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## Hypervalent Diorganoantimony(III) Fluorides via Diorganoantimony(III) Cations – A General Method of Synthesis

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Received 00th January 20xx,  
Accepted 00th January 20xx

DOI: 10.1039/x0xx00000x

www.rsc.org/

The novel diorganoantimony(III) fluorides containing ligands with pendant arms, R<sub>2</sub>SbF (5), (R)PhSbF (6) [R = 2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>], R''<sub>2</sub>SbF (7) and (R'')PhSbF (8) [R'' = 2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>], were prepared *via* the ionic derivatives [R<sub>2</sub>Sb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup> (1), [(R)PhSb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup> (2), [R''<sub>2</sub>Sb]<sup>+</sup>[SbF<sub>6</sub>]<sup>-</sup> (4) and [(R'')PhSb]<sup>+</sup>[SbF<sub>6</sub>]<sup>-</sup> (obtained *in situ*) by treatment with [Bu<sub>4</sub>N]F·3H<sub>2</sub>O. The ionic species used as starting materials as well as [R'<sub>2</sub>Sb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup> (3) [R' = 2-(2',4',6'-Me<sub>3</sub>C<sub>6</sub>H<sub>2</sub>N=CH)C<sub>6</sub>H<sub>4</sub>] were obtained from the corresponding bromides or chlorides and Ti[PF<sub>6</sub>] or Ag[SbF<sub>6</sub>]. The compounds were investigated by multinuclear NMR spectroscopy in solution, MS and IR spectroscopy in the solid state. The molecular structures of the ionic species 1·2CH<sub>2</sub>Cl<sub>2</sub> and 3·2CHCl<sub>3</sub> as well as the fluorides 5–8 were determined by single-crystal X-ray diffraction.

### Introduction

The interest in the development of new sensors for the potentially toxic fluoride anion led to recent achievements based on main group chemistry and, particularly, organoantimony(III) and -antimony(V) compounds.<sup>1–6</sup> A survey of the literature concerning organoantimony(III) fluorides revealed some interesting aspects with regard to the preparation of the few R<sub>2</sub>SbF<sup>7–12</sup> and RSbF<sub>2</sub><sup>11–14</sup> species reported so far. In earlier works [NH<sub>4</sub>]<sub>2</sub>[PhSiF<sub>5</sub>] was used for phenylation of SbF<sub>3</sub> in aqueous solution to give Ph<sub>2</sub>SbF.<sup>7,8</sup> This is, so far, the only R<sub>2</sub>SbF species investigated by single-crystal X-ray diffraction; its solid state structure consisting of infinite chains of Ph<sub>2</sub>SbF units connected by strong intermolecular fluorine bridges.<sup>8</sup> It should be noted here that organotin(IV) fluorinating agents such as Me<sub>3</sub>SnF or [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>Sn(<sup>t</sup>Bu)<sub>2</sub>F were used successfully in halogen exchange reactions to prepare organoantimony(III) difluorides of the type [2,6-(YCH<sub>2</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>]<sub>2</sub>SbF<sub>2</sub> (Y = MeO, <sup>t</sup>BuO, Me<sub>2</sub>N) from the corresponding dichlorides containing (O,C,O)- or (N,C,N)-pincer ligands.<sup>13</sup> The difluoride [2,6-(Me<sub>2</sub>NCH<sub>2</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>]<sub>2</sub>SbF<sub>2</sub> was also obtained by reacting the oxide [{2,6-(Me<sub>2</sub>NCH<sub>2</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>]<sub>2</sub>SbO<sub>2</sub>] and HBF<sub>4</sub>·Et<sub>2</sub>O as result of a polar group

exchange.<sup>14</sup>

Several other methods failed to produce the desired Ph<sub>2</sub>SbF derivative.<sup>8</sup> Thus, the reaction of Ph<sub>2</sub>SbCl with AgF in acetonitrile and AsF<sub>3</sub> afforded the organoantimony(V) species Ph<sub>3</sub>SbF<sub>2</sub> following a process of simultaneous oxidative fluorination and redistribution of the phenyl groups. The redistribution reaction between R<sub>3</sub>Sb and SbX<sub>3</sub> (X = Cl, Br) in absence of any solvent,<sup>15–18</sup> or the halogen exchange reaction between R<sub>2</sub>SbCl and KBr or NaI,<sup>17,18</sup> worked very well for the preparation of chlorides, bromides or iodides. By contrast, no reaction occurs between Ph<sub>3</sub>Sb and SbF<sub>3</sub> in CH<sub>2</sub>Cl<sub>2</sub> or MeOH solutions, at reflux, or in absence of a solvent, or between Ph<sub>2</sub>SbCl and KF even after long periods of heating at reflux in methanol.<sup>8</sup> However, the fluorination was effective when the dibenzoazastibocine chloride MeN(CH<sub>2</sub>C<sub>6</sub>H<sub>4</sub>)<sub>2</sub>SbCl was reacted with KF in DMF solution.<sup>9</sup> While the partial phenylation of SbF<sub>3</sub> with PhLi or PhMgBr reagents failed, the isolated product always being Ph<sub>3</sub>Sb regardless of the molar ratio of the reagents used,<sup>8</sup> for other organolithium reagents the reaction with SbF<sub>3</sub> led to the desired organoantimony(III) fluorides,<sup>10–12</sup> even if the stoichiometry could not be fully controlled and from the reaction mixture both R<sub>2</sub>SbF and RSbF<sub>2</sub> were isolated by fractional crystallization, *e.g.* for R = 2,4,6-<sup>t</sup>Bu<sub>3</sub>C<sub>6</sub>H<sub>2</sub>.<sup>11,12</sup>

Taking into account the ability of the organoantimony(V) cations to react with the fluoride anions we have decided to investigate the possibility to prepare diorganoantimony(III) fluorides using ionic species such as the diorganoantimony(III) cation, [R<sub>2</sub>Sb]<sup>+</sup>. Monocations of this type can be stabilized by intermolecular<sup>19–24</sup> coordination, *e.g.* [Ph<sub>2</sub>Sb{OP(NMe<sub>2</sub>)<sub>3</sub>}]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup>,<sup>19</sup> [Me<sub>2</sub>Sb(SbMe<sub>3</sub>)]<sup>+</sup>[GaCl<sub>4</sub>]<sup>-</sup>,<sup>21</sup> [Ph<sub>2</sub>Sb(PPh<sub>3</sub>)<sub>2</sub>]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup>,<sup>23</sup> [Ph<sub>2</sub>Sb(PMe<sub>3</sub>)<sub>2</sub>]<sup>+</sup>[O<sub>3</sub>SCF<sub>3</sub>]<sup>-</sup> and [Ph<sub>2</sub>Sb(PMe<sub>3</sub>)<sub>2</sub>]<sup>+</sup>[O<sub>3</sub>SCF<sub>3</sub>]<sup>-</sup>,<sup>24</sup> or by intramolecular coordination, *e.g.* [{2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>Sb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup>,<sup>19</sup> and [{2,6-(MeOCH<sub>2</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>]<sub>2</sub>Sb]<sub>4</sub><sup>+</sup>[Sb<sub>6</sub>Cl<sub>22</sub>]<sup>-</sup>.

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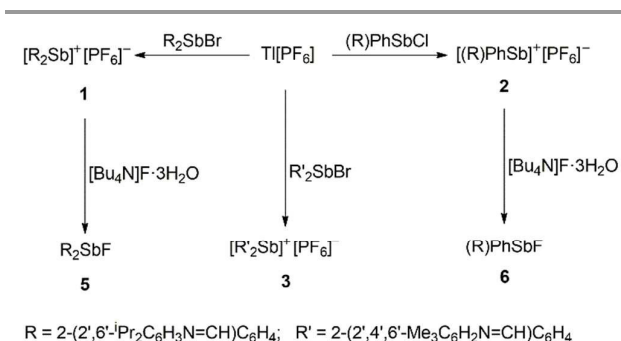
Electronic Supplementary Information (ESI) available: NMR numbering schemes; X-ray crystallographic data in CIF format for 1·2CH<sub>2</sub>Cl<sub>2</sub>, 3·2CHCl<sub>3</sub> and 5–8; figures representing the optical isomers as well as the supramolecular architectures in the crystals of these compounds. See DOI: 10.1039/x0xx00000x

We report herein a new route for the preparation of the diorganoantimony(III) fluorides *via* ionic diorganoantimony(III) derivatives stabilized by (*C,N*)-chelating ligands as well as their structural characterization both in solution and in the solid state.

## Results and discussion

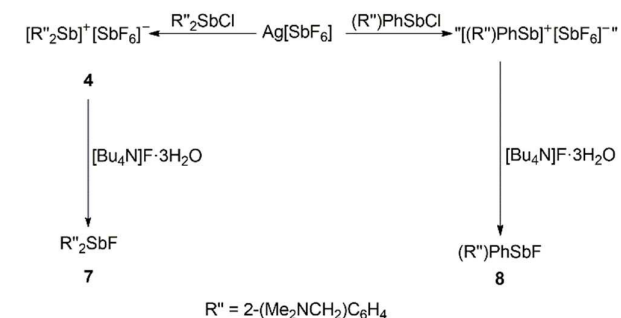
### Synthesis and characterization of ionic diorganoantimony(III) compounds

The monoalides  $R_2SbBr$ ,  $(R)PhSbCl$  [ $R = 2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4$ ] and  $R'_2SbBr$  [ $R' = 2-(2',4',6'-Me_3C_6H_2N=CH)C_6H_4$ ] were reacted with  $Tl[PF_6]$  in THF, at room temperature, to give the ionic diorganoantimony(III) species  $\{[2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4]_2Sb\}^+[PF_6]^-$  (**1**),  $\{[2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4]PhSb\}^+[PF_6]^-$  (**2**) and  $\{[2-(2',4',6'-Me_3C_6H_2N=CH)C_6H_4]_2Sb\}^+[PF_6]^-$  (**3**) (Scheme 1).



**Scheme 1.** Preparation of the ionic species **1–3** and the fluorides **5** and **6**.

Using a similar procedure, treatment of the monochloride  $R''_2SbCl$  [ $R'' = 2-(Me_2NCH_2)C_6H_4$ ] with  $Ag[SbF_6]$  gave the ionic compound  $\{[2-(Me_2NCH_2)C_6H_4]_2Sb\}^+[SbF_6]^-$  (**4**) (Scheme 2). The species  $\{[2-(Me_2NCH_2)C_6H_4]PhSb\}^+[SbF_6]^-$  was prepared *in situ* from the corresponding monochloride  $(R'')PhSbCl$  and  $Ag[SbF_6]$  and converted, without isolation, into the fluoride **8** (Scheme 2).



