



Crystal structure of $[\text{Ag}(\text{NH}_3)_3]_2[\text{Ag}(\text{NH}_3)_2]_2[\text{SnF}_6]\text{F}_2$, a compound showing argentophilic interactions

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Bis[triamminesilver(I)] bis[diamminesilver(I)] hexafluorostannate(IV) difluoride, $[\text{Ag}(\text{NH}_3)_3]_2[\text{Ag}(\text{NH}_3)_2]_2[\text{SnF}_6]\text{F}_2$, was obtained in the form of colourless crystals from the reaction of CsAgSnF_7 in anhydrous ammonia. Two different ammine complexes of silver(I) are present in the structure, *i.e.* a linear diammine and a T-shaped triammine complex. The ammine silver(I) complexes show $\text{Ag} \cdots \text{Ag}$ distances in the range of argentophilic interactions. In the crystal, several $\text{N}-\text{H} \cdots \text{F}$ hydrogen bonds are present between the complex cations and the SnF_6^- and F^- anions, leading to the formation of a three-dimensional network.

1. Chemical context

Metallophilicity, especially argento- and aurophilicity, is a theoretically and experimentally well-established concept, see, for example, the seminal works of Jansen (Jansen, 1987), Schmidbaur and co-workers (Scherbaum *et al.*, 1988; Schmidbaur, 1995; Schmidbaur & Schier, 2012, 2015) or Pyykkö and co-workers (Pyykkö & Zhao, 1991; Pyykkö, 1997, 2004; Pyykkö *et al.*, 1997; Pyykkö & Mendizabal, 1997). We reacted a silver(II) compound, CsAgSnF_7 , with anhydrous

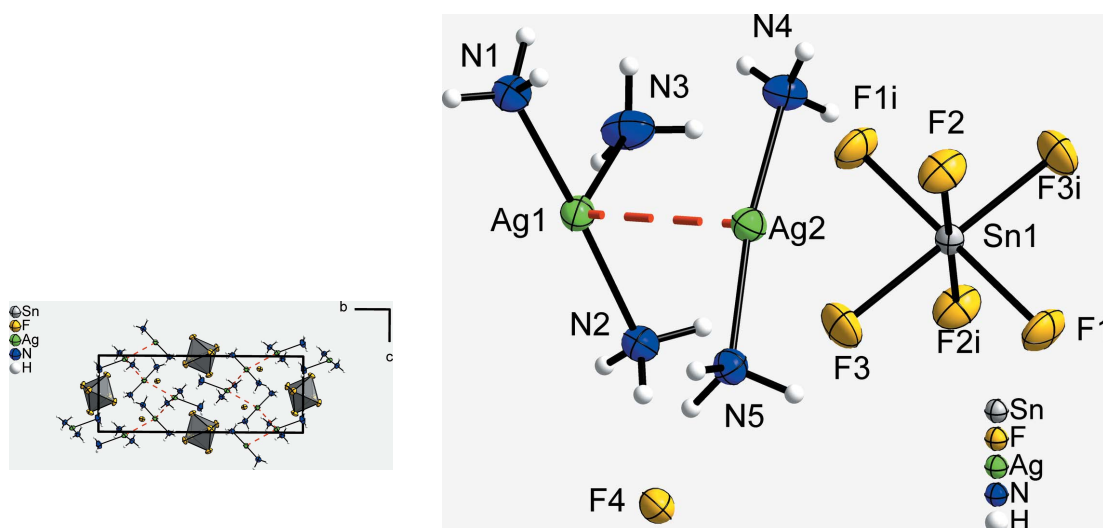
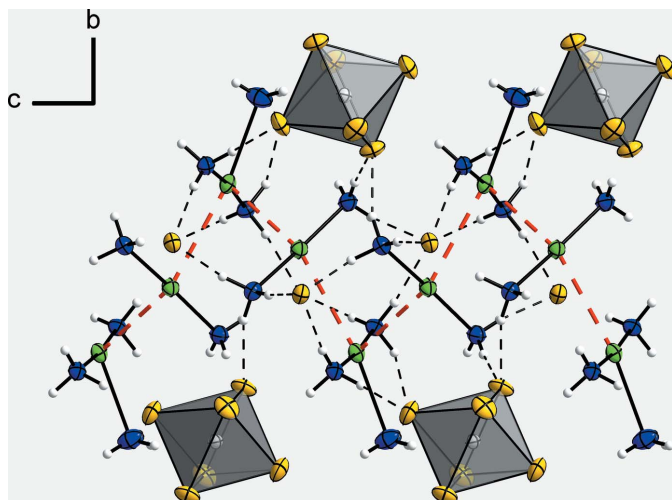


Figure 1
The principal building units in the crystal structure of the title compound, showing the F^- anion, the $[\text{SnF}_6]^{2-}$ anion, as well as the argentophilic interaction (in red) between the $[\text{Ag}(\text{NH}_3)_2]^+$ and $[\text{Ag}(\text{NH}_3)_3]^+$ cations. Displacement ellipsoids are drawn at the 70% probability level and H atoms are shown with an arbitrary radius. [Symmetry code: (i) $-x + 1, -y, -z + 1$.]

