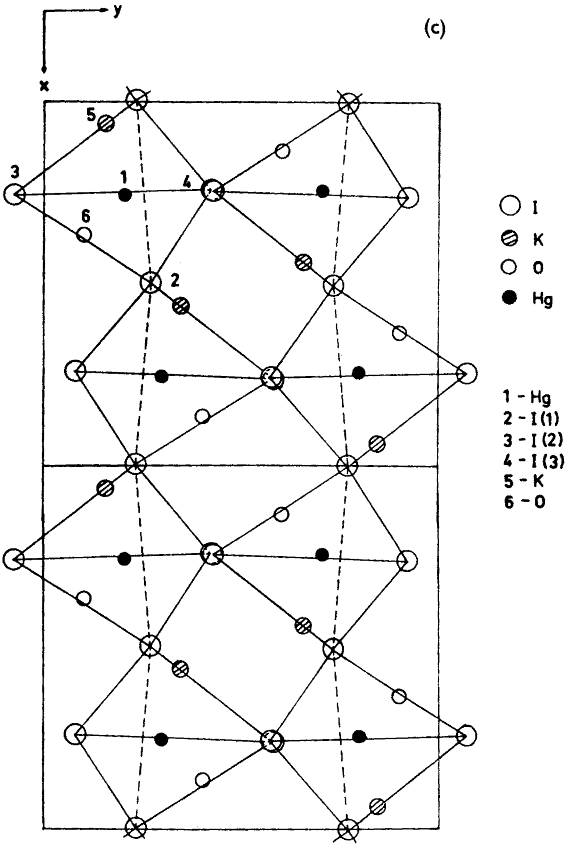

y
x
(c)
5
3
1
4
6
2
I
K
O
Hg
1 - Hg
2 - I(1)
3 - I(2)
4 - I(3)
5 - K
6 - O

Fig. 1a. Projection of the structure of $KHgI_3H_2O$ along the *a*-axis. The distances between K and I(1) and their nearest neighbours are indicated.

Fig. 1b. Projection of the structure of $KHgI_3H_2O$ along the *b*-axis.

Fig. 1c. Projection of the structure of $KHgI_3H_2O$ along the *c*-axis. Two unit cells have been included in the direction of the *a*-axis.

Each mercury atom is tetrahedrally coordinated by four iodine atoms, the coordination polyhedron being somewhat distorted (Fig. 2). The tetrahedra are linked through common corners to form chains running parallel to the *a* axis, as shown in Fig. 1. The Hg – I bond lengths vary between 2.70$_5$ and 2.90$_4$ Å, with an average value of 2.79 Å, the two bonds involving the bridging iodine (I(1)) atoms being significantly longer than the other two (Fig. 3).

Table 5a. Atomic distances in $KHgI_3H_2O$. Standard deviations within brackets.

Mercury-iodine distances within the tetrahedron		Iodine-iodine distances within the tetrahedron	
Hg – I(2)	2.705 (3)	I(1) – I(1)	4.326 (1)
– I(3)	2.731 (4)	– I(2)	4.475 (5)
– I(1)	2.834 (4)	– I(2)	4.629 (5)
– I(1)	2.904 (4)	– I(3)	4.494 (5)
		– I(3)	4.564 (5)
		I(2) – I(3)	4.735 (4)

Iodine-iodine distances between different chains		Distances between potassium and its nearest neighbours	
I(1) – I(2)	4.082 (5)	K – O	2.68 (4)
– I(2)	4.200 (5)	– O	2.84 (3)
– I(3)	4.244 (5)	– I(1)	3.66 (1)
– I(3)	4.373 (5)	– I(2)	3.67 (2)
I(2) – I(3)	4.526 (7)	– I(2)	3.79 (2)
– I(3)	4.737 (5)	– I(3)	3.74 (2)
		– I(3)	3.80 (2)

Distances between oxygen and its nearest neighbours	
O – K	2.68 (4)
– K	2.84 (3)
– I(1)	3.66 (3)
– I(2)	3.86 (6)
– I(3)	3.89 (6)

Table 5b. Angles around the Hg atom in an HgI_4 tetrahedron. Standard deviations within brackets.

I(1) – Hg – I(1)	97.9 (1)
I(1) – Hg – I(2)	105.8 (1)
I(1) – Hg – I(3)	108.2 (1)
I(1) – Hg – I(2)	113.4 (1)
I(1) – Hg – I(3)	107.7 (1)
I(2) – Hg – I(3)	121.2 (1)

The potassium ions are each surrounded by two water molecules at 2.68 and 2.84 Å, and five iodine atoms from three different chains of HgI_4 tetrahedra at 3.65 – 3.80 Å. The water molecules are not coordinated to the mercury atoms, but are in contact with potassium ions and iodine atoms at the distances given in Table 5.

Although the crystals of $KHgI_3H_2O$ are formed from solutions in which, presumably, HgI_3^- or $HgI_3H_2O^-$ complexes occur, they do not contain these units, but are built up from infinite complexes in which the mercury atoms are coordinated only to iodine atoms. This is analogous to what has been found in the newly determined structure of $KHgBr_3H_2O$, which is built up from infinite chains of $HgBr_4$ tetrahedra.[24]

Table 6. Interatomic distances found in mercury-iodide compounds.