**Scheme 2.** Preparation of the ionic species **4** and the fluorides **7** and **8**.

The compounds were isolated in fair good yields as pale yellow (**1**, **2**, **3**) and white (**4**) solids, soluble in chlorinated solvents. The spectroscopic data as well as elemental analytical data are consistent with the anticipated formulas. For compounds **1–3** the IR spectra exhibit a  $\nu(CH=N)$  stretching

vibration of medium intensity in the region  $1620\text{--}1600\text{ cm}^{-1}$ , which is typical for compounds containing Schiff-base ligands.<sup>18</sup> In addition, strong  $\nu(E-F)$  stretching vibrations corresponding to the inorganic  $[EF_6]^-$  anions were observed, as expected,<sup>26</sup> in the regions  $835\text{--}800\text{ cm}^{-1}$  ( $E = P$ ) for compounds **1–3** and around  $750\text{ cm}^{-1}$  ( $E = Sb$ ) for compound **4**. In the ESI(+) (for **1**, **3**, **4**) and APCI(+) (for **2**) mass spectra the base peaks were assigned to the corresponding fragments  $[R_2Sb]^+$ ,  $[R'_2Sb]^+$  and  $[R''_2Sb]^+$ , and  $[RPhSb]^+$ , respectively.

All ionic compounds were investigated by multinuclear NMR spectroscopy in  $CDCl_3$  solution, at room temperature. The assignment of the resonances was based on 2D NMR spectra, according with the numbering schemes illustrated in Scheme S1 (see Supporting Information). The  $^1H$  NMR spectra of **1** and **2** exhibit four doublet resonances for the methyl protons. This indicates a diastereotopic behaviour of the isopropyl groups as well as non-equivalence of the two halves of a  $2',6'-Pr_2C_6H_3$  moiety, the free rotation of the bulky aromatic group around the  $C-N(=C)$  single bond being blocked. This is also supported, for example, by the presence of two singlet resonances for the methine  $C-7'_a$  and  $C-7'_b$  atoms in the  $^{13}C$  NMR spectra ( $\delta$  30.21 and 28.96 ppm for **1** and  $\delta$  29.15 and 28.13 ppm for **2**, respectively). By contrast, for the cation of **3** both  $^1H$  and  $^{13}C$  NMR spectra exhibit only two sharp resonances assigned to the methyl protons (1:2 integral ration) of the  $2',4',6'-Me_3C_6H_2$  moieties attached to the metal atom, suggesting that there is no restriction of free rotation of the mesityl groups around the  $C-N(=C)$  single bonds. This different freedom of rotation around a  $C-N(=C)$  single bond observed for compounds **1** (or **2**) and **3**, respectively, in  $CDCl_3$  solution at room temperature, is related to the bulkiness of the organic group attached to nitrogen. The presence of only one set of resonances in the  $^1H$  and  $^{13}C$  NMR spectra for the two organic groups in the cations of **1**, **3** and **4** is consistent with equivalence of the aromatic ligands attached to the same metal atom. The room temperature  $^1H$  and  $^{13}C$  NMR spectra of **4** show one set of singlet resonances for the methyl and methylene groups, respectively, suggesting a fast dynamic behaviour which involves de-coordination – re-coordination of nitrogen to the metal centre. The presence of the octahedral fluorine-containing anions is indicated by the doublet  $^{19}F$  resonance ( $^1J_{P,F} = 713\text{ Hz}$ ) observed for compounds **1–3** and the multiplet  $^{19}F$  resonance observed for compound **4**. Consequently, the  $^{31}P$  NMR spectra of **1–3** exhibit a septet resonance centered at  $\delta -144\text{ ppm}$ .

Single crystals of **1**· $2CH_2Cl_2$  and **3**· $2CHCl_3$  were investigated by X-ray diffraction. The crystals contain the corresponding diorganoantimony(III) cations and hexafluorophosphate anions. The structure of the cations of **1** and **3** are depicted in Fig. 1 and S5, respectively, and the important bond lengths and angles are listed in Table 1.

In the cations of **1** and **3** both nitrogen atoms are coordinated to antimony in an almost *trans* arrangement  $[N(1)-Sb(1)-N(2)]$   $159.67(10)^\circ$  for **1**;  $155.02(17)^\circ$  for **3**) resulting in a *pseudo*-trigonal bipyramidal (“*see-saw*”) coordination geometry at antimony, with the *ipso* carbon atoms placed in equatorial positions  $[C(1)-Sb(1)-C(20)]$   $105.05(14)^\circ$  for **1**;  $C(1)-$

Sb(1)–C(17) 102.8(2)° for **3**. The antimony–nitrogen bond distances [Sb–N 2.353(3) / 2.367(3) Å for **1**; 2.365(5) / 2.395(5) Å for **3**] compare well with those found in the related ionic species  $[[2-(\text{Me}_2\text{NCH}_2)_2\text{C}_6\text{H}_4]_2\text{Sb}]^+[\text{PF}_6]^-$  [Sb–N 2.412(3) / 2.416(4) Å],<sup>19</sup> but are shorter than in the bromide precursor  $[2-(2',6'\text{-}^i\text{Pr}_2\text{C}_6\text{H}_3\text{N}=\text{CH})\text{C}_6\text{H}_4]_2\text{SbBr}$  [Sb–N 2.498(4) / 2.996(4) Å]<sup>18</sup> [cf. sums of the corresponding covalent,  $\Sigma r_{\text{cov}}(\text{Sb},\text{N})$  2.11 Å, and van der Waals radii,  $\Sigma r_{\text{vdW}}(\text{Sb},\text{N})$  3.74 Å],<sup>27</sup> due to the more electrophilic nature of the antimony in the cation.

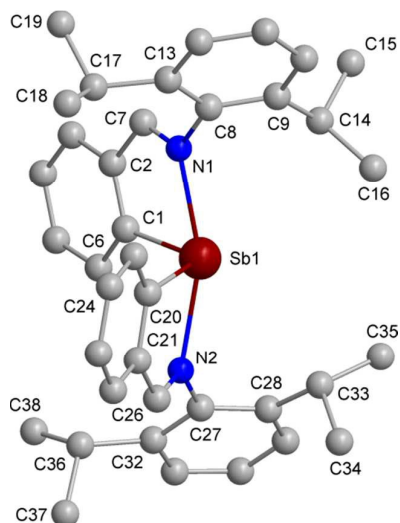


Fig. 1. Structure of the (Λ)-cation in 1·2CH<sub>2</sub>Cl<sub>2</sub>, showing the atom numbering scheme. Hydrogen atoms are omitted for clarity.

Table 1 Selected bond distances (Å) and angles (°) for compounds 1·2CH<sub>2</sub>Cl<sub>2</sub> and 3·2CHCl<sub>3</sub>

1·2CH <sub>2</sub> Cl <sub>2</sub>		3·2CHCl <sub>3</sub>	
Sb(1)–C(1)	2.145(4)	Sb(1)–C(1)	2.167(6)
Sb(1)–C(20)	2.131(4)	Sb(1)–C(17)	2.151(5)
Sb(1)–N(1)	2.353(3)	Sb(1)–N(1)	2.365(5)
Sb(1)–N(2)	2.367(3)	Sb(1)–N(2)	2.395(5)
N(1)–C(7)	1.276(5)	N(1)–C(7)	1.269(9)
N(1)–C(8)	1.450(5)	N(1)–C(8)	1.442(8)
N(2)–C(26)	1.285(5)	N(2)–C(23)	1.267(7)
N(2)–C(27)	1.446(5)	N(2)–C(24)	1.435(7)
C(1)–Sb(1)–C(20)	105.05(14)	C(1)–Sb(1)–C(17)	102.8(2)
N(1)–Sb(1)–N(2)	159.67(10)	N(1)–Sb(1)–N(2)	155.02(17)
N(1)–Sb(1)–C(1)	75.70(12)	N(1)–Sb(1)–C(1)	75.16(19)
N(1)–Sb(1)–C(20)	92.23(12)	N(1)–Sb(1)–C(17)	89.21(19)
N(2)–Sb(1)–C(1)	91.70(12)	N(2)–Sb(1)–C(1)	89.2(2)
N(2)–Sb(1)–C(20)	75.46(12)	N(2)–Sb(1)–C(17)	75.21(18)

The cations of both these ionic species exhibit a helical structure due to the (C,N)-chelating ligands. The corresponding configurations at the metal can be given as Δ<sub>Sb</sub> (or P<sub>Sb</sub>) and Λ<sub>Sb</sub> (or M<sub>Sb</sub>) with respect to the right-handed or left-handed helicity of the two chelate rings along the C<sub>2</sub>-axis passing through the centre of the C···C edge (carbon atoms attached to antimony), the metal ion and the centre of the N···N edge.<sup>28</sup>

Both compounds **1** and **3** crystallize as a 1:1 mixture of (Δ<sub>Sb</sub>)- and (Λ<sub>Sb</sub>)-cations. No cation–anion interactions between heavy atoms were observed. However, for both compounds supramolecular associations are built through halogen···hydrogen and C–H···π (Ar<sub>centroid</sub>) interactions. Thus, in the crystal of 1·2CH<sub>2</sub>Cl<sub>2</sub> chain polymers are formed based on F···H<sub>imine</sub> contacts between anions and (Δ<sub>Sb</sub>)- or (Λ<sub>Sb</sub>)-cations (see Fig. S3, Supporting Information). Alternating, parallel, polymeric chains containing (Δ<sub>Sb</sub>)- and (Λ<sub>Sb</sub>)-cations, respectively, are connected through Cl<sub>solvent</sub>···H contacts into a layer (see Fig. S4, Supporting Information). By contrast, in the crystal of 3·2CHCl<sub>3</sub> centrosymmetric dinuclear units are formed from (Δ<sub>Sb</sub>)- and (Λ<sub>Sb</sub>)-cations based on C–H<sub>methyl</sub>···π (Ar<sub>centroid</sub>) interactions (i.e. H···Ar<sub>centroid</sub> contacts shorter than 3.1 Å, with an angle γ between the normal to the aromatic ring and the line defined by the H atom and Ar<sub>centroid</sub> smaller than 30°):<sup>29</sup> C(16)–H(16B)<sub>methyl</sub>···Ar<sub>centroid</sub>{C(24')–C(29')} 2.85 Å (γ = 3.8°). These dinuclear units are further connected through anions and solvent molecules into chain polymers (see Fig. S8, Supporting Information). In the crystals there are no further contacts between parallel layers (for 1·2CH<sub>2</sub>Cl<sub>2</sub>) or polymeric chains (for 3·2CHCl<sub>3</sub>).