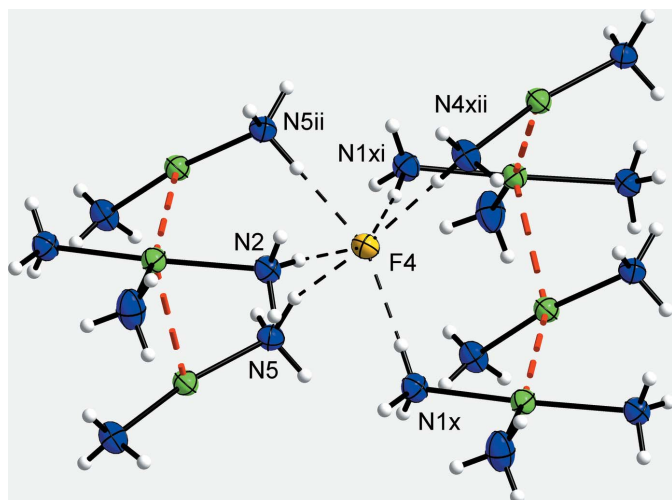

Figure 2

A section of the crystal structure in a view along [100], showing a corrugated strand of complex cations running along [001]. The argentophilic interactions are drawn as red dashed bonds between the Ag^{I} atoms and $\text{N}-\text{H}\cdots\text{F}$ hydrogen bonds are shown as dashed lines. $[\text{SnF}_6]^{2-}$ anions are shown as polyhedra to highlight their positions relative to the kinks of the strand. Displacement ellipsoids are as in Fig. 1.

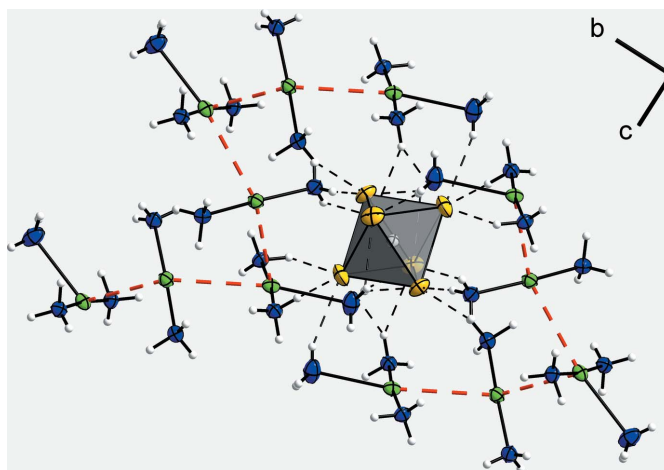
liquid ammonia and observed the reduction of Ag^{II} . The preparation conditions and crystal structure of the thus obtained Ag^{I} title compound, $[\text{Ag}(\text{NH}_3)_3][\text{Ag}(\text{NH}_3)_2]_2[\text{SnF}_6]\text{F}_2$, is reported here. The short $\text{Ag}\cdots\text{Ag}$ distances between the complex cations are in the range of argentophilic interactions.

2. Structural commentary

$[\text{Ag}(\text{NH}_3)_3][\text{Ag}(\text{NH}_3)_2]_2[\text{SnF}_6]\text{F}_2$ crystallizes in space group type $P2_1/c$. The Sn atom occupies Wyckoff position 2d (site


Figure 3

A section of the crystal structure of the title compound, showing the $\text{N}-\text{H}\cdots\text{F}$ hydrogen bonds (dashed lines) around the free fluoride anion and the bridging of the corrugated $\text{Ag}\cdots\text{Ag}$ strands (red dashed lines). Displacement ellipsoids are as in Fig. 1. [Symmetry codes: (ii) $x, -y + \frac{1}{2}, z + \frac{1}{2}$; (x) $1 + x, y, z$; (xi) $1 + x, \frac{1}{2} - y, \frac{1}{2} + z$; (xii) $1 + x, y, 1 + z$.]