Compound	Hg – I bond (Å)	I – I distances (Å) within a coordination polyhedron	Shortest distance between I atoms belonging to different coordination polyhedra	Reference
HgI_2(yellow)	2 atoms 2.62	4.36 – 5.24	4.02	25
	4 » 3.51			
HgI_2(red)	4 » 2.783	4.36 – 4.64	4.14	26
β-Ag_2HgI_4	4 » 2.77	4.47 – 4.56	4.29	27
β-Cu_2HgI_4	4 » 2.80	4.58 – 4.65	3.96	27
$(CH_3)_3SHgI_3$	3 » 2.69 – 2.72	4.53 – 4.75	4.33	25
	2 » 3.52, 3.69			
$[(CH_3)_3S]_2HgI_4$	4 » 2.68 – 2.80	4.38 – 4.52	4.72	28
$KHgI_3H_2O$	4 » 2.71 – 2.90	4.33 – 4.74	4.08	Present work

The bonding arrangement around the Hg atom in $KHgI_3H_2O$ is not, however, regularly tetrahedral. The Hg atom is closer to one of the sides of the HgI_4 tetrahedron than to the others. This results in one Hg – I bond being much longer (2.90_4 Å) than the other bonds (average value 2.75_7 Å). The I – Hg – I angles in the resulting HgI_3 pyramid (113°, 108°, and 121°) are larger than the other angles around the Hg atom, as shown in Table 5b. This seems to be an indication of a tendency towards a lower coordination of the mercury atom than the tetrahedral one. Discrete HgI_3^- complexes have been found in other structures. In $(CH_3)_3SHgI_3$, the HgI_3^- complexes are approximately planar[25] with Hg – I bond lengths of 2.69 – 2.72 Å. The coordination polyhedron of the mercury atom is, however, completed by two more iodine atoms at the much larger distances of 3.52 and 3.69 Å, and is thus a trigonal bipyramid. Interatomic distances found in a number of mercury iodide compounds are compared in Table 6 with those found in the present structure de-

Table 7. Observed and calculated structure factors. The column headings are the index k, $|F_o|$, $|F_c|$, and α.