#### Synthesis and characterization of diorganoantimony(III) fluorides

The treatment of the ionic compounds **1**, **2**, **4** and  $[[2-(\text{Me}_2\text{NCH}_2)_2\text{C}_6\text{H}_4]\text{PhSb}]^+[\text{SbF}_6]^-$  with  $[\text{Bu}_4\text{N}]\text{F} \cdot 3\text{H}_2\text{O}$  in acetonitrile, at room temperature, followed by extraction with *n*-hexane leads to the formation of the organoantimony(III) fluorides:  $[2-(2',6'\text{-}^i\text{Pr}_2\text{C}_6\text{H}_3\text{N}=\text{CH})\text{C}_6\text{H}_4]_2\text{SbF}$  (**5**),  $[2-(2',6'\text{-}^i\text{Pr}_2\text{C}_6\text{H}_3\text{N}=\text{CH})\text{C}_6\text{H}_4]\text{PhSbF}$  (**6**) (Scheme 1),  $[2-(\text{Me}_2\text{NCH}_2)_2\text{C}_6\text{H}_4]_2\text{SbF}$  (**7**) and  $[2-(\text{Me}_2\text{NCH}_2)_2\text{C}_6\text{H}_4]\text{PhSbF}$  (**8**) (Scheme 2). The fluorides were obtained as air-stable, yellow (**5**, **6**) or white (**7**, **8**) solids. They are easily soluble in chlorinated organic solvents as CHCl<sub>3</sub>, a behaviour consistent with their molecular structure observed in solid state. In the case of fluorides **5** and **6** an absorption band was observed at 1641 and 1622 cm<sup>-1</sup>, respectively, which was assigned to the ν<sub>CH=N</sub> stretching vibration, consistent with the presence of the imine ligand. In the ESI(+) (for **5**, **7** and **8**) and APCI(+) (for **6**) mass spectra the base peaks were assigned to the corresponding fragments  $[\text{R}_2\text{Sb}^+]$ ,  $[\text{R}'_2\text{Sb}^+]$ ,  $[\text{R}''\text{PhSb}^+]$ , and  $[\text{RPhSb}^+]$ , respectively. The mass spectrum of **6** showed a fragment with *m/z* value (i.e. 945) higher than that corresponding to the molecular ion, which was assigned to the dinuclear cation containing fluorine bridge between metal atoms,  $[(\text{RPhSb})_2\text{F}^+]$ .

The <sup>19</sup>F NMR spectra of the new fluorides exhibit a sharp singlet resonance at δ –181.3, –174.7, –176.9 and –169.2 ppm (for **5**, **6**, **7** and **8**, respectively), a behaviour consistent with the presence of only one species in the solution of these compounds. The structure of the fluorides **5–8** in CDCl<sub>3</sub> solutions was investigated by <sup>1</sup>H and <sup>13</sup>C NMR spectroscopy at room temperature. The assignment of the observed resonances, according with the numbering schemes illustrated in Scheme S1 (see Supporting Information), was based on 2D NMR spectra. For the fluoride **5**, the NMR spectra at room temperature are consistent with a similar behaviour as

Table 2 Selected bond distances (Å) and angles (°) for compounds 5–8

	5	6		7	8
Sb(1)–C(1)	2.172(7)	2.128(3)	Sb(1)–C(1)	2.134(6)	2.141(3)
Sb(1)–C(20)	2.172(8)	2.122(3)	Sb(1)–C(10)	2.151(5)	2.150(3)
Sb(1)–F(1)	1.997(5)	1.9989(19)	Sb(1)–F(1)	2.032(4)	2.001(2)
Sb(1)–N(1)	2.693(6)	2.466(3)	Sb(1)–N(1)	2.512(5)	2.526(3)
Sb(1)–N(2)	2.778(7)		Sb(1)–N(2)	3.379(6)	
N(1)–C(7)	1.268(11)	1.269(4)	N(1)–C(7)	1.466(8)	1.464(4)
N(1)–C(8)	1.445(10)	1.428(4)	N(1)–C(8)	1.463(9)	1.476(5)
			N(1)–C(9)	1.473(9)	1.473(5)
N(2)–C(26)	1.264(11)		N(2)–C(16)	1.450(9)	
N(2)–C(27)	1.439(11)		N(2)–C(17)	1.442(11)	
			N(2)–C(18)	1.452(11)	
F(1)–Sb(1)–N(1)	158.66(18)	158.97(8)	F(1)–Sb(1)–N(1)	161.74(16)	161.48(9)
C(1)–Sb(1)–C(20)	93.4(3)	102.15(11)	C(1)–Sb(1)–C(10)	96.9(2)	95.74(12)
F(1)–Sb(1)–C(1)	87.1(3)	88.78(10)	F(1)–Sb(1)–C(1)	89.69(19)	88.94(11)
F(1)–Sb(1)–C(20)	93.3(2)	89.14(10)	F(1)–Sb(1)–C(10)	89.5(2)	90.52(11)
N(1)–Sb(1)–C(1)	71.8(3)	72.88(9)	N(1)–Sb(1)–C(1)	73.26(18)	73.31(11)
N(1)–Sb(1)–C(20)	85.5(2)	84.89(10)	N(1)–Sb(1)–C(10)	86.2(2)	86.18(10)
N(2)–Sb(1)–C(1)	156.1(3)		N(2)–Sb(1)–C(1)	154.30(17)	
N(1)–Sb(1)–N(2)	120.87(19)		N(1)–Sb(1)–N(2)	86.25(14)	
N(2)–Sb(1)–C(20)	69.3(2)		N(2)–Sb(1)–C(10)	65.73(19)	
N(2)–Sb(1)–F(1)	78.06(19)		N(2)–Sb(1)–F(1)	108.11(15)	

observed previously for the analogous chloride<sup>30</sup> and bromide<sup>18</sup>, *i.e.* the presence in the same molecule of one organic ligand for which the free rotation around the C–N(=C) single bond is blocked (non-equivalence of the two halves of a 2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub> moiety) and one organic ligand with no restriction of free rotation around the C–N(=C) single bond. A similar restricted rotation around the C–N(=C) single bond was observed for the imine ligand in **6**, at room temperature. This is consistent with four doublet <sup>1</sup>H resonances for the methyl protons and two septet resonances for the methine protons of the <sup>i</sup>Pr groups indicating that the two halves of the 2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub> moiety are not equivalent. The NMR spectra of fluorides **7** and **8** are consistent with the expected structures. For **7** only one set of resonances was observed suggesting a dynamic behaviour which results in equivalent organic ligands on the NMR time scale, at room temperature. The fluoride **8**, with different organic groups attached to antimony, exhibits two singlet <sup>1</sup>H resonances, a behaviour consistent with the presence of intramolecular N→Sb interaction in solution. Interesting, an evident AB system was not observed for the CH<sub>2</sub> group of the pendant arm due to isochronous chemical shifts of the methylene protons. It should be also noted that for several carbon atoms the corresponding resonances appear as doublets due to carbon-fluorine couplings at two or even three bond distances.

Single crystals of the diorganoantimony(III) fluorides **5–8**, suitable for X-ray diffraction studies, were obtained by slow evaporation of their *n*-hexane solutions. The molecular

structures are depicted in Fig. 2, 3, S20 and S24. Selected bond lengths and angles are listed in Table 2.

The crystals of all four fluorides **5–8** contain discrete molecules with no intermolecular contacts between heavy atoms. This contrasts with the chain polymeric structure of Ph<sub>2</sub>SbF in which molecular units are connected by strong, almost symmetric Sb–F···Sb bridges.<sup>8</sup> As a consequence, the terminal antimony-fluorine bond distances in the title fluorides [Sb(1)–F(1) 1.997(5) Å in **5**, 1.9989(19) Å in **6**, 2.032(4) Å in **7** and 2.001(2) Å in **8**, respectively] are shorter than those found in the unique polymeric monofluoride Ph<sub>2</sub>SbF [intramolecular Sb–F 2.166(5) Å; intermolecular Sb···F 2.221(5) Å].<sup>8</sup> The lack of fluorine bridges in the case of the fluorides **5–8** is the result of intramolecular coordination of the nitrogen atom from the pendant arm to the metal centre.

Indeed, in the molecules of **5** and **7**, which contain two similar organic ligands with one pendant arm, both nitrogen atoms are coordinated intramolecularly to antimony. As expected, one nitrogen atom is strongly coordinated to the metal [Sb(1)–N(1) 2.693(6) Å in **5**, and 2.512(5) Å in **7**] in *trans* position to the fluorine atom [F(1)–Sb(1)–N(1) 158.66(18)° in **5**, and 161.74(16)° in **7**]. Due to a stronger *trans* influence of the fluorine atom these N→Sb distances are considerably longer for both **5** and **7** than observed in the related chlorides/bromides/iodides, *i.e.* [2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbX [Sb–N 2.416(2) Å for X = Cl;<sup>30</sup> 2.498(4) Å for X = Br<sup>18</sup>] or [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbX [Sb–N 2.463(2) Å for X = Cl;<sup>29</sup> 2.423(3) Å for X = Br; 2.417(3) Å for X = I<sup>17</sup>]. The nitrogen

atom of the second pendant arm in the molecule is placed in *trans* position to an *ipso* carbon atom and exhibits a slightly longer intramolecular bond in **5** [Sb(1)–N(2) 2.778(7) Å; N(2)–Sb(1)–C(1) 156.1(3)°], but being considerably longer in **7** [Sb(1)–N(2) 3.379(6) Å; N(2)–Sb(1)–C(1) 154.30(17)°]; *cf.* sums of the respective covalent,  $\Sigma r_{\text{cov}}(\text{Sb},\text{N})$  2.11 Å, and van der Waals radii,  $\Sigma r_{\text{vdw}}(\text{Sb},\text{N})$  3.74 Å.<sup>28</sup> While for the fluoride **7** the length of the N→Sb bond placed in *trans* position to the carbon atom is similar to those observed for the other analogous halides [*cf.* Sb–N 3.216(3) Å for X = Cl;<sup>31</sup> 3.276(3) Å for X = Br; 3.211(3) Å for X = I<sup>17</sup>], for the imine derivative **5** this N→Sb distance is considerably shorter than in the corresponding chloride or bromide [Sb–N 2.952(3) Å for X = Cl;<sup>30</sup> 2.996(4) Å for X = Br<sup>18</sup>].

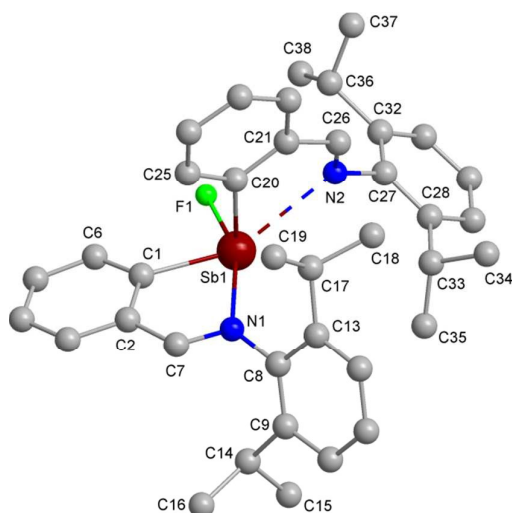


Fig. 2 Molecular structure of (*C<sub>sb</sub>*)-**5**, showing the atom numbering scheme. Hydrogen atoms are omitted for clarity.