Figure 4

A section of the crystal structure, showing the hydrogen bonding towards the $[\text{SnF}_6]^{2-}$ anion, which is shown as a polyhedron. Ag^{I} atoms are interconnected by $\text{Ag}\cdots\text{Ag}$ interactions (red dashed lines) to show the formation of strands. Displacement ellipsoids are as in Fig. 1.

symmetry $\bar{1}$), all other atoms reside on general positions 4e. The structure comprises of $[\text{Ag}(\text{NH}_3)_3]^+$ and $[\text{Ag}(\text{NH}_3)_2]^+$ complex cations as well as F^- and $[\text{SnF}_6]^{2-}$ anions (Fig. 1). The diamminesilver(I) cation ($\text{Ag}2$) is almost linear with an $\text{N}-\text{Ag}-\text{N}$ angle of $170.93(7)^\circ$ and $\text{Ag}-\text{N}$ distances of $2.1160(16)$ and $2.1183(16)$ Å. The deviation from linearity is likely to arise from the surrounding, *i.e.* $\text{N}-\text{H}\cdots\text{F}$ hydrogen bonding to adjacent $[\text{SnF}_6]^{2-}$ and F^- anions. This $[\text{Ag}(\text{NH}_3)_2]^+$ cation shows a short $\text{Ag}\cdots\text{Ag}$ distance of $3.0611(2)$ Å to a neighboring $[\text{Ag}(\text{NH}_3)_3]^+$ cation and another slightly longer $\text{Ag}\cdots\text{Ag}$ distance of $3.3282(2)$ Å to a second $[\text{Ag}(\text{NH}_3)_3]^+$ cation (symmetry code $x, -y + \frac{1}{2}, z + \frac{1}{2}$). The triammine silver(I) cation ($\text{Ag}1$) is T-shaped and can be viewed as a linear diammine silver(I) cation to which another ammine ligand is bound at a longer distance. The short $\text{Ag}-\text{N}$ distances are $2.1434(16)$ and $2.1662(16)$ Å, and the remote ammine ligand is bound at a distance of $2.5870(19)$ Å. The $\text{N}-\text{Ag}-\text{N}$ angle between the shortly bonded ligands is $173.74(7)^\circ$. The deviation of $\text{N}-\text{Ag}-\text{N}$ angles including the remote ammine ligand from 90° [$85.44(6)$ and $110.82(6)^\circ$] are probably due to hydrogen bonding of the ammine ligands to F atoms of the anions.

3. Supramolecular features

As a result of the short $\text{Ag}1\cdots\text{Ag}2$ contacts, corrugated strands of alternating $[\text{Ag}(\text{NH}_3)_3]^+$ and $[\text{Ag}(\text{NH}_3)_2]^+$ cations occur where the $[\text{Ag}(\text{NH}_3)_3]^+$ cations form the kinks which are connected by the $[\text{Ag}(\text{NH}_3)_2]^+$ cations. The strands run parallel to the c axis (Fig. 2). Similar metallophilic interactions have been observed in the ammine copper(I) fluoride $\{[\text{Cu}(\text{NH}_3)_3][\text{Cu}_2(\text{NH}_3)_4]\}\text{F}_4\cdot 4\text{NH}_3$ (Woidy *et al.*, 2015). However, the cuprophilic interactions are only observed between the diammine copper(I) cations forming linear strands whereas the triammine copper(I) cations do not show such interactions.

Table 1
Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
N1—H1A···F4 ⁱ	0.85 (3)	2.03 (3)	2.884 (2)	178 (2)
N1—H1B···F4 ⁱⁱ	0.89 (3)	1.96 (3)	2.844 (2)	171 (3)
N1—H1C···F3 ⁱ	0.98 (4)	2.14 (4)	3.057 (2)	156 (3)
N2—H2A···F1 ⁱⁱⁱ	0.91 (3)	2.43 (3)	3.227 (2)	146 (2)
N2—H2A···F3 ^{iv}	0.91 (3)	2.56 (3)	3.354 (2)	145.4 (19)
N2—H2B···F3	0.94 (3)	2.04 (3)	2.961 (2)	167 (3)
N2—H2C···F4	0.83 (3)	2.02 (3)	2.849 (2)	172 (3)
N3—H3A···F1 ⁱ	0.88 (3)	2.57 (3)	3.274 (2)	138 (3)
N3—H3A···F2 ^v	0.88 (3)	2.42 (3)	3.223 (2)	153 (3)
N3—H3B···F3 ^{iv}	0.79 (3)	2.61 (3)	3.345 (3)	157 (3)
N3—H3C···F1 ^{vi}	0.91 (3)	2.39 (3)	3.279 (3)	167 (3)
N4—H4A···F2	0.90 (3)	2.04 (3)	2.930 (2)	170 (2)
N4—H4B···F4 ^{viii}	0.84 (3)	1.97 (3)	2.7955 (19)	171 (3)
N4—H4C···F1 ⁱ	0.79 (3)	2.33 (3)	3.045 (2)	151 (3)
N5—H5A···F4	0.96 (3)	1.90 (3)	2.8305 (19)	160 (3)
N5—H5B···F4 ^{viii}	0.95 (3)	1.93 (3)	2.882 (2)	173 (2)
N5—H5C···F2 ^{ix}	0.93 (3)	2.09 (3)	2.999 (2)	163 (3)