0 K 0			
0	-	1044	356
2	203	219	172
4	69	76	350
6	212	207	177
8	118	122	172
10	40	46	344
12	-	6	71
14	-	29	350
0 K 1			
1	331	324	161
3	367	393	321
5	112	111	119
7	42	37	224
9	55	57	27
11	55	62	171
13	-	20	333
15	-	3	188
0 K 2			
0	265	251	185
2	380	374	286
4	163	149	98
6	105	98	111
8	161	152	40
10	66	67	186
12	38	40	322
14	36	18	203
0 K 3			
1	82	76	295
3	180	173	195
5	219	197	205
7	152	144	0
9	63	59	132
11	75	73	1
13	35	25	335
15	-	6	231
0 K 4			
0	181	163	107
2	189	172	198
4	95	90	52
6	145	136	326
8	60	50	164
10	87	82	332
12	49	44	156
14	-	3	55
0 K 5			
1	320	315	172
3	341	321	77
5	85	79	163
7	40	34	132
9	119	112	305
11	43	29	220
13	-	18	341
15	-	10	116
0 K 6			
0	347	343	189
2	286	270	0
4	131	121	165
6	40	45	19
8	-	16	312
10	44	47	177
12	-	21	323
14	-	5	177
0 K 7			
1	320	315	343
3	123	117	91
5	164	164	347
7	-	24	80
9	83	90	191
11	-	3	326
13	-	21	172
0 K 8			
0	84	81	307
2	198	194	134
4	126	121	293
6	82	87	3
8	39	43	220
10	46	39	24
12	44	39	157
14	-	5	325
0 K 9			
1	30	26	347
3	120	120	271
5	55	48	321
7	62	69	193
9	56	58	14
11	39	42	133
13	-	15	359
0 K 10			
0	70	80	51
2	98	94	46
4	59	57	251
6	82	94	193
8	41	48	296
10	33	31	146
12	43	30	0
0 K 11			
1	98	99	28
3	73	72	216
5	41	42	103
7	-	18	262
9	-	30	144
11	-	26	325
0 K 12			
0	164	172	341
2	94	87	215
4	54	53	27
6	51	57	142
8	36	39	124
10	-	12	344
12	-	9	249
0 K 13			
1	90	98	169
3	63	80	315
5	33	30	149
7	-	9	27
9	43	27	229
11	-	13	176
0 K 14			
0	81	87	160
2	40	57	281
4	41	40	104
6	-	18	313
8	37	42	23
10	-	10	183
0 K 15			
1	45	22	238
3	45	44	128
5	39	31	195
7	-	31	358
9	-	9	230
0 K 16			
0	-	12	95
2	-	5	89
4	-	15	133
6	-	20	330
8	-	15	191
0 K 17			
1	-	11	212
3	39	41	238
5	-	8	357
7	41	10	315
0 K 18			
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2	38	25	15
4	-	10	215
1 K 0			
1	-	22	359
2	98	98	4
3	88	90	178
4	406	451	355
5	80	82	358
6	95	95	167
7	28	34	176
8	-	9	269
9	28	37	355
10	81	76	174
11	46	38	175
12	41	33	351
13	39	23	354
14	-	23	347
15	-	12	173
1 K 1			
1	146	134	155
2	-	18	55
3	160	156	356
4	29	24	275
5	171	164	183
6	69	67	119
7	153	151	341
8	67	73	299
9	39	27	153
10	36	42	120
11	-	12	120
12	33	22	300
13	-	12	354
14	-	14	117
15	-	18	168
1 K 2			
1	55	52	77
2	296	293	290
3	97	92	248
4	295	290	216
5	78	73	58
6	152	141	335
7	43	51	237
8	96	90	134
9	38	37	58
10	57	56	60
11	35	32	243
12	33	26	212
13	34	22	67
14	-	16	182
15	-	10	243
1 K 3			
1	314	302	22
2	-	20	124
3	188	174	170
4	54	49	359
5	112	100	306
6	72	72	189
7	194	183	198
8	59	62	12
9	32	35	312
10	49	41	188
11	-	26	15
12	-	20	358
13	-	12	92
14	-	11	178
15	-	15	0
1 K 4			
1	34	28	144
2	209	195	168
3	81	76	329
4	84	77	12
5	75	72	142
6	177	171	163
7	45	45	301
8	89	84	348
9	33	37	122
10	-	14	322
11	-	30	310
12	-	11	251
13	36	19	126
14	-	17	341
15	33	10	301
1 K 5			
1	204	195	274
2	28	23	73
3	175	168	341
4	32	20	229
5	236	228	142
6	57	52	262
7	104	100	60
8	59	56	84
9	55	53	140
10	31	34	248
11	36	24	271
12	-	21	61
13	41	29	313
14	-	13	242
1 K 6			
1	-	14	229
2	97	89	347
3	44	43	36
4	148	133	175
5	51	50	201
6	124	127	353
7	40	39	6
8	49	48	139
9	33	33	187
10	-	6	345
11	-	28	15
12	-	4	317
13	33	18	195
14	-	18	182
1 K 7			
1	140	133	199
2	-	29	271
3	141	133	173
4	35	34	131
5	200	197	360
6	37	43	318
7	32	33	62
8	-	42	143
9	54	54	351
10	33	31	143
11	-	8	171
12	-	19	132
13	38	30	178
14	-	11	310
1 K 9			
1	-	18	294
2	165	161	155
3	33	37	92
4	56	50	29
5	38	43	257
6	89	84	174
7	36	40	78
8	74	77	329
9	-	31	257
10	-	16	376
11	-	21	80
12	-	7	156
13	-	14	265
14	-	8	34
1 K 9			
1	94	90	114
2	-	20	25
3	88	95	11
4	39	38	17
5	81	81	191
6	33	39	32
7	74	80	310
8	31	33	214
9	-	29	215
10	-	25	23
11	-	5	213
12	-	16	199
13	-	14	31
1 K 10			
1	-	11	319
2	132	129	24
3	27	26	170
4	71	73	100
5	36	34	348
6	67	68	357
7	31	32	145
8	63	60	191
9	-	25	326
10	36	30	54
11	-	17	149
12	-	5	303
13	-	11	317
1 K 11			
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2	-	15	100
3	43	42	175
4	-	20	278
5	66	69	346
6	42	25	99
7	48	50	161
8	-	24	280
9	-	2	180
10	-	19	90
11	-	9	137
12	-	13	260
1 K 12			
1	-	5	112
2	56	46	273
3	-	14	224
4	97	107	323
5	-	22	33
6	38	33	186
7	30	20	219
8	-	13	39
9	-	19	30
10	-	30	119
11	-	15	209
12	-	12	144
1 K 13			
1	32	29	110
2	-	12	138
3	38	36	337
4	-	16	336
5	48	50	198
6	-	19	156
7	41	31	316
1 K 14			
4	64	64	186
5	-	17	99
6	-	16	310
7	-	20	277
8	-	12	136
9	-	14	100
10	-	14	2
1 K 15			
1	46	41	340
2	-	7	239
3	-	23	167
4	-	17	44
5	-	6	60
6	-	16	227
7	34	37	158
8	-	13	49
9	-	6	314
1 K 16			
1	-	3	174
2	-	17	157
3	-	10	360
4	-	19	18
5	-	13	181
6	-	24	138
7	-	12	352
8	-	8	5
1 K 17			
1	34	26	225
2	-	7	303
3	-	14	336
4	-	7	128
5	-	18	113
6	-	10	299
7	-	21	24
1 K 18			
1	-	1	265
2	-	3	311
3	-	5	62
4	-	15	170
5	-	8	237
2 K 0			
0	-	407	174
1	-	10	188
2	151	155	184
3	28	33	175
4	101	101	1
5	-	14	1
6	85	78	359
7	-	2	225
8	188	193	353
9	-	4	168
10	87	86	170
11	-	10	354
12	34	14	334
13	-	0	152
14	-	25	170
15	-	3	173
2 K 1			
0	46	45	319
1	219	208	38
2	34	34	151
3	141	128	200
4	-	8	73
5	139	138	124
6	-	19	338
7	115	116	316
8	-	8	185
9	69	66	166
10	-	5	116
11	65	62	342
12	-	3	255
13	-	19	149
14	-	1	332
15	-	3	43
2 K 2			
0	483	590	47
1	23	20	175
2	250	238	174
3	31	27	77
4	125	119	4
5	39	33	78
6	193	179	259
7	-	21	245
8	77	73	198
9	-	14	301
10	58	54	325
11	-	4	157
12	49	40	124
13	-	2	76
14	-	18	33
15	-	0	319
2 K 3			
0	22	24	191
1	281	281	163
2	-	20	221
3	406	430	11
4	-	7	347
5	84	61	139
6	-	22	39
7	44	24	162
8	-	12	19
9	37	33	260
10	-	15	197
11	60	59	188
12	-	1	6
13	-	22	341
14	-	0	8
15	-	4	69
2 K 4			
0	259	247	152
1	30	31	22
2	368	371	333
3	-	3	46
4	166	159	146
5	-	16	156
6	68	62	238
7	-	17	335
8	54	46	81
9	-	6	292
10	51	48	172
11	-	2	127
12	39	35	349
13	33	2	324
14	-	6	203
15	-	1	3
2 K 5			
0	33	42	109
1	304	298	306
2	-	19	215
3	101	67	271
4	-	12	337
5	193	190	278
6	-	8	337
7	83	86	48
8	-	5	226
9	98	102	149
10	-	6	341
11	45	43	34
12	-	5	134
13	-	22	162
14	-	2	130
2 K 6			
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1	29	13	7
2	93	66	119
3	-	16	28
4	73	62	219
5	26	12	68
6	67	67	349
7	-	5	143
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9	-	5	51
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12	-	29	150
13	-	1	24
14	-	7	310