In the molecules of the chiral fluorides **6** and **8**, which contain one phenyl group and one organic ligand of the same type as in **5** and **7**, again the nitrogen atom of the pendant arm is strongly coordinated to the metal atom [Sb(1)–N(1) 2.466(3) Å in **6**, and 2.526(3) Å in **8**] in *trans* position to the fluorine atom [F(1)–Sb(1)–N(1) 158.97(8)° in **6**, and 161.48(9)° in **8**]. The intramolecular N→Sb bond distance is longer than found in the related halides *i.e.* [2-(2',6'-*Pr*<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbX [Sb–N 2.433(2) Å]<sup>32</sup> or [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>PhSbX [Sb–N 2.452(2) Å for X = Cl;<sup>33</sup> 2.444(4) Å for X = Br; 2.426(3) Å for X = I<sup>34</sup>].

Taking into account both intramolecular N→Sb interactions the coordination geometry around the antimony atom in **5** and **7** is distorted square pyramidal [(*C,N*)<sub>2</sub>SbF core; hypervalent 12-Sb-5 species<sup>35,36</sup>], with an *ipso* carbon atom in the apical position (Fig. 2 and S20). For the fluorides **6** and **8**, the molecules of which contain only one intramolecular N→Sb interaction, the coordination geometry is distorted *pseudo*-trigonal bipyramidal [(*C,N*)CSbF core; hypervalent 10-Sb-4 species<sup>35,36</sup>], with the halogen and the nitrogen atoms placed in the axial positions. The intramolecular N→Sb interactions result in *chelate induced-Sb-chirality*<sup>34,37</sup> and therefore the crystals of the fluorides **5** and **6** contain 1:1 mixtures of (*C<sub>sb</sub>*)

and (*A<sub>sb</sub>*) isomers.<sup>28</sup> While the resulting SbC<sub>3</sub>N rings are basically planar for the imine ligands in **5** and **6**, the C<sub>3</sub>SbN rings in **7** and **8** are folded along the Sb⋯C<sub>methylene</sub> axis, with the N(sp<sup>3</sup>) atom lying out of the best plane through the residual SbC<sub>3</sub> fragment. As result, in addition to the chirality at antimony, this folding induces planar chirality (with the aromatic ring and the nitrogen atom as chiral plane and pilot atom, respectively; for planar chirality the enantiomers are given as *pS<sub>N</sub>* and *pR<sub>N</sub>*).<sup>38</sup> Indeed, the crystals contain racemic mixtures of (*C<sub>sb</sub>*)(*pR<sub>N1</sub>*,*pR<sub>N2</sub>*)-**7** / (*A<sub>sb</sub>*)(*pS<sub>N1</sub>*,*pS<sub>N2</sub>*)-**7** isomers and (*C<sub>sb</sub>*)(*pS<sub>N1</sub>*)-**8** / (*A<sub>sb</sub>*)(*pR<sub>N1</sub>*)-**8** isomers, respectively.

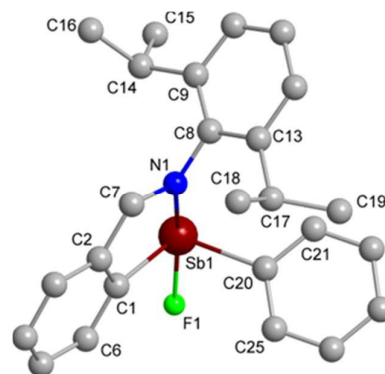


Fig. 3 Molecular structure of (*C<sub>sb</sub>*)-**6**, showing the atom numbering scheme. Hydrogen atoms are omitted for clarity.

A closer investigation of the crystal packing revealed that, in addition to intramolecular F⋯H contacts established in the molecules of all fluorides **5–8**, intermolecular F⋯H and C–H⋯π (*Ar<sub>centroid</sub>*) interactions are present and led to different supramolecular architectures (see Supporting Information). Thus, ribbon-like polymers of either (*C<sub>sb</sub>*) or (*A<sub>sb</sub>*) isomers based on C–H<sub>aryl</sub>⋯π (*Ar<sub>centroid</sub>*) interactions are formed in the crystal of **5**. Parallel pairs of chains built from (*C<sub>sb</sub>*)(*pR<sub>N1</sub>*,*pR<sub>N2</sub>*)-**7** or (*A<sub>sb</sub>*)(*pS<sub>N1</sub>*,*pS<sub>N2</sub>*)-**7** isomers, respectively, through weak F(1)⋯H(3a)<sub>aryl</sub> contacts [2.49 Å; *cf.* sum of the corresponding van der Waals radii,  $\Sigma r_{\text{vdw}}(\text{F},\text{H})$  2.55 Å]<sup>27</sup> and C(14)–H(14)<sub>aryl</sub>⋯*Ar<sub>centroid</sub>*{C(10c)–C(15c)} (3.09 Å;  $\gamma = 13.3^\circ$ ) are developed along axis *b* in the crystal of **7**. By contrast, in the crystal of **6** a 3D architecture is formed based on weak C–H⋯π (*Ar<sub>centroid</sub>*) contacts between parallel chain polymers of alternating (*C<sub>sb</sub>*)-**6** and (*A<sub>sb</sub>*)-**6** isomers connected through F(1)⋯H(7b)<sub>imine</sub> (2.31 Å) interactions. Surprisingly, no intermolecular F⋯H contacts are present in the crystal of **8**; in this case a dimer association of (*C<sub>sb</sub>*)(*pS<sub>N1</sub>*)-**8** and (*A<sub>sb</sub>*)(*pR<sub>N1</sub>*)-**8** isomers is formed through C(7)–H(7b)<sub>methylene</sub>⋯*Ar<sub>centroid</sub>*{C(10')–C(15')} (2.99 Å;  $\gamma = 17.7^\circ$ ) contacts and these dimer units are further associated into a layer based on C(11)–H(11)<sub>aryl</sub>⋯*Ar<sub>centroid</sub>*{C(10'a)–C(15'a)} (3.02 Å;  $\gamma = 13.7^\circ$ ) contacts.

## Experimental

### Materials and instrumentation

The syntheses were performed under argon or nitrogen atmosphere using standard Schlenk techniques. THF was dried over sodium or potassium and distilled under argon prior to use. Reagents such as <sup>n</sup>BuLi, Ti[PF<sub>6</sub>], Ag[SbF<sub>6</sub>] and [Bu<sub>4</sub>N]F were purchased from commercial suppliers and used without further purification. The other starting materials were prepared according to the literature procedures: 2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>Br [2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbBr, [2-(2',4',6'-Me<sub>3</sub>C<sub>6</sub>H<sub>2</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbBr,<sup>18</sup> PhSbCl<sub>2</sub>,<sup>15,39</sup> [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]PhSbCl.<sup>34</sup> Elemental analyses were carried out with Perkin-Elmer 2400 and CHN-Analysator Type FlashAE 1112 (Co. Thermo) instruments. The melting point of compounds was measured with an Electrothermal 9200 or a Melting Point B-540 (Co. Büchi) apparatus. The <sup>1</sup>H, <sup>13</sup>C, <sup>19</sup>F NMR spectra were recorded at room temperature using Bruker Avance 300 (for **2**, **7**, **8**), Bruker Avance II 400 (for **5**, **6**) and Bruker Avance III 500 (for **1**, **3**) instruments, respectively. The chemical shifts are reported in δ units relative to the residual peak of the solvent (CHCl<sub>3</sub>, δ 7.26 ppm; DMSO-*d*<sub>5</sub>, δ 2.50 ppm) in <sup>1</sup>H NMR spectra and to the peak of the deuterated solvent (CDCl<sub>3</sub>, δ 77.16 ppm; DMSO-*d*<sub>6</sub>, δ 39.52 ppm) in <sup>13</sup>C NMR spectra, respectively.<sup>40</sup> The <sup>1</sup>H and <sup>13</sup>C resonances were assigned using 2D NMR experiments (COSY, HSQC and HMBC). The <sup>19</sup>F and <sup>31</sup>P chemical shifts are quoted in δ units (ppm) relative to external standards (CFCl<sub>3</sub> for <sup>19</sup>F NMR, and H<sub>3</sub>PO<sub>4</sub> 85% for <sup>31</sup>P NMR, respectively). The NMR spectra were processed using the *MestReNova* software.<sup>41</sup> Infrared spectra were recorded on a BioRad FTS-165 spectrometer, using ATR accessory. Mass spectra were recorded on a Thermo Scientific LTQ Orbitrap XL mass spectrometer equipped with a standard ESI/APCI source.

#### Crystal structure determination

Single crystals of 1·2CH<sub>2</sub>Cl<sub>2</sub> were obtained by slow diffusion of *n*-hexane into a solution of CH<sub>2</sub>Cl<sub>2</sub> (3:1 v/v) or slow evaporation of a CHCl<sub>3</sub> solution for 3·2CHCl<sub>3</sub>. Colorless crystals of **5–8** were grown by slow evaporation of a *n*-hexane solution. The details of the crystal structure determination and refinement are given in Tables S1 and S2 (see Supporting Information). The crystals were attached with Krytox™ to a glass fiber (1·2CH<sub>2</sub>Cl<sub>2</sub>, 3·2CHCl<sub>3</sub>) or mounted on cryoloops (**5–8**). For 3·2CHCl<sub>3</sub>, **5–8** data were collected at room temperature, while for 1·2CH<sub>2</sub>Cl<sub>2</sub> the crystal was cooled under a nitrogen stream at low temperature. Data were collected on Oxford (Type Gemini S) and (1·2CH<sub>2</sub>Cl<sub>2</sub>, 3·2CHCl<sub>3</sub>) Bruker SMART APEX (**5–8**) diffractometers, using graphite-monochromated Mo-Kα radiation (λ = 0.71073 Å), except for 3·2CHCl<sub>3</sub> for which Cu-Kα (λ = 0.54184 Å) radiation was used. The structures were refined with anisotropic thermal parameters. The hydrogen atoms were refined with a riding model and a mutual isotropic thermal parameter. For structure solving and refinement the software package SHELX-97 was used.<sup>42</sup> The drawings were created with the Diamond program.<sup>43</sup> CCDC reference numbers 1020707 (1·2CH<sub>2</sub>Cl<sub>2</sub>), 1020708 (3·2CHCl<sub>3</sub>), 1020709 (**5**), 10207010 (**6**), 10207011 (**7**) and 10207012 (**8**) contain the supplementary crystallographic data for this paper. These data can be obtained free of charge

from the Cambridge Crystallographic Data Centre ([www.ccdc.cam.ac.uk/data\\_request/cif](http://www.ccdc.cam.ac.uk/data_request/cif)).