Symmetry codes: (i) $x-1, y, z$; (ii) $x-1, -y+\frac{1}{2}, z-\frac{1}{2}$; (iii) $x, y, z+1$; (iv) $-x+1, -y, -z+2$; (v) $-x, -y, -z+1$; (vi) $-x+1, -y, -z+1$; (vii) $x-1, y, z-1$; (viii) $x, -y+\frac{1}{2}, z-\frac{1}{2}$; (ix) $x, -y+\frac{1}{2}, z+\frac{1}{2}$.

In the title structure, the fluoride anions reside above and below the cation strands and connect neighbouring strands *via* N—H···F hydrogen bonds, whereas the $[\text{SnF}_6]^{2-}$ anions lie on the sides of the strands, also connecting neighbouring ones. The free fluoride ion (F4) is an acceptor of six hydrogen bonds (Fig. 3). Its coordination environment resembles an octahedron with one longer edge. It interconnects the $\text{Ag}\cdots\text{Ag}$ strands along the *a*-axis. The $[\text{SnF}_6]^{2-}$ anion interconnects four of the $\text{Ag}\cdots\text{Ag}$ strands (Fig. 4). Four of the six F atoms bonded to the Sn atom are acceptors of four hydrogen bonds (two regular, two bifurcated), the other two F atoms are acceptors of three hydrogen bonds. The diammine silver(I) cations only form regular hydrogen bonds, whereas the

Table 2
Experimental details.

Crystal data	
Chemical formula	$[\text{Ag}(\text{NH}_3)_3]_2[\text{Ag}(\text{NH}_3)_2][\text{SnF}_6]\text{F}_2$
M_r	872.51
Crystal system, space group	Monoclinic, $P2_1/c$
Temperature (K)	123
a, b, c (Å)	7.3274 (2), 19.4495 (4), 7.8579 (3)
β (°)	113.205 (4)
V (Å ³)	1029.27 (6)
Z	2
Radiation type	Mo $K\alpha$
μ (mm ⁻¹)	5.01
Crystal size (mm)	0.20 × 0.05 × 0.05
Data collection	
Diffractometer	Oxford-Diffraction Xcalibur3
Absorption correction	Multi-scan (<i>CrysAlis RED</i> ; Oxford Diffraction, 2008)
$T_{\text{min}}, T_{\text{max}}$	0.602, 1.000
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	30418, 5731, 4330
R_{int}	0.030
$(\sin \theta/\lambda)_{\text{max}}$ (Å ⁻¹)	0.889
Refinement	
$R[F^2 > 2\sigma(F^2)], wR(F^2), S$	0.020, 0.046, 0.99
No. of reflections	5731
No. of parameters	167
H-atom treatment	All H-atom parameters refined
$\Delta\rho_{\text{max}}, \Delta\rho_{\text{min}}$ (e Å ⁻³)	1.04, -0.93

Computer programs: *CrysAlis CCD* and *CrysAlis RED* (Oxford Diffraction, 2008), *SHELXS97* (Sheldrick, 2008), *SHELXL2016* (Sheldrick, 2015), *SHELXL1E* (Hübschle *et al.*, 2011), *DIAMOND* (Brandenburg, 2012) and *publCIF* (Westrip, 2010).

triammine silver(I) cations form regular as well as bifurcated hydrogen bonds. The bifurcated hydrogen bonds bridge four edges of each $[\text{SnF}_6]^{2-}$ octahedron. Overall, a rather complex three-dimensional hydrogen-bonded network results (Fig. 5). Numerical details of the hydrogen-bonding interactions are summarized in Table 1.