Table 7. Continued.

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3	142	129	173
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5	83	69	227
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7	72	67	147
8	-	0	335
9	99	101	348
10	-	1	341
11	-	19	100
12	-	4	43
13	-	18	335
14	-	1	308
2 K 8			
0	156	149	243
1	-	15	3
2	168	163	15
3	-	8	301
4	94	92	194
5	-	10	325
6	92	89	120
7	-	9	101
8	-	23	298
9	33	10	184
10	-	24	167
11	-	3	24
12	43	33	324
13	-	2	270
14	-	1	24
2 K 9			
0	26	19	349
1	182	183	12
2	-	3	254
3	144	146	154
4	-	5	167
5	87	87	48
6	-	2	83
7	-	3	345
8	-	7	183
9	37	23	34
10	-	6	47
11	39	26	120
12	-	2	244
13	-	12	205
2 K 10			
0	149	154	299
1	25	17	247
2	163	168	174
3	-	8	255
4	94	97	346
5	34	5	315
6	76	81	63
7	-	5	174
8	-	11	62
9	-	8	41
10	32	16	358
11	-	2	147
12	-	29	196
13	-	0	338
2 K 11			
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1	94	102	130
2	-	7	69
3	76	78	304
4	-	5	231
5	45	40	64
6	29	4	129
7	34	31	251
8	-	5	18
9	-	36	11
10	-	2	217
11	-	30	169
12	-	1	5
2 K 12			
0	112	121	121
1	-	9	73
2	28	18	173
3	-	14	198
4	32	29	16
5	-	6	138
6	49	51	258
7	32	3	171
8	45	57	334
9	-	3	307
10	34	26	170
11	38	2	191
12	-	10	21
2 K 13			
0	-	8	10
1	35	31	60
2	-	10	227
3	39	19	54
4	-	6	53
5	34	27	142
6	-	5	97
7	-	34	306
8	-	2	235
9	46	28	184
10	-	1	350
11	-	18	323
2 K 14			
0	77	86	31
1	-	6	180
2	38	18	243
3	-	7	57
4	-	23	61
5	-	4	101
6	34	32	238
7	-	2	273
8	-	31	166
9	-	1	31
10	-	10	288
2 K 15			
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1	50	43	22
2	-	0	61
3	64	69	356
4	-	2	36
5	-	13	240
6	-	3	335
7	-	12	117
8	-	4	38
9	-	10	155
2 K 16			
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2	35	50	331
3	-	1	4
4	37	26	163
5	-	1	294
6	-	9	322
7	-	2	5
8	-	14	82
2 K 17			
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1	33	39	293
3	-	4	51
4	-	17	219
5	-	1	276
3 K 0			
1	83	92	357
2	140	149	182
3	80	87	176
4	333	357	174
5	52	48	354
6	109	107	349
7	68	77	175
8	30	21	154
9	46	41	355
10	67	70	354
11	-	29	176
12	35	30	351
13	-	19	356
14	-	21	167
15	-	9	176
3 K 1			
1	184	163	327
2	-	16	209
3	181	180	161
4	68	72	311
5	132	137	3
6	75	72	127
7	116	119	165
8	53	50	309
9	-	21	338
10	36	39	116
11	-	7	296
12	41	22	285
13	-	8	197
14	-	10	108
15	-	15	353
3 K 2			
1	21	8	58
2	-	174	121
3	64	58	267
4	254	251	37
5	73	64	86
6	135	131	145
7	37	34	243
8	93	88	306
9	40	41	50
10	45	44	237
11	33	32	239
12	-	22	209
13	-	18	48
14	-	15	356
15	-	12	231
3 K 3			
1	207	194	199
2	-	19	176
3	122	117	332
4	-	14	321
5	93	88	130
6	44	43	193
7	177	168	10
8	53	54	8
9	43	31	137
10	-	34	180
11	-	25	198
12	-	25	4
13	-	10	296
14	-	16	180
15	-	15	182
3 K 4			
1	34	34	163
2	231	212	346
3	48	41	301
4	81	78	189
5	35	50	96
6	131	131	342
7	46	48	305
8	63	61	167
9	38	36	127
10	-	16	141
11	-	29	306
12	-	8	72
13	-	20	136
14	-	14	160
15	-	10	314
3 K 5			
1	202	189	97
2	39	46	173
3	136	121	171
4	67	67	77
5	208	196	322
6	56	59	245
7	87	84	232
8	44	41	238
9	52	49	321
10	41	37	263
11	-	18	85
12	-	19	76
13	-	29	130
14	-	9	249
3 K 6			
1	30	35	214
2	91	80	146
3	61	59	27
4	123	115	351
5	44	51	197
6	109	114	178
7	45	53	17
8	44	41	333
9	40	37	196
10	-	8	188
11	-	19	12
12	-	3	121
13	-	13	193
3 K 7			
1	98	94	19
2	41	35	6
3	139	134	356
4	32	40	135
5	170	172	178
6	41	48	339
7	35	32	244
8	42	40	158
9	53	48	170
10	-	26	305
11	-	9	356
12	-	17	130
13	33	24	357
14	-	10	304
3 K 8			
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2	123	124	335
3	28	24	123