**Synthesis of [(2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>)<sub>2</sub>Sb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup> (**1**).** A suspension of Ti[PF<sub>6</sub>] (0.750 g, 2.15 mmol) in THF (20 mL) was added dropwise to a solution of [2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbBr (1.570 g, 2.15 mmol) in THF (25 mL) at room temperature, resulting in immediate formation of a white precipitate. The reaction mixture was stirred for 1.5 h and then filtered off through celite. The solvent was removed in vacuum from the clear yellowish solution to give **1** as a pale yellow solid (1.380 g, 81%), m.p. 235–237 °C. Anal. calc. for C<sub>38</sub>H<sub>44</sub>F<sub>6</sub>N<sub>2</sub>PSb (795.49): C, 57.37; H, 5.58; N, 3.52. Found: C, 57.31; H, 5.46; N, 3.30%. IR (ATR, cm<sup>-1</sup>): 1606(m) [ν(CH=N)], 834(s) [ν(P–F)]. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 1.17 [d, <sup>3</sup>J<sub>H,H</sub> = 6.7 Hz, 6H, H-8'a1, CH(CH<sub>3</sub>)<sub>2</sub>], 1.38 [d, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 6H, H-8'a2, CH(CH<sub>3</sub>)<sub>2</sub>], 1.43 [d, <sup>3</sup>J<sub>H,H</sub> = 6.7 Hz, 6H, H-8'b1, CH(CH<sub>3</sub>)<sub>2</sub>], 1.51 [d, <sup>3</sup>J<sub>H,H</sub> = 6.6 Hz, 6H, H-8'b2, CH(CH<sub>3</sub>)<sub>2</sub>], 3.03 [sept, <sup>3</sup>J<sub>H,H</sub> = 6.7 Hz, 2H, H-7'b, CH(CH<sub>3</sub>)<sub>2</sub>], 3.29 [sept, <sup>3</sup>J<sub>H,H</sub> = 6.7 Hz, 2H, H-7'a, CH(CH<sub>3</sub>)<sub>2</sub>], 7.34 [dd, <sup>3</sup>J<sub>H,H</sub> = 6.3 Hz, <sup>4</sup>J<sub>H,H</sub> = 2.8 Hz, 2H, H-3'a or H-3'b, C<sub>6</sub>H<sub>3</sub>], 7.46 (m, 4H, H-3'b or H-3'a, H-4', C<sub>6</sub>H<sub>3</sub>), 7.52 (d, <sup>3</sup>J<sub>H,H</sub> = 7.4 Hz, 2H, H-6, C<sub>6</sub>H<sub>4</sub>), 7.59 (ddd, <sup>3</sup>J<sub>H,H</sub> = 7.5 Hz, <sup>4</sup>J<sub>H,H</sub> = 1.2 Hz, 2H, H-5, C<sub>6</sub>H<sub>4</sub>), 7.70 (ddd, <sup>3</sup>J<sub>H,H</sub> = 7.5 Hz, <sup>4</sup>J<sub>H,H</sub> = 1.1 Hz, 2H, H-4, C<sub>6</sub>H<sub>4</sub>), 8.17 (dd, <sup>3</sup>J<sub>H,H</sub> = 7.6 Hz, <sup>4</sup>J<sub>H,H</sub> = 0.9 Hz, 2H, H-3, C<sub>6</sub>H<sub>4</sub>), 8.94 (s, 2H, H-7, CH=N). <sup>13</sup>C{<sup>1</sup>H} NMR (75.5 MHz, CDCl<sub>3</sub>): δ 23.86 [s, C-8'b2, CH(CH<sub>3</sub>)<sub>2</sub>], 24.49 [s, C-8'a2, CH(CH<sub>3</sub>)<sub>2</sub>], 24.78 [s, C-8'a1, CH(CH<sub>3</sub>)<sub>2</sub>], 27.35 [s, C-8'b1, CH(CH<sub>3</sub>)<sub>2</sub>], 28.96 [s, C-7'b, CH(CH<sub>3</sub>)<sub>2</sub>], 30.21 [s, C-7'a, CH(CH<sub>3</sub>)<sub>2</sub>], 125.14, 126.21, 129.23 (s, C-3'a, C-3'b, C-4'), 131.61 (s, C-4), 135.01 (s, C-6), 135.14 (s, C-5), 135.82 (s, C-3), 138.78 (s, C-2), 140.27 (s, C-2'b), 141.12 (s, C-1'), 141.36 (s, C-2'a), 146.94 (s, C-1), 174.41 (s, C-7, CH=N). <sup>19</sup>F{<sup>1</sup>H} NMR (282.4 MHz, CDCl<sub>3</sub>): δ -73.0 (d, <sup>1</sup>J<sub>P,F</sub> = 713.1 Hz). <sup>31</sup>P{<sup>1</sup>H} NMR (121.5 MHz, CDCl<sub>3</sub>): δ -144.3 (sept, <sup>1</sup>J<sub>P,F</sub> = 713.3 Hz). MS (ESI+, CH<sub>2</sub>Cl<sub>2</sub>/CH<sub>3</sub>CN): *m/z* (%) 649 (100%) [R<sub>2</sub>Sb<sup>+</sup>] [R = 2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>].

**Synthesis of [(2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>)PhSb]<sup>+</sup>[PF<sub>6</sub>]<sup>-</sup> (**2**).** A solution of <sup>n</sup>BuLi in *n*-hexane (5.45 mL, 8.7 mmol, 1.6 M) was added dropwise, at -78 °C to a stirred solution of 2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>Br (3.00 g, 8.7 mmol) in anhydrous *n*-hexane (40 mL) and the reaction mixture was stirred for 1.5 h. The resulting yellow-orange suspension of organolithium compound was added dropwise to a suspension of PhSbCl<sub>2</sub> (2.35, 8.7 mmol) in *n*-hexane (30 mL), at -78 °C, and the mixture was stirred for 2 h at -78 °C, then for 12 h at room temperature. The solvent was removed, the residual yellow-orange solid was washed several times with cold *n*-hexane and the extracted with CH<sub>2</sub>Cl<sub>2</sub>. Evaporation of the solvent in vacuum gave 2.15 g (50%) of [2-(2',6'-<sup>i</sup>Pr<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]PhSbCl as a yellow powder (m.p. 233–235 °C; cf. 238 °C<sup>32</sup>) which was used without further purification. To a solution of this chloride (1.00 g, 2.00 mmol) in THF (25 mL) a suspension of Ti[PF<sub>6</sub>] (0.70 g, 2.00 mmol) in THF (15 mL) was added dropwise, at room temperature. A white precipitate is formed immediately. The reaction mixture was stirred for 2 h and then filtered off through celite. The solvent was removed under vacuum from the pale-yellow solution and the resulting precipitate was washed with *n*-hexane to give **2** as a pale yellow solid (0.873 g, 72%), m.p. 169–170 °C. Anal.

calc. for  $C_{25}H_{27}F_6NPSb$  (608.21): C, 49.37; H, 4.47; N, 2.30. Found: C, 49.02; H, 4.26; N, 2.33%. IR (ATR,  $cm^{-1}$ ): 1615(m) [ $\nu(CH=N)$ ], 802(s) [ $\nu(P-F)$ ].  $^1H$  NMR (300 MHz,  $CDCl_3$ ):  $\delta$  0.35 [d,  $^3J_{H,H} = 6.7$  Hz, 3H, H-8'a1,  $CH(CH_3)_2$ ], 0.88 [d,  $^3J_{H,H} = 6.8$  Hz, 3H, H-8'a2,  $CH(CH_3)_2$ ], 1.13 [d,  $^3J_{H,H} = 6.8$  Hz, 3H, H-8'b1,  $CH(CH_3)_2$ ], 1.34 [d,  $^3J_{H,H} = 6.8$  Hz, 3H, H-8'b2,  $CH(CH_3)_2$ ], 1.73 [sept,  $^3J_{H,H} = 6.8$  Hz, 1H, H-7'a,  $CH(CH_3)_2$ ], 2.93 [sept,  $^3J_{H,H} = 6.8$  Hz, 1H, H-7'b,  $CH(CH_3)_2$ ], 7.06 (dd,  $^3J_{H,H} = 7.3$  Hz,  $^4J_{H,H} = 1.3$  Hz, 1H, H-3'a,  $C_6H_3$ ), 7.26 (m, 7H, H-3'b, H-4',  $C_6H_3$  + H-ortho,meta,para,  $C_6H_5$ ), 7.77 (dd,  $^3J_{H,H} = 7.3$  Hz, 1H, H-4,  $C_6H_4$ ), 7.84 (ddd,  $^3J_{H,H} = 7.5$  Hz,  $^4J_{H,H} = 1.0$  Hz, 1H, H-5,  $C_6H_4$ ), 8.08 (d,  $^3J_{H,H} = 7.1$  Hz, 1H, H-3,  $C_6H_4$ ), 8.38 (s, br, 1H, H-6,  $C_6H_4$ ), 8.65 (s, 1H, H-7,  $CH=N$ ).  $^{13}C\{^1H\}$  NMR (75.5 MHz,  $CDCl_3$ ):  $\delta$  22.33 [s, C-8'a1,  $CH(CH_3)_2$ ], 23.98 [s, C-8'b2,  $CH(CH_3)_2$ ], 24.98 [s, C-8'b1,  $CH(CH_3)_2$ ], 26.07 [s, C-8'a2,  $CH(CH_3)_2$ ], 28.13 [s, C-7'a,  $CH(CH_3)_2$ ], 29.15 [s, C-7'b,  $CH(CH_3)_2$ ], 123.98 (s, C-3'b), 124.26 (s, C-3'a), 127.94 (s, C-4'), 129.39 (s, C-meta), 130.15 (s, C-4), 130.44 (s, C-para), 133.60 (s, C-3), 134.41 (s, C-ortho), 134.58 (s, C-5), 136.13 (s, C-6), 139.64 (s, C-1'), 140.39 (s, C-2), 140.66 (s, C-2'b), 141.02 (s, C-2'a), 144.45 (s, C-*ipso*), 151.42 (s, C-1), 174.86 (s, C-7,  $CH=N$ ).  $^{19}F\{^1H\}$  NMR (282.4 MHz,  $CDCl_3$ ):  $\delta$  -72.9 (d,  $^1J_{P,F} = 713.1$  Hz).  $^{31}P\{^1H\}$  NMR (121.5 MHz,  $CDCl_3$ ):  $\delta$  -144.3 (sept,  $^1J_{P,F} = 713.3$  Hz). MS (APCI+,  $CH_3CN$ ):  $m/z$  (%) 462 (100%) [ $RPhSb^+$ ] [ $R = 2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4$ ].