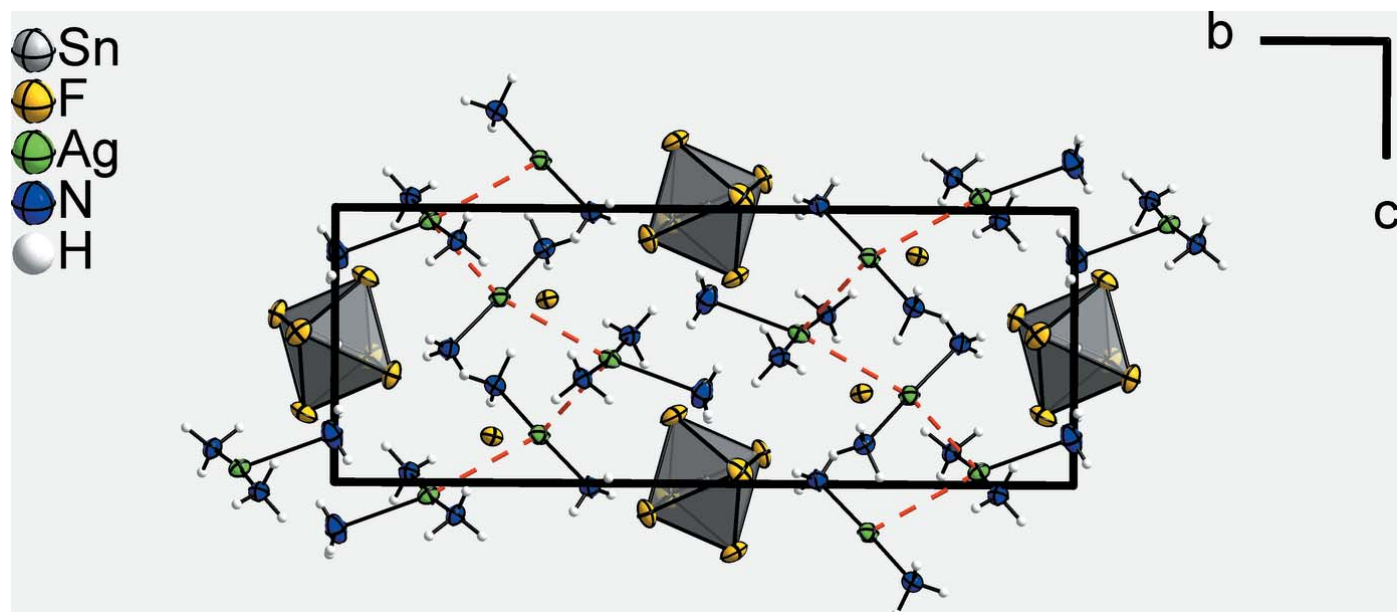


Figure 5
The crystal structure of the title compound. Ag^{I} atoms are interconnected by argentophilic interactions (red dashed lines) to show the formation of strands and $[\text{SnF}_6]^{2-}$ anions are shown as polyhedra. Displacement ellipsoids are as in Fig. 1.

4. Synthesis and crystallization

870 mg of CsAgSnF₇ were reacted with approximately 10 ml of anhydrous liquid ammonia at 195 K. Upon contact, the greenish colour of the educt vanished and a white powder was observed. This indicates that Ag^{II} was reduced to Ag^I and ammonia was oxidized to N₂. From this white powder, colorless crystals grew within three months of storage at 233 K of which a suitable one was selected for the diffraction experiment. The role of the Cs atoms remains unclear.

5. Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2. Hydrogen atoms were localized from difference Fourier syntheses and were refined freely.

Acknowledgements

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Computing details

Data collection: *CrysAlis CCD* (Oxford Diffraction, 2008); cell refinement: *CrysAlis RED* (Oxford Diffraction, 2008); data reduction: *CrysAlis RED* (Oxford Diffraction, 2008); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL2016* (Sheldrick, 2015) and *SHELXLE* (Hübschle *et al.*, 2011); molecular graphics: *DIAMOND* (Brandenburg, 2012); software used to prepare material for publication: *pubCIF* (Westrip, 2010).