4	41	41	205
5	39	38	296
6	73	82	350
7	28	28	80
8	67	74	149
9	-	25	260
10	-	11	154
11	33	22	80
12	-	6	350
13	-	14	244
14	-	7	215
3 K 9			
1	88	86	291
2	29	19	162
3	70	75	181
4	-	13	241
5	67	71	8
6	32	22	18
7	69	68	128
8	-	28	199
9	37	24	33
10	41	23	31
11	-	6	49
12	-	17	195
13	-	14	215
3 K 10			
1	-	14	53
2	116	116	204
3	-	19	126
4	63	62	280
5	29	34	290
6	47	57	173
7	-	24	153
8	53	49	7
9	31	24	322
10	-	28	51
11	-	18	137
12	-	6	132
13	-	12	338
3 K 11			
1	29	29	169
2	-	17	57
3	32	33	353
4	-	33	260
5	53	59	166
6	-	30	87
7	56	43	343
8	-	25	261
9	-	3	328
10	-	19	90
11	38	6	314
12	-	12	279
3 K 12			
1	-	19	14
2	31	39	87
3	-	24	225
4	93	94	144
5	-	26	52
6	-	29	10
7	32	32	207
8	-	14	227
9	-	19	38
10	38	24	301
11	-	11	219
3 K 13			
1	35	23	293
2	-	15	207
3	39	32	161
4	-	22	349
5	55	46	16
6	-	22	172
7	33	29	140
8	-	18	358
9	-	10	298
10	-	14	151
11	-	9	242
3 K 14			
1	-	6	236
2	-	16	82
3	-	10	312
4	53	59	4
5	-	17	122
6	-	17	136
7	-	11	310
8	-	12	321
9	-	14	98
10	-	14	178
3 K 15			
1	-	36	158
2	-	9	205
3	36	23	343
4	-	4	113
5	-	5	212
6	-	9	228
7	36	34	334
8	-	13	36
9	-	7	125
3 K 16			
1	-	4	175
2	-	16	332
3	-	5	320
4	-	16	193
5	37	10	139
4 K 0			
0	-	592	355
1	-	27	174
2	147	164	171
3	40	33	354
4	103	110	353
5	44	50	357
6	162	158	177
7	34	35	174
8	87	92	171
9	-	4	202
10	43	36	344
11	-	6	164
12	-	5	116
13	-	3	350
14	-	23	350
15	-	1	341
4 K 1			
0	21	25	285
1	289	278	152
2	26	26	75
3	234	246	323
4	30	17	188
5	69	65	114
6	-	15	255
7	28	31	238
8	27	18	343
9	44	41	31
10	-	16	134
11	50	47	173
12	-	6	344
13	-	16	336
14	-	0	270
15	-	4	166
4 K 2			
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1	54	49	311
2	248	255	285
3	52	57	258
4	152	148	92
5	-	14	88
6	59	60	116
7	-	7	325
8	117	113	37
9	-	15	137
10	54	53	182
11	-	10	46
12	38	32	320
13	-	1	267
14	-	15	202
15	-	3	244
4 K 3			
0	111	112	27
1	89	81	254
2	30	27	187
3	134	134	200
4	33	18	219
5	142	127	202
6	-	6	227
7	116	112	0
8	-	13	196
9	41	48	139
10	-	7	339
11	59	59	1
12	-	5	27
13	-	21	155
14	-	2	71
15	-	6	231
4 K 4			
0	123	103	78
1	-	23	208
2	131	121	199
3	-	15	330
4	65	61	81
5	33	26	165
6	112	109	324
7	-	2	279
8	42	38	157
9	-	17	18
10	64	63	331
11	-	6	201
12	33	33	155
13	-	1	351
14	-	2	40
15	-	2	313
4 K 5			
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1	222	212	180
2	31	40	326
3	238	220	71
4	-	9	116
5	64	69	162
6	27	31	141
7	31	32	304
8	-	12	65
9	84	88	305
10	-	13	244
11	33	21	211
12	-	5	358
13	-	15	337
14	-	2	275
4 K 6			
0	260	241	181
1	36	20	57
2	222	208	359
3	-	14	178
4	110	102	176
5	-	17	228
6	33	37	24
7	26	24	204
8	-	9	310
9	-	8	185
10	32	35	177
11	-	4	352
12	-	17	327
13	36	4	19
14	-	5	177
4 K 7			
0	40	27	215
1	257	253	343
2	-	27	237
3	99	92	99
4	-	21	62
5	119	120	341
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7	-	21	86
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14	-	2	205
4 K 8			
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2	151	149	131
3	29	26	121
4	106	101	294
5	-	8	289
6	58	63	7
7	-	4	199
8	32	36	217
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13	-	2	103
4 K 9			
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11	33	33	134
12	-	2	84
13	-	12	357
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2	76	70	47
3	-	13	126
4	42	39	255
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6	68	72	190
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12	-	23	356
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Table 7. Continued.