**Synthesis of  $[(2-(2',4',6'-Me_3C_6H_2N=CH)C_6H_4)_2Sb]^+[PF_6]^-$  (3).** A suspension of  $Tl[PF_6]$  (0.120 g, 0.34 mmol) in THF (15 mL) was added dropwise to a solution of  $[2-(2',4',6'-Me_3C_6H_2N=CH)C_6H_4)_2SbBr$  (0.222 g, 0.34 mmol) in THF (20 mL) at room temperature, resulting in immediate formation of a white precipitate. The reaction mixture was stirred for 1.5 h and then filtered off through celite. The solvent was removed in vacuum from the clear yellowish solution to give **3** as a pale yellow solid (0.139 g, 57%), m.p. 200–202 °C. Anal. calc. for  $C_{22}H_{22}F_6N_2Psb$  (711.33): C, 54.03; H, 4.53; N, 3.94. Found: C, 53.16; H, 4.61; N, 3.89%. IR (ATR,  $cm^{-1}$ ): 1602(m) [ $\nu(CH=N)$ ], 825(s) [ $\nu(P-F)$ ].  $^1H$  NMR (500 MHz,  $CDCl_3$ ):  $\delta$  2.37 (s, 6H, H-8',  $CH_3$ ), 2.45 (s, 12H, H-7',  $CH_3$ ), 7.11 (s, 4H, H-3',5',  $C_6H_2$ ), 7.48 (d,  $^3J_{H,H} = 7.5$  Hz, 2H, H-6,  $C_6H_4$ ), 7.55 (ddd,  $^3J_{H,H} = 7.5$  Hz,  $^4J_{H,H} = 1.2$  Hz, 2H, H-5,  $C_6H_4$ ), 7.62 (ddd,  $^3J_{H,H} = 7.5$  Hz,  $^4J_{H,H} = 1.1$  Hz, 2H, H-4,  $C_6H_4$ ), 8.12 (dd,  $^3J_{H,H} = 7.5$  Hz,  $^4J_{H,H} = 0.8$  Hz, 2H, H-3,  $C_6H_4$ ), 8.94 (s, 2H, H-7,  $CH=N$ ).  $^{13}C\{^1H\}$  NMR (125.8 MHz,  $CDCl_3$ ):  $\delta$  20.25 (s, br, C-7',  $CH_3$ ), 21.07 (s, C-8',  $CH_3$ ), 129.79 (s, C-2',6'), 131.26 (s, C-4), 131.36 (s, C-3',5'), 134.96 (s, C-5), 135.12 (s, C-6), 135.29 (s, C-3), 138.58 (s, C-4'), 138.72 (s, C-2), 142.30 (s, C-1'), 146.17 (s, C-1), 174.43 (s, C-7,  $CH=N$ ).  $^{19}F\{^1H\}$  NMR (282.4 MHz,  $CDCl_3$ ):  $\delta$  -72.8 (d,  $^1J_{P,F} = 713.2$  Hz).  $^{31}P\{^1H\}$  NMR (202.5 MHz,  $CDCl_3$ ):  $\delta$  -144.3 (sept,  $^1J_{P,F} = 713.2$  Hz). MS (ESI+,  $CH_2Cl_2/CH_3CN$ ):  $m/z$  (%) 565 (100%) [ $R_2Sb^+$ ] [ $R' = 2-(2',4',6'-Me_3C_6H_2N=CH)C_6H_4$ ].

**Synthesis of  $[(2-(Me_2NCH_2)C_6H_4)_2Sb]^+[SbF_6]^-$  (4).** To a solution of  $[2-(Me_2NCH_2)C_6H_4)_2SbCl$  (0.48 g, 1.13 mmol) in THF (15 mL) was added a suspension of  $Ag[SbF_6]$  (0.39 g, 1.13 mmol) in THF (10 mL), which led to the immediate formation of a white precipitate. The flask was covered with aluminum foil against light. The reaction mixture was stirred for 30 minutes and then filtered off through celite, resulting in a colorless solution. Removal of the solvent under vacuum gave **4** as a white solid

(0.35 g, 50%), m.p. 212–214 °C. Anal. calc. for  $C_{18}H_{24}F_6N_2Sb_2$  (625.91): C, 34.54; H, 3.86; N, 4.48. Found: C, 34.58; H, 4.09; N, 4.47%. IR (ATR,  $cm^{-1}$ ): 750(s) [ $\nu(Sb-F)$ ].  $^1H$  NMR (300 MHz,  $DMSO-d_6$ ):  $\delta$  2.42 (s, 12H,  $CH_3$ ), 3.90 (s, 4H,  $CH_2$ ), 7.44 (m, 6H, H-3,4,5,  $C_6H_4$ ), 7.61 (d,  $^3J_{H,H} = 6.0$  Hz, 2H, H-6,  $C_6H_4$ ).  $^{13}C\{^1H\}$  NMR (75.5 MHz,  $DMSO-d_6$ ):  $\delta$  45.44 (s,  $CH_3$ ), 65.36 (s,  $CH_2$ ), 128.48 (s, C-5 or C-3), 128.56 (s, C-3 or C-5), 129.96 (s, C-4), 135.08 (s, C-6), 143.96 (s, C-2), 145.58 (s, C-1).  $^{19}F\{^1H\}$  NMR (282.4 MHz,  $DMSO-d_6$ ):  $\delta$  -119.5 (m). MS (ESI+,  $CH_3CN$ ):  $m/z$  (%) 389 (100) [ $R_2Sb^+$ ] [ $R' = 2-(Me_2NCH_2)C_6H_4$ ].

**Synthesis of  $[2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4)_2SbF$  (5).** A solution of  $[Bu_4N]F \cdot 3H_2O$  (0.088 g, 0.28 mmol) in acetonitrile (10 mL) was added to a solution of **1** (0.224 g, 0.28 mmol) in acetonitrile (15 mL). The reaction mixture was stirred for 16 h, the color of the solution being changed from colourless to yellow. The solvent was removed in vacuum to obtain a yellow precipitate, which was extracted with *n*-hexane. Slow evaporation of the clear *n*-hexane solution gave yellow crystals of **5** (0.103 g, 55%), m.p. 166–168 °C. Anal. calc. for  $C_{38}H_{44}FN_2Sb$  (669.53): C, 68.17; H, 6.62; N, 4.18. Found: C, 68.46; H, 6.81; N, 4.34%. IR (ATR,  $cm^{-1}$ ): 1641(m) [ $\nu(CH=N)$ ].  $^1H$  NMR (300 MHz,  $CDCl_3$ ):  $\delta$  0.44 [d,  $^3J_{H,H} = 5.4$  Hz, 3H, H-8'a1 (A),  $CH(CH_3)_2$ ], 0.73 [d,  $^3J_{H,H} = 5.3$  Hz, 3H, H-8'a2 (A),  $CH(CH_3)_2$ ], 0.88 [d,  $^3J_{H,H} = 5.3$  Hz, 6H, H-8'1 (B),  $CH(CH_3)_2$ ], 1.06 [m, 12H, H-8'b1 (A) + H-8'b2 (A) + H-8'2 (B)  $CH(CH_3)_2$ ], 1.91 [m, 1H, H-7'a (A),  $CH(CH_3)_2$ ], 2.80 [m, 3H, H-7'b (A) + H-7' (B),  $CH(CH_3)_2$ ], 6.98 [s, br, 1H, H-3'a (A),  $C_6H_3$ ], 7.11 [s, br, 5H, H-3'b (A) + H-4' (A) + H-3' (B) + H-4' (B),  $C_6H_3$ ], 7.22 [s, br, 1H, H-6 (B),  $C_6H_4$ ], 7.26 [s, br, 1H, H-5 (B),  $C_6H_4$ ], 7.44 [dd, 1H,  $^3J_{H,H} = 6.4$  Hz, H-4 (B),  $C_6H_4$ ], 7.62 [m, 2H, H-4 (A) + H-3 (B),  $C_6H_4$ ], 7.74 [dd,  $^3J_{H,H} = 7.3$  Hz, 1H, H-5 (A),  $C_6H_4$ ], 7.85 [d,  $^3J_{H,H} = 6.7$  Hz, 1H, H-3 (A),  $C_6H_4$ ], 8.38 [m, 3H, H-6 (A),  $C_6H_4$  + H-7 (A) + H-7 (B),  $CH=N$ ].  $^{13}C\{^1H\}$  NMR (75.5 MHz,  $CDCl_3$ ):  $\delta$  22.12 [s, C-8'a1 (A),  $CH(CH_3)_2$ ], 23.78 [s, C-8'1 (B),  $CH(CH_3)_2$ ], 24.03 [s, C-8'2 (B),  $CH(CH_3)_2$ ], 24.40 [s, C-8'b1 (A),  $CH(CH_3)_2$ ], 24.92 [s, C-8'a2 (A),  $CH(CH_3)_2$ ], 25.32 [s, C-8'b2 (A),  $CH(CH_3)_2$ ], 28.14 [s, br, C-7'a (A) + C-7' (B),  $CH(CH_3)_2$ ], 28.31 [s, C-7'b (A),  $CH(CH_3)_2$ ], 122.99 [s, C-3'a (A) + C-4' (A) or C-4' (B)], 123.97 [s, C-3'b (A)], 124.42 [s, C-4' (B) or C-4' (A)], 126.32 [s, C-3' (B)], 128.95 [s, C-4 (A)], 129.69 [s, C-4 (B)], 131.96 [s, C-5 (B)], 132.47 [s, C-3 (A)], 132.94 [s, C-5 (A) and C-3 (B)], 135.53 [s, C-6 (A)], 136.06 [s, C-6 (B)], 138.57 [s, C-2' (B)], 139.00 [s, C-2 (B)], 139.47 [s, C-2'b (A)], 140.64 [s, C-2 (A) + C-2'a (A)], 144.69 [s, C-1' (A)], 148.15 [s, C-1' (B)], 148.53 [s, C-1 (B)], 160.00 [s, C-1 (A)], 164.74 [s, C-7 (B),  $CH=N$ ], 168.76 [s, C-7 (A),  $CH=N$ ].  $^{19}F\{^1H\}$  NMR (282.4 MHz,  $CDCl_3$ ):  $\delta$  -181.3 (s). MS (ESI+,  $CH_3CN$ ):  $m/z$  (%) 649 (100%) [ $R_2Sb^+$ ] [ $R = 2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4$ ].