Bis[triamminesilver(I)] bis[diamminesilver(I)] hexafluoridostannate(IV) difluoride

Crystal data

$[\text{Ag}(\text{NH}_3)_3]_2[\text{Ag}(\text{NH}_3)_2]_2[\text{SnF}_6]\text{F}_2$

$M_r = 872.51$

Monoclinic, $P2_1/c$

$a = 7.3274$ (2) Å

$b = 19.4495$ (4) Å

$c = 7.8579$ (3) Å

$\beta = 113.205$ (4)°

$V = 1029.27$ (6) Å³

$Z = 2$

$F(000) = 820$

$D_x = 2.815$ Mg m⁻³

Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å

Cell parameters from 16653 reflections

$\theta = 2.8\text{--}39.1^\circ$

$\mu = 5.01$ mm⁻¹

$T = 123$ K

Block, colorless

$0.20 \times 0.05 \times 0.05$ mm

Data collection

Oxford-Diffraction Xcalibur3

diffractometer

Radiation source: Enhance (Mo) X-ray Source

Graphite monochromator

Detector resolution: 16.0238 pixels mm⁻¹

phi- and ω -rotation scans

Absorption correction: multi-scan

(*CrysAlis RED*; Oxford Diffraction, 2008)

$T_{\min} = 0.602$, $T_{\max} = 1.000$

30418 measured reflections

5731 independent reflections

4330 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.030$

$\theta_{\max} = 39.2^\circ$, $\theta_{\min} = 3.0^\circ$

$h = -12 \rightarrow 13$

$k = -34 \rightarrow 30$

$l = -13 \rightarrow 13$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.020$

$wR(F^2) = 0.046$

$S = 0.99$

5731 reflections

167 parameters

0 restraints

Primary atom site location: structure-invariant direct methods

Secondary atom site location: difference Fourier map

Hydrogen site location: difference Fourier map

All H-atom parameters refined

$w = 1/[\sigma^2(F_o^2) + (0.0215P)^2]$

where $P = (F_o^2 + 2F_c^2)/3$

$$(\Delta/\sigma)_{\max} = 0.002$$

$$\Delta\rho_{\max} = 1.04 \text{ e } \text{\AA}^{-3}$$

$$\Delta\rho_{\min} = -0.93 \text{ e } \text{\AA}^{-3}$$

Extinction correction: SHELXL2016
(Sheldrick, 2015),
 $F_c^* = kF_c[1 + 0.001x F_c^2 \lambda^3 / \sin(2\theta)]^{-1/4}$
Extinction coefficient: 0.00277 (14)

Special details

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
SN1	0.500000	0.000000	0.500000	0.01140 (3)
F1	0.71015 (17)	0.04893 (6)	0.45645 (18)	0.0254 (3)
F2	0.31983 (17)	0.07728 (6)	0.39037 (17)	0.0232 (2)
F3	0.58561 (19)	0.04104 (7)	0.74794 (16)	0.0274 (3)
AG1	0.16018 (2)	0.12778 (2)	0.95234 (2)	0.01661 (3)
N1	-0.1364 (2)	0.16467 (9)	0.8813 (2)	0.0179 (3)
H1A	-0.170 (4)	0.1789 (14)	0.968 (4)	0.029 (7)*
H1B	-0.171 (4)	0.2005 (14)	0.805 (4)	0.028 (7)*
H1C	-0.222 (5)	0.1286 (19)	0.805 (5)	0.070 (11)*
N2	0.4708 (2)	0.10144 (9)	1.0373 (2)	0.0175 (3)
H2A	0.509 (4)	0.0701 (13)	1.131 (3)	0.021 (6)*
H2B	0.485 (4)	0.0811 (15)	0.935 (4)	0.041 (8)*
H2C	0.557 (5)	0.1316 (16)	1.084 (4)	0.044 (9)*
N3	0.0911 (3)	0.00306 (10)	0.8291 (3)	0.0277 (4)
H3A	-0.031 (5)	-0.0050 (15)	0.751 (5)	0.046 (9)*
H3B	0.149 (5)	-0.0181 (16)	0.920 (5)	0.043 (9)*
H3C	0.133 (5)	-0.0059 (15)	0.737 (4)	0.043 (9)*
AG2	0.23394 (2)	0.22258 (2)	0.67497 (2)	0.01676 (3)
N4	0.0292 (3)	0.15407 (9)	0.4859 (2)	0.0196 (3)
H4A	0.111 (4)	0.1257 (14)	0.459 (4)	0.033 (7)*
H4B	-0.052 (4)	0.1757 (14)	0.396 (4)	0.034 (7)*
H4C	-0.034 (4)	0.1288 (15)	0.520 (4)	0.033 (8)*
N5	0.4733 (2)	0.28292 (9)	0.8539 (2)	0.0167 (3)
H5A	0.543 (4)	0.2617 (14)	0.973 (4)	0.033 (7)*
H5B	0.562 (4)	0.2883 (12)	0.793 (3)	0.020 (6)*
H5C	0.439 (5)	0.3248 (17)	0.891 (4)	0.052 (9)*
F4	0.74284 (16)	0.21290 (6)	1.16824 (14)	0.0177 (2)