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6	35	44	142
7	-	9	213
8	-	30	120
9	-	6	86
10	-	9	337
11	-	6	190
4	K	13	
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2	-	9	76
3	57	65	315
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6	-	8	233
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11	32	11	175
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9	-	3	150
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3	36	35	301
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7	39	25	177
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9	33	8	39
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3	-	4	43
4	32	12	136
5	-	5	189
6	-	17	326
7	-	1	147
8	35	13	185
4	K	17	
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2	-	7	349
3	33	33	56
5	K	0	
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2	43	46	9
3	-	7	196
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5	46	50	359
6	65	62	165
7	-	19	180
8	-	11	218
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10	49	46	353
11	-	35	173
12	-	22	170
13	-	15	351
14	-	16	346
15	38	12	171
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2	38	40	85
3	87	88	360
4	34	30	264
5	92	93	187
6	36	37	103
7	97	105	340
8	34	41	284
9	32	24	153
10	-	30	123
11	-	11	125
12	37	26	132
13	-	11	340
14	-	15	123
15	-	13	163
5	K	2	
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2	164	155	291
3	45	47	216
4	168	165	207
5	44	48	21
6	105	95	335
7	68	68	242
8	46	52	148
9	34	38	65
10	38	40	58
11	-	18	243
12	-	17	35
13	-	16	77
14	-	11	174
15	-	8	257
5	K	3	
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2	-	18	171
3	116	116	171
4	94	92	14
5	83	73	323
6	51	64	184
7	113	114	185
8	39	29	1
9	-	25	305
10	34	32	191
11	-	11	10
12	-	17	3
13	-	10	82
14	-	6	185
5	K	4	
1	25	17	88
2	129	122	164
3	49	47	332
4	36	44	14
5	63	60	163
6	112	115	161
7	42	43	315
8	68	69	345
9	46	37	131
10	-	5	294
11	-	19	305
12	-	7	248
13	-	11	97
14	-	11	343
5	K	5	
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2	54	55	309
3	122	114	335
4	-	10	58
5	158	155	140
6	38	32	98
7	64	64	55
8	39	39	90
9	33	35	140
10	-	23	227
11	-	18	273
12	-	20	62
13	-	18	315
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5	K	6	
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3	95	82	169
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7	32	19	73
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9	49	37	353
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6	42	43	214
7	52	55	310
8	-	27	214
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5	36	38	16
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9	34	20	336
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7	37	38	157
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7	-	9	263
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10	43	22	295
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5	-	33	187
6	-	13	134
7	38	22	312
8	-	17	309
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2	64	64	187
3	73	76	175
4	78	77	0
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6	-	8	6
7	-	15	349
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13	-	3	172
14	-	16	169
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2	39	33	163
3	72	71	209
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5	63	58	118
6	-	14	45
7	65	63	316
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9	37	49	154
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11	-	43	337
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2	136	131	174
3	-	16	70
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5	35	34	74
6	122	120	256
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9	-	18	327
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12	-	24	127
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14	-	11	26
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1	194	185	169
2	-	13	243
3	223	229	188
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9	51	54	154
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11	40	27	35
12	-	8	131
13	-	16	160
14	-	2	139
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3	37	38	213
4	51	47	219
5	-	13	245
6	53	49	2
7	-	11	186
8	50	45	171
9	-	3	26
10	45	45	351
6	K	7	
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1	84	79	207
2	49	45	26
3	67	72	165
4	-	16	205
5	38	47	230
6	-	24	227
7	38	43	140
8	-	0	153
9	54	64	345
10	-	4	214
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12	33	7	45
13	-	12	331
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2	101	101	16
3	-	5	282
4	58	54	205
5	-	13	320
6	55	57	116
7	-	13	80
8	-	17	287
9	-	15	194
10	-	14	152
11	-	6	43
12	-	20	321
13	-	3	251
6	K	9	
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2	-	8	251
3	88	89	155
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5	47	54	36
6	-	10	77
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8	-	13	187
9	-	13	197
10	-	10	32
11	43	17	119
12	-	5	233
13	-	7	206
6	K	10	
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2	100	106	167
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6	36	42	66
7	30	9	162
8	-	5	54
9	-	16	36
10	-	11	11
11	-	5	166
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7	-	22	243
8	-	9	12
9	-	22	11
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12	-	3	359
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6	K	14	
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2	-	15	243
3	-	13	47
4	-	17	66
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6	-	21	237
7	-	5	264
8	-	19	156
9	-	3	40
6	K	15	
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2	-	1	357
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4	-	4	39
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1	-	6	61
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7	K	0	
1	38	41	353
2	28	33	188
3	33	34	170
4	154	166	172
5	32	36	352
6	50	51	345
7	74	69	174
8	-	19	160
9	-	30	355
10	50	40	353
11	-	9	179
12	-	14	350
13	-	10	358
14	-	10	165
7	K	1	
1	65	61	335
2	47	46	153
3	80	77	164
4	66	62	317
5	72	72	351
6	42	41	130
7	64	69	161
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10	-	23	112
11	-	2	314
12	-	15	275
13	-	4	209
14	-	8	105
7	K	2	
1	38	35	262
2	95	85	114
3	-	14	319
4	110	113	28
5	50	53	99
6	78	67	149
7	35	30	257
8	49	44	306
9	-	30	60
10	-	18	224
11	38	25	236
12	-	13	217
13	-	11	29
14	-	9	357
7	K	3	
1	93	88	196
2	51	43	211
3	66	62	336
4	-	11	228
5	50	47	128
6	-	11	177
7	68	76	4
7	K	4	
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5	-	35	80
6	70	71	340
7	33	34	308
8	-	32	165
9	-	25	126
10	38	10	320
11	47	22	306
12	-	4	44
13	-	15	140
14	-	9	156
7	K	5	
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3	74	65	163
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5	95	91	325
6	39	43	227
7	34	43	230
8	36	27	40

Table 7. Continued.