**Synthesis of  $[2-(2',6'-Pr_2C_6H_3N=CH)C_6H_4)PhSbF$  (6).** A solution of  $[Bu_4N]F \cdot 3H_2O$  (0.262 g, 0.83 mmol) in acetonitrile (10 mL) was added to a solution of **2** (0.505 g, 0.83 mmol) in acetonitrile (20 mL). The reaction mixture was stirred for 16 h, while the color changed from colorless to yellow. The solvent was then removed in vacuum to obtain a yellow solid, which was extracted with *n*-hexane. Slow evaporation of the clear *n*-hexane solution gave yellow crystals of **6** (0.326 g, 82%), m.p. 222–224 °C. Anal. calc. for  $C_{25}H_{27}FNSb$  (482.25): C, 62.26; H, 5.64; N, 2.90. Found: C, 61.64; H, 5.93; N, 3.01%. IR (ATR,



cm<sup>-1</sup>): 1622(s) [ν(CH=N)]. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 0.51 [d, <sup>3</sup>J<sub>H,H</sub> = 6.7 Hz, 3H, H-8'a1, CH(CH<sub>3</sub>)<sub>2</sub>], 0.86 [d, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 3H, H-8'a2, CH(CH<sub>3</sub>)<sub>2</sub>], 1.12 [d, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 3H, H-8'b1, CH(CH<sub>3</sub>)<sub>2</sub>], 1.33 [d, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 3H, H-8'b2, CH(CH<sub>3</sub>)<sub>2</sub>], 1.82 [sept, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 1H, H-7'a, CH(CH<sub>3</sub>)<sub>2</sub>], 3.05 [sept, <sup>3</sup>J<sub>H,H</sub> = 6.8 Hz, 1H, H-7'b, CH(CH<sub>3</sub>)<sub>2</sub>], 7.06 (m, 1H, H-3'a, C<sub>6</sub>H<sub>5</sub>), 7.23 (m, 5H, H-3'b, H-4', C<sub>6</sub>H<sub>3</sub> + H-*meta,para*, C<sub>6</sub>H<sub>5</sub>), 7.42 (m, 2H, H-*ortho*, C<sub>6</sub>H<sub>5</sub>), 7.64 (dd, <sup>3</sup>J<sub>H,H</sub> = 7.4 Hz, 1H, H-4, C<sub>6</sub>H<sub>4</sub>), 7.81 (m, 2H, H-3, H-5, C<sub>6</sub>H<sub>4</sub>), 8.44 (m, 2H, H-6, C<sub>6</sub>H<sub>4</sub> + H-7, CH=N). <sup>13</sup>C{<sup>1</sup>H} NMR (100.6 MHz, CDCl<sub>3</sub>): δ 22.64 [s, C-8'a1, CH(CH<sub>3</sub>)<sub>2</sub>], 24.25 [s, C-8'b2, CH(CH<sub>3</sub>)<sub>2</sub>], 24.98 [s, C-8'b1, CH(CH<sub>3</sub>)<sub>2</sub>], 26.21 [s, C-8'a2, CH(CH<sub>3</sub>)<sub>2</sub>], 27.93 [s, C-7'a, CH(CH<sub>3</sub>)<sub>2</sub>], 28.81 [s, C-7'b, CH(CH<sub>3</sub>)<sub>2</sub>], 123.71 (s, C-3'b), 123.93 (s, C-3'a), 126.67 (s, C-4'), 129.02 (s, C-*meta*), 129.35 (s, C-4), 129.46 (s, C-*para*), 132.49 (s, C-3), 133.33 (s, C-5), 134.25 (d, <sup>3</sup>J<sub>C,F</sub> = 1.0 Hz, C-*ortho*), 134.92 (d, <sup>3</sup>J<sub>C,F</sub> = 9.9 Hz, C-6), 139.45 (s, C-2), 140.17 (s, C-2'b), 140.37 (s, C-2'a), 143.27 (s, C-1'), 147.72 (d, <sup>2</sup>J<sub>C,F</sub> = 9.2 Hz, C-*ipso*), 153.75 (d, <sup>2</sup>J<sub>C,F</sub> = 6.3 Hz, C-1), 168.43 (s, C-7, CH=N). <sup>19</sup>F{<sup>1</sup>H} NMR (376.5 MHz, CDCl<sub>3</sub>): δ -174.7 (s, br). MS (APCI+, CH<sub>3</sub>CN): *m/z* (%) 945 (30%) [(RPhSb)<sub>2</sub>F<sup>+</sup>], 462 (100%) [RPhSb<sup>+</sup>] [R = 2-(2',6'-*Pr*<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>].

**Synthesis of [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbF (7).** A solution of [Bu<sub>4</sub>N]F·3H<sub>2</sub>O (0.131 g, 0.42 mmol) in acetonitrile (15 mL) was added to a solution of [{2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>Sb<sup>+</sup>}[SbF<sub>6</sub><sup>-</sup>] (4) (0.260 g, 0.42 mmol) in acetonitrile (15 mL). The reaction mixture was stirred for 16 h, then the solvent was removed in vacuum to yield a white solid, which was extracted with *n*-hexane. Slow evaporation of the clear *n*-hexane solution gave white crystals of **7** (0.105 g, 62%), m.p. 64–66 °C. Anal. calc. for C<sub>18</sub>H<sub>24</sub>FN<sub>2</sub>Sb (409.15): C, 52.84; H, 5.91; N, 6.85. Found: C, 52.56; H, 5.94; N, 6.99%. <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ 2.21 (s, 12H, H-8, CH<sub>3</sub>), AB spin system with A at 3.50 and B at 3.70 ppm (<sup>2</sup>J<sub>H,H</sub> = 13.5 Hz, 4H, H-7, CH<sub>2</sub>-N), 7.26 (m, 6H, H-3,4,5, C<sub>6</sub>H<sub>4</sub>), 7.68 (d, <sup>3</sup>J<sub>H,H</sub> = 5.5 Hz, 2H, H-6, C<sub>6</sub>H<sub>4</sub>). <sup>13</sup>C{<sup>1</sup>H} NMR (75.5 MHz, CDCl<sub>3</sub>): δ 45.10 (s, C-8), 65.78 (s, C-7), 127.67, 128.14, 128.77 (s, C-3, C-4, C-5), 135.21 (d, <sup>3</sup>J<sub>C,F</sub> = 4.0 Hz, C-6), 143.72 (s, C-2), 150.15 (s, br, C-1). <sup>19</sup>F{<sup>1</sup>H} NMR (282.4 MHz, CDCl<sub>3</sub>): δ -176.9 (s, br). MS (ESI+, CH<sub>3</sub>CN): *m/z* (%) 409 (3%) [M<sup>+</sup>+H], 389 (100%) [R''<sub>2</sub>Sb<sup>+</sup>] [R'' = 2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>].

**Synthesis of [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]PhSbF (8).** To a solution of [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]PhSbCl<sup>34</sup> (0.500 g, 1.36 mmol) in THF (20 mL) was added Ag[SbF<sub>6</sub>] (0.470 g, 1.36 mmol), resulting in the immediate formation of a white precipitate. The flask was covered with aluminum foil against light and the reaction mixture was stirred 3 h, then filtered off through celite, resulting in a colorless solution. Evaporation of the solvent in vacuum gave 0.70 g (87%) of crude [{2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]PhSb<sup>+</sup>}[SbF<sub>6</sub><sup>-</sup>] as a white solid (m.p. 105–107 °C) which was used without further purification. To a solution of this ionic species (0.200 g, 0.34 mmol) in acetonitrile (15 mL) was added a solution of [Bu<sub>4</sub>N]F·3H<sub>2</sub>O (0.110 g, 0.35 mmol) in acetonitrile (10 mL). The reaction mixture was stirred for 16 h, then the solvent was removed in vacuum to yield a white solid, which was extracted with *n*-hexane. Slow evaporation of the clear *n*-hexane solution gave white crystals of **8** (0.051 g, 43%), m.p. 164–166 °C. Anal. calc. for C<sub>15</sub>H<sub>17</sub>FNsb (352.06): C, 51.17; H, 4.87; N, 3.98. Found: C, 50.76; H, 5.10; N,

3.81%. <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ 2.01 (s, 3H, H-8a, CH<sub>3</sub>), 2.39 (s, 3H, H-8b, CH<sub>3</sub>), 3.51 (s, 2H, H-7, CH<sub>2</sub>-N), 7.21 (d, <sup>3</sup>J<sub>H,H</sub> = 7.4 Hz, 1H, H-3, C<sub>6</sub>H<sub>4</sub>), 7.32 (m, 3H, H-*meta,para*, C<sub>6</sub>H<sub>5</sub>), 7.37 (dd, <sup>3</sup>J<sub>H,H</sub> = 7.4 Hz, 1H, H-4, C<sub>6</sub>H<sub>4</sub>), 7.47 (dd, <sup>3</sup>J<sub>H,H</sub> = 7.3 Hz, 1H, H-5, C<sub>6</sub>H<sub>4</sub>), 7.52 (m, 2H, H-*ortho*, C<sub>6</sub>H<sub>5</sub>), 8.16 (d, <sup>3</sup>J<sub>H,H</sub> = 7.3 Hz, 1H, H-6, C<sub>6</sub>H<sub>4</sub>). <sup>13</sup>C{<sup>1</sup>H} NMR (75.5 MHz, CDCl<sub>3</sub>): δ 45.48, 45.50 (s, C-8a, C-8b), 65.45 (s, C-7), 126.51 (s, C-3), 128.32 (s, C-5), 128.90 (s, C-*meta*), 129.18 (s, C-4), 129.46 (s, C-*para*), 134.67 (d, <sup>3</sup>J<sub>C,F</sub> = 1.1 Hz, C-*ortho*, C<sub>6</sub>H<sub>5</sub>), 135.22 (d, <sup>2</sup>J<sub>C,F</sub> = 6.9 Hz, C-6), 143.22 (s, C-2), 144.07 (d, <sup>2</sup>J<sub>C,F</sub> = 10.1 Hz, C-*ipso*), 148.27 (d, <sup>3</sup>J<sub>C,F</sub> = 7.7 Hz, C-1). <sup>19</sup>F{<sup>1</sup>H} NMR (282.4 MHz, CDCl<sub>3</sub>): δ -169.2 (s, br). MS (ESI+, CH<sub>3</sub>CN): *m/z* (%) 332 (100%) [R''PhSb<sup>+</sup>] [R'' = 2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>].

## Conclusions

The present work reports on a new general method for the synthesis of hypervalent diorganoantimony(III) fluorides containing either one or two organic ligands with a pendant arm, e.g. [2-(2',6'-*Pr*<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbF (5), [2-(2',6'-*Pr*<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]PhSbF (6) (Scheme 1), [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>SbF (7) and [2-(Me<sub>2</sub>NCH<sub>2</sub>)C<sub>6</sub>H<sub>4</sub>]PhSbF (8), using as starting materials diorganoantimony(III) cations stabilized by intramolecular N→Sb interactions. It is worthwhile to mention that the diorganoantimony(III) fluorides could be obtained just by [Bu<sub>4</sub>N]F·3H<sub>2</sub>O addition to *in situ* prepared cationic species. The ionic species [{2-(2',6'-*Pr*<sub>2</sub>C<sub>6</sub>H<sub>3</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>Sb<sup>+</sup>}[PF<sub>6</sub><sup>-</sup>] (1) and [{2-(2',4',6'-Me<sub>3</sub>C<sub>6</sub>H<sub>2</sub>N=CH)C<sub>6</sub>H<sub>4</sub>]<sub>2</sub>Sb<sup>+</sup>}[PF<sub>6</sub><sup>-</sup>] (3) exhibit helical chirality and crystallize as 1:1 mixture of (Δ<sub>Sb</sub>)- and (Λ<sub>Sb</sub>)-cations. In contrast to Ph<sub>2</sub>SbF, which exhibits a chain polymeric structure based on almost symmetric Sb–F…Sb bridges, the crystals of the novel fluorides 5–8 contain discrete molecules as result of intramolecular N→Sb interactions.