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
SN1	0.01283 (6)	0.01077 (7)	0.01170 (7)	-0.00057 (5)	0.00600 (5)	-0.00041 (5)
F1	0.0194 (5)	0.0291 (7)	0.0314 (6)	-0.0056 (5)	0.0139 (5)	0.0066 (5)
F2	0.0207 (5)	0.0175 (5)	0.0319 (6)	0.0053 (4)	0.0110 (5)	0.0065 (5)
F3	0.0329 (6)	0.0314 (7)	0.0179 (5)	-0.0038 (5)	0.0098 (5)	-0.0095 (5)

AG1	0.01565 (5)	0.01867 (7)	0.01611 (6)	0.00126 (5)	0.00689 (4)	0.00184 (5)
N1	0.0179 (7)	0.0166 (7)	0.0183 (7)	0.0021 (6)	0.0061 (6)	0.0005 (6)
N2	0.0175 (6)	0.0178 (7)	0.0160 (7)	0.0000 (6)	0.0053 (5)	-0.0007 (6)
N3	0.0206 (8)	0.0236 (9)	0.0346 (10)	0.0001 (7)	0.0063 (8)	-0.0068 (8)
AG2	0.01614 (6)	0.01801 (7)	0.01510 (6)	-0.00111 (5)	0.00505 (4)	0.00066 (4)
N4	0.0184 (7)	0.0174 (8)	0.0194 (7)	-0.0010 (6)	0.0035 (6)	0.0012 (6)
N5	0.0169 (6)	0.0173 (7)	0.0161 (7)	0.0003 (5)	0.0066 (5)	0.0011 (5)
F4	0.0176 (5)	0.0200 (5)	0.0143 (5)	-0.0003 (4)	0.0051 (4)	-0.0015 (4)

Geometric parameters (Å, °)

Sn1—F1 ⁱ	1.9518 (11)	N2—H2A	0.91 (3)
Sn1—F1	1.9518 (11)	N2—H2B	0.94 (3)
Sn1—F2	1.9617 (11)	N2—H2C	0.83 (3)
Sn1—F2 ⁱ	1.9617 (11)	N3—H3A	0.88 (3)
Sn1—F3 ⁱ	1.9655 (11)	N3—H3B	0.79 (3)
Sn1—F3	1.9656 (11)	N3—H3C	0.91 (3)
Ag1—N1	2.1434 (16)	Ag2—N4	2.1160 (16)
Ag1—N2	2.1662 (16)	Ag2—N5	2.1183 (16)
Ag1—N3	2.5870 (19)	N4—H4A	0.90 (3)
Ag1—Ag2	3.0611 (2)	N4—H4B	0.84 (3)
Ag1—Ag2 ⁱⁱ	3.3283 (2)	N4—H4C	0.79 (3)
N1—H1A	0.85 (3)	N5—H5A	0.96 (3)
N1—H1B	0.89 (3)	N5—H5B	0.95 (3)
N1—H1C	0.98 (4)	N5—H5C	0.93 (3)
F1 ⁱ —Sn1—F1	180.0	Ag1—N2—H2A	110.8 (15)
F1 ⁱ —Sn1—F2	90.56 (5)	Ag1—N2—H2B	107.2 (17)
F1—Sn1—F2	89.44 (5)	H2A—N2—H2B	108 (2)
F1 ⁱ —Sn1—F2 ⁱ	89.44 (5)	Ag1—N2—H2C	119 (2)
F1—Sn1—F2 ⁱ	90.56 (5)	H2A—N2—H2C	100 (2)
F2—Sn1—F2 ⁱ	180.0	H2B—N2—H2C	111 (3)
F1 ⁱ —Sn1—F3 ⁱ	90.58 (6)	Ag1—N3—H3A	115 (2)
F1—Sn1—F3 ⁱ	89.42 (6)	Ag1—N3—H3B	101 (2)
F2—Sn1—F3 ⁱ	88.80 (5)	H3A—N3—H3B	126 (3)
F2 ⁱ —Sn1—F3 ⁱ	91.19 (5)	Ag1—N3—H3C	113.7 (19)
F1 ⁱ —Sn1—F3	89.42 (6)	H3A—N3—H3C	89 (3)
F1—Sn1—F3	90.58 (6)	H3B—N3—H3C	113 (3)
F2—Sn1—F3	91.19 (5)	N4—Ag2—N5	170.93 (7)
F2 ⁱ —Sn1—F3	88.81 (5)	N4—Ag2—Ag1	81.11 (5)
F3 ⁱ —Sn1—F3	180.0	N5—Ag2—Ag1	101.15 (5)
N1—Ag1—N2	173.74 (7)	N4—Ag2—Ag1 ⁱⁱⁱ	104.96 (5)
N1—Ag1—N3	100.82 (6)	N5—Ag2—Ag1 ⁱⁱⁱ	77.58 (4)
N2—Ag1—N3	85.44 (6)	Ag1—Ag2—Ag1 ⁱⁱⁱ	149.685 (7)
N1—Ag1—Ag2	93.35 (5)	Ag2—N4—H4A	101.3 (17)
N2—Ag1—Ag2	84.44 (5)	Ag2—N4—H4B	110.4 (19)
N3—Ag1—Ag2	111.20 (6)	H4A—N4—H4B	115 (3)
N1—Ag1—Ag2 ⁱⁱ	77.42 (5)	Ag2—N4—H4C	120 (2)