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4	36	29	320
5	87	92	172
6	34	35	341
7	43	13	279
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9	-	28	170
10	-	16	290
11	-	7	339
12	-	11	125
13	-	11	352
	7 K 8		
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4	-	28	183
5	36	32	319
6	44	46	345
7	-	14	90
8	38	40	144
9	-	16	261
10	-	2	177
11	-	17	81
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4	-	10	315
5	41	40	356
6	-	11	345
7	-	40	124
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7	38	23	336
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10	-	14	87
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3	34	22	219
4	45	49	140
5	-	22	58
6	-	17	4
7	-	27	203
8	-	11	220
	7 K 13		
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2	-	16	222
3	38	20	158
4	-	19	354
5	45	28	7
6	48	19	356
7	-	17	147
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10	43	10	326
	8 K 0		
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2	77	84	170
3	27	34	353
4	64	67	352
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6	76	83	176
7	-	28	172
8	-	33	168
9	-	4	328
10	-	20	344
11	-	12	169
12	-	5	147
13	-	3	350
14	-	11	348
	8 K 1		
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3	110	121	320
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5	32	32	112
	8 K 2		
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6	-	16	180
7	-	8	339
8	52	55	37
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	8 K 3		
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	8 K 4		
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2	47	50	203
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5	-	13	152
6	60	63	318
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6	-	27	27
7	-	19	24
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9	-	10	192
10	33	16	180
11	-	7	13
12	-	8	334
13	37	4	24
	8 K 7		
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1	126	125	336
2	-	23	235
3	45	53	109
4	-	12	81
5	54	57	333
	8 K 8		
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2	73	72	122
3	-	22	101
4	58	50	286
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7	-	6	197
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11	-	3	173
12	-	17	157
13	-	2	82
	8 K 9		
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7	-	28	180
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12	-	3	83
	8 K 10		
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2	-	30	52
3	30	15	313
4	-	19	265
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6	38	37	177
7	-	1	239
8	-	23	298
9	-	12	238
10	-	14	135
11	-	2	42
12	-	12	343
	8 K 11		
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2	-	15	178
3	37	33	35
4	-	10	342
5	-	22	86
6	-	5	48
7	-	13	261
8	-	10	230
9	-	13	128
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11	34	11	316
	8 K 12		
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2	44	42	202
3	-	16	345
4	-	28	20
5	-	9	16
6	-	20	150
7	-	9	210
8	-	15	109
9	-	7	73
10	-	3	317
11	-	7	195
	8 K 13		
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1	52	47	158
2	-	8	78
3	47	37	318
4	-	6	292
5	-	17	142
6	-	9	221
7	-	5	337
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9	-	9	44
10	-	5	176
	8 K 14		
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2	42	29	278
3	35	15	85
4	-	20	97
5	-	5	191
6	40	11	297
	9 K 0		
1	27	31	174
2	-	14	14
3	-	9	343
4	81	88	351
5	-	24	1
6	-	27	162
7	-	9	185
8	-	9	334
9	-	23	355
10	39	16	351
11	43	22	172
12	-	13	171
13	-	10	349
14	-	8	345
	9 K 1		
1	33	31	161
2	-	27	97
3	31	41	347
4	-	17	253
5	-	39	174
6	-	16	85
7	33	36	349
8	-	22	277
9	-	7	182
10	42	18	303
11	-	3	123
12	-	16	314
13	-	4	332
14	-	10	124
	9 K 2		
1	26	22	68
2	43	47	296
3	-	24	194
4	73	68	207
5	-	31	12
6	48	40	334
7	41	43	240
8	-	24	140
9	-	21	64
0	-	18	51
11	-	10	244
12	-	5	359
13	-	11	82
14	-	5	155
	9 K 3		
1	52	51	17
2	-	19	175
3	34	40	161
4	68	58	15
5	62	34	323
6	-	36	180
7	45	53	185
8	-	17	353
9	-	13	335
10	-	19	193
11	42	4	19
12	-	8	4
13	-	4	79
14	-	3	183
	9 K 4		
1	-	5	57
2	57	50	156
3	36	23	336
4	49	31	357
5	52	38	161
6	49	48	160
7	-	27	323
8	-	25	337
9	-	21	133
10	-	3	189
11	-	11	298
12	-	4	311
13	-	7	90
14	-	4	343
	9 K 5		
1	36	34	263
2	40	37	305
3	52	43	335
4	-	5	141
5	62	57	139
6	-	16	295
7	-	23	22
8	40	22	88
	9 K 6		
1	-	9	29
2	-	28	335
3	-	8	234
4	36	33	155
5	-	10	193
6	36	35	340
7	-	11	20
8	37	17	142
9	-	13	190
10	-	3	260
11	-	17	6
12	-	3	29
13	-	11	186
	9 K 7		
1	-	26	193
2	40	24	64
3	36	35	165
4	-	13	152
5	53	50	347
6	-	19	268
7	-	9	62
8	-	21	96
9	46	13	343
	10 K 0		
0	-	49	168
1	-	24	350
2	25	29	186
3	32	34	172
4	35	32	359
5	-	7	174
6	-	8	170
7	-	7	342
8	-	45	351
9	-	4	13
10	-	19	166
11	-	5	345
12	-	5	331
13	-	1	157
	10 K 1		
0	-	25	329
1	36	41	69
2	-	19	158
3	31	30	229
4	-	14	327
5	-	28	116
6	-	10	82
7	35	27	134
8	-	10	183
9	-	19	145
10	-	5	348
11	-	18	331
12	-	3	229
13	40	6	151
	10 K 2		
0	91	98	33
1	26	27	119
2	59	52	189
3	-	12	60
4	37	38	36
5	-	11	57
6	-	45	249
7	-	14	222
8	-	12	156
9	-	10	347
10	-	14	317
11	-	7	210
12	-	8	135
13	-	2	47
	10 K 3		
0	24	30	199
1	85	81	171
2	-	5	248
3	76	84	3
4	-	17	19
5	-	23	151
6	-	5	154
7	-	4	40
8	-	14	7
9	-	8	257
10	-	11	178
11	-	10	179
12	-	1	353
13	-	5	330
	10 K 4		
0	63	59	141
1	-	16	56
2	77	92	322
3	-	6	314
4	48	50	138
5	-	5	93
6	-	12	275
7	-	13	331
8	-	13	87
9	-	14	178
10	-	12	176
11	-	4	356
12	-	10	343
13	-	2	131
	10 K 5		
0	-	27	73
1	67	73	292
2	-	21	199
3	-	10	88
4	-	9	57
5	-	40	265
6	-	20	308
7	-	21	37
8	-	3	210
9	-	22	157
10	-	4	6
11	-	12	29
12	-	5	142
13	-	6	158
	10 K 6		
0	-	13	248
1	-	26	212
2	40	17	76
3	37	19	207
4	-	22	217
5	-	5	203
6	-	25	356
7	-	4	164
8	34	22	171
9	-	4	339
10	-	18	347
11	-	2	216
12	-	9	139
13	35	1	65
	10 K 7		
0	-	11	147
1	35	22	216
2	-	27	16
3	-	30	143
4	-	18	193