## Acknowledgements

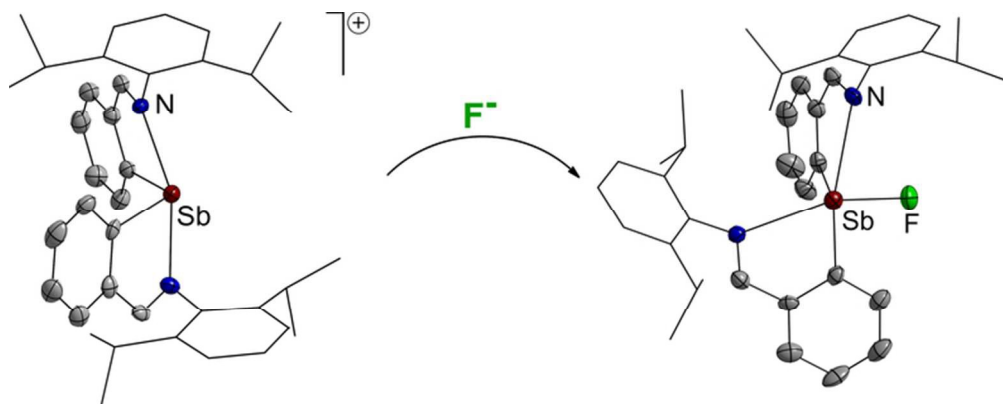
Financial support from National Research Council of Romania (CNCS, Research Project No. PN-II-ID-PCE-2011-3-0933) is greatly appreciated. A.M.P. thanks the European Social Fund for a Scholarship (Education and Training Program 2008–2013, POSDRU/6/1.5/S/3). We also thank DAAD (program “Ostpartnerschaften”) for financial support and Technische Universität Chemnitz for providing research facilities during research stays of A.M.P. The support provided by the NATIONAL CENTER FOR X-RAY DIFFRACTION (Babeş-Bolyai University, Cluj-Napoca, Romania) for the solid state structure determinations is highly acknowledged.

- 1 M. Jean, *Anal. Chim. Acta*, 1971, **57**, 438–439.
- 2 C. R. Wade and F. P. Gabbaï, *Organometallics*, 2011, **30**, 4479–4481.
- 3 C. R. Wade, I.-S. Ke and F. P. Gabbaï, *Angew. Chem., Int. Ed.*, 2012, **51**, 478–481, and references cited therein.
- 4 I.-S. Ke, M. Myahkostupov, F. N. Castellano and F. P. Gabbaï, *J. Am. Chem. Soc.*, 2012, **134**, 15309–15311.
- 5 I.-S. Ke, J. S. Jones and F. P. Gabbaï, *Angew. Chem., Int. Ed.*, 2014, **53**, 2633–2637.

- 6 J. S. Jones, C. R. Wade and F. P. Gabbaï, *Organometallics*, 2015, **34**, 2647–2654.
- 7 R. Müller and C. Dathe, *Chem. Ber.*, 1966, **99**, 1609–1613.
- 8 S. P. Bone and D. B. Sowerby, *J. Chem. Soc., Dalton Trans.*, 1979, 1430–1433.
- 9 K. Ohkata, S. Takemoto, M. Ohnishi and K.-y. Akiba, *Tetrahedron Lett.*, 1989, **30**, 4841–4844.
- 10 L. Baiget, M. Bouslikhane, J. Escudié, G. Cretiu Nemes, I. Silaghi-Dumitrescu and L. Silaghi-Dumitrescu, *Phosphorus, Sulfur Silicon Relat. Elem.*, 2003, **178**, 1949–1961.
- 11 L. Baiget, H. Ranaivonjatovo, J. Escudié, G. Cretiu Nemes, I. Silaghi-Dumitrescu and L. Silaghi-Dumitrescu, *J. Organomet. Chem.*, 2005, **690**, 307–312.
- 12 L. Baiget, R. El Ayoubi, H. Ranaivonjatovo, J. Escudié and H. Gornitzka, *J. Organomet. Chem.*, 2008, **693**, 2293–2298.
- 13 L. Dostál, R. Jambor, A. Růžička, R. Jirásko, I. Císařová and J. Holeček, *J. Fluorine Chem.*, 2008, **129**, 167–172.
- 14 A. Fridrichová, T. Svoboda, R. Jambor, Z. Padělková, A. Růžička, M. Erben, R. Jirásko and L. Dostál, *Organometallics*, 2009, **28**, 5522–5528.
- 15 M. Nunn, D. B. Sowerby and D. Wesolek, *J. Organomet. Chem.*, 1983, **251**, C45–C46.
- 16 G. Becker, O. Mundt, M. Sachs, H. J. Breunig, E. Lork, J. Probst and A. Silvestru, *Z. Anorg. Allg. Chem.*, 2001, **627**, 699–714.
- 17 L. M. Oprea, A. Silvestru, C. Silvestru, H. J. Breunig and E. Lork, *Dalton Trans.*, 2003, 4367–4374.
- 18 A. M. Preda, C. I. Raț, C. Silvestru, H. J. Breunig, H. Lang, T. Ruffer and M. Mehring, *Dalton Trans.*, 2013, **42**, 1144–1158.
- 19 C. J. Carmalt, D. Walsh, A. H. Cowley and N. C. Norman, *Organometallics*, 1997, **16**, 3597–3600.
- 20 H. Althaus, H. J. Breunig and E. Lork, *Chem. Commun.*, 1999, 1971–1972.
- 21 C. Hering, M. Lehmann, A. Schulz and A. Villinger, *Inorg. Chem.*, 2012, **51**, 8212–8224.
- 22 J. W. Wielandt, N. L. Kilah, A. C. Willis and S. B. Wild, *Chem. Commun.*, 2006, 3679–3680.
- 23 N. L. Kilah, S. Petrie, R. Stranger, J. W. Wielandt, A. C. Willis and S. B. Wild, *Organometallics*, 2007, **26**, 6106–6113.
- 24 S. S. Chitnis, N. Burford, R. McDonald and M. J. Ferguson, *Inorg. Chem.*, 2014, **53**, 5359–5372.
- 25 L. Dostál, R. Jambor, I. Císařová, L. Beneš, A. Růžička, R. Jirásko and J. Holeček, *J. Organomet. Chem.*, 2007, **692**, 2350–2353.
- 26 K. Nakamoto, *Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A: Theory and Applications in Inorganic Chemistry*, 6<sup>th</sup> Ed., John Wiley & Sons, Hoboken, New Jersey, 2009.
- 27 J. Emsley, *Die Elemente*, Walter de Gruyter, Berlin, 1994.
- 28 *Nomenclature of Inorganic Chemistry – IUPAC Recommendations*, ed. N. G. Connolly, T. Damhus, R. M. Hartshorn and A. T. Hutton, RSC Publishing, Cambridge, 2005.
- 29 M. Nishio, *Phys. Chem. Chem. Phys.*, 2011, **13**, 13873–13900.
- 30 L. Dostál, R. Jambor, A. Růžička and P. Šimon, *Eur. J. Inorg. Chem.*, 2011, 2380–2386.
- 31 C. J. Carmalt, A. H. Cowley, R. D. Culp, R. A. Jones, S. Kamepalli and N. C. Norman, *Inorg. Chem.*, 1997, **36**, 2770–2776.
- 32 I. Urbanová, R. Jambor, A. Růžička, R. Jirásko and L. Dostál, *Dalton Trans.*, 2014, **43**, 505–512.
- 33 D. Copolovici, F. Isaia, H. J. Breunig, C. I. Raț and C. Silvestru, *RSC Advances*, 2014, **4**, 26569–26576.
- 34 D. Copolovici, V. R. Bojan, C. I. Raț, A. Silvestru, H. J. Breunig and C. Silvestru, *Dalton Trans.*, 2010, **39**, 6410–6418.
- 35 *Chemistry of Hypervalent Compounds*, ed. K.-y. Akiba, Wiley-VCH, New York, 1999.
- 36 The *N-X-L* nomenclature system has been described previously: *N* valence shell electrons about a central atom *X* with *L* ligands; C. W. Perkins, J. C. Martin, A. J. Arduengo III, W. Lau, A. Alegria and K. Kochi, *J. Am. Chem. Soc.*, 1980, **102**, 7753–7759.
- 37 C. I. Raț, C. Silvestru and H. J. Breunig, *Coord. Chem. Rev.*, 2013, **257**, 818–879.
- 38 *Nomenclature of Organic Chemistry, Sections A, B, C, D, E, F and H*, ed. J. Rigaudy and S. P. Klesney, Pergamon Press, Oxford, 1979.
- 39 A. Silvestru and C. Silvestru, *Studia Univ. “Babeş-Bolyai”, Chemia*, 1998, **43**, 273–280.
- 40 G. R. Fulmer, A. J. M. Miller, N. H. Sherden, H. E. Gottlieb, A. Nudelman, B. M. Stoltz, J. E. Bercaw and K. I. Goldberg, *Organometallics*, 2010, **29**, 2176–2179.
- 41 *MestReC and MestReNova*, Mestrelab Research S. L., A Coruña 15706, Santiago de Compostela.
- 42 G. M. Sheldrick, *SHELXL-97, Program for the Solution of Crystal Structures*, University of Göttingen, Göttingen, Germany, 1997.
- 43 *DIAMOND-Visual Crystal Structure Information System, Crystal Impact: Postfach 1251, D-53002 Bonn, Germany*, 2001.

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A new general method for the synthesis of molecular, hypervalent diorganoantimony(III) fluorides with either one or two organic ligands with a pendant arm based on treatment of isolated or *in situ* prepared cationic species of the type  $[\{2-(2',6'\text{-}i\text{Pr}_2\text{C}_6\text{H}_3\text{N}=\text{CH})\text{C}_6\text{H}_4\}_2\text{Sb}]^+[\text{PF}_6]^-$  or  $[\{2-(\text{Me}_2\text{NCH}_2)\text{C}_6\text{H}_4\}\text{PhSb}]^+[\text{SbF}_6]^-$  with  $[\text{Bu}_4\text{N}]\text{F}\cdot 3\text{H}_2\text{O}$ .



33x13mm (600 x 600 DPI)