N2—Ag1—Ag2 ⁱⁱ	96.40 (5)	H4A—N4—H4C	104 (3)
N3—Ag1—Ag2 ⁱⁱ	169.75 (6)	H4B—N4—H4C	107 (3)
Ag2—Ag1—Ag2 ⁱⁱ	79.041 (4)	Ag2—N5—H5A	113.0 (16)
Ag1—N1—H1A	118.6 (17)	Ag2—N5—H5B	106.2 (14)
Ag1—N1—H1B	115.3 (18)	H5A—N5—H5B	109 (2)
H1A—N1—H1B	101 (2)	Ag2—N5—H5C	115.7 (19)
Ag1—N1—H1C	105 (2)	H5A—N5—H5C	100 (2)
H1A—N1—H1C	114 (3)	H5B—N5—H5C	112 (2)
H1B—N1—H1C	102 (3)		

Symmetry codes: (i) $-x+1, -y, -z+1$; (ii) $x, -y+1/2, z+1/2$; (iii) $x, -y+1/2, z-1/2$.

Hydrogen-bond geometry ($\text{\AA}, ^\circ$)

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
N1—H1A \cdots F4 ^{iv}	0.85 (3)	2.03 (3)	2.884 (2)	178 (2)
N1—H1B \cdots F4 ^v	0.89 (3)	1.96 (3)	2.844 (2)	171 (3)
N1—H1C \cdots F3 ^{iv}	0.98 (4)	2.14 (4)	3.057 (2)	156 (3)
N2—H2A \cdots F1 ^{vi}	0.91 (3)	2.43 (3)	3.227 (2)	146 (2)
N2—H2A \cdots F3 ^{vii}	0.91 (3)	2.56 (3)	3.354 (2)	145.4 (19)
N2—H2B \cdots F3	0.94 (3)	2.04 (3)	2.961 (2)	167 (3)
N2—H2C \cdots F4	0.83 (3)	2.02 (3)	2.849 (2)	172 (3)
N3—H3A \cdots F1 ^{iv}	0.88 (3)	2.57 (3)	3.274 (2)	138 (3)
N3—H3A \cdots F2 ^{viii}	0.88 (3)	2.42 (3)	3.223 (2)	153 (3)
N3—H3B \cdots F3 ^{vii}	0.79 (3)	2.61 (3)	3.345 (3)	157 (3)
N3—H3C \cdots F1 ⁱ	0.91 (3)	2.39 (3)	3.279 (3)	167 (3)
N4—H4A \cdots F2	0.90 (3)	2.04 (3)	2.930 (2)	170 (2)
N4—H4B \cdots F4 ^{ix}	0.84 (3)	1.97 (3)	2.7955 (19)	171 (3)
N4—H4C \cdots F1 ^{iv}	0.79 (3)	2.33 (3)	3.045 (2)	151 (3)
N5—H5A \cdots F4	0.96 (3)	1.90 (3)	2.8305 (19)	160 (3)
N5—H5B \cdots F4 ⁱⁱⁱ	0.95 (3)	1.93 (3)	2.882 (2)	173 (2)
N5—H5C \cdots F2 ⁱⁱ	0.93 (3)	2.09 (3)	2.999 (2)	163 (3)

Symmetry codes: (i) $-x+1, -y, -z+1$; (ii) $x, -y+1/2, z+1/2$; (iii) $x, -y+1/2, z-1/2$; (iv) $x-1, y, z$; (v) $x-1, -y+1/2, z-1/2$; (vi) $x, y, z+1$; (vii) $-x+1, -y, -z+2$; (viii) $-x, -y, -z+1$; (ix) $x-1, y, z-1$.