termination. In DMSO solutions of mercury(II) iodide, the Hg – I bond lengths have been found to be 2.80 Å in the HgI_4^{2-} complex, and 2.73 Å in the HgI_3^- complex.[5]

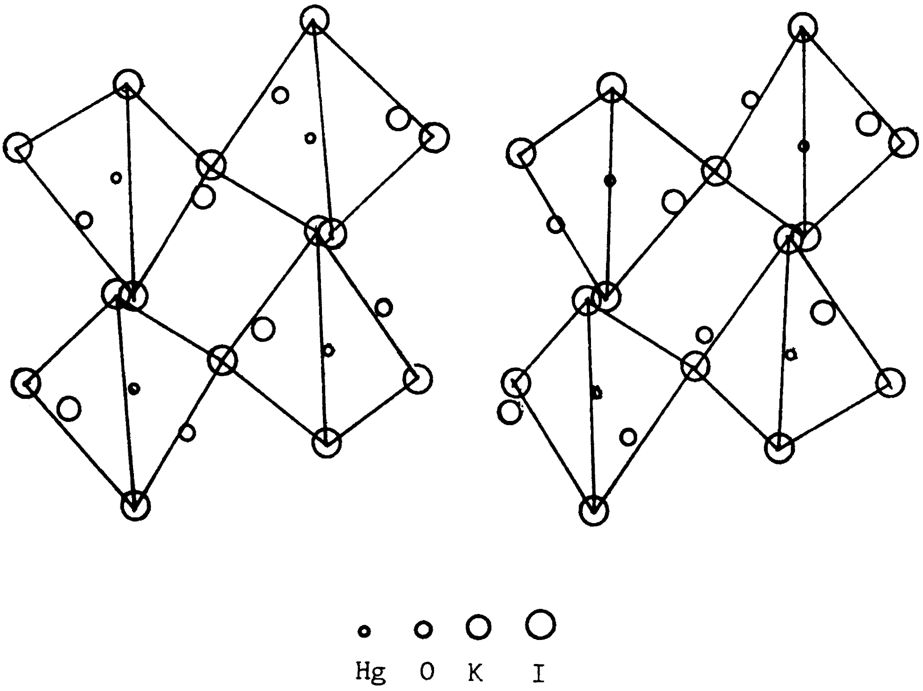

Fig. 2. Stereographic projection of the structure of $KHgI_3H_2O$. The *a*-axis is parallel to the chain, the *b*-axis is horizontal, and the *c*-axis perpendicular.

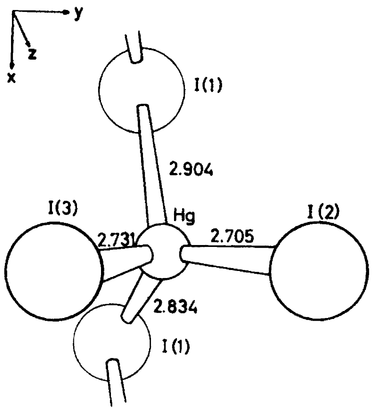

Fig. 3. The configuration of an HgI_4-group.

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