

LONG RANGE  $^{13}\text{C}$ - $^{19}\text{F}$  AND  $^1\text{H}$ - $^{19}\text{F}$  COUPLING IN FLUOROSTEROIDS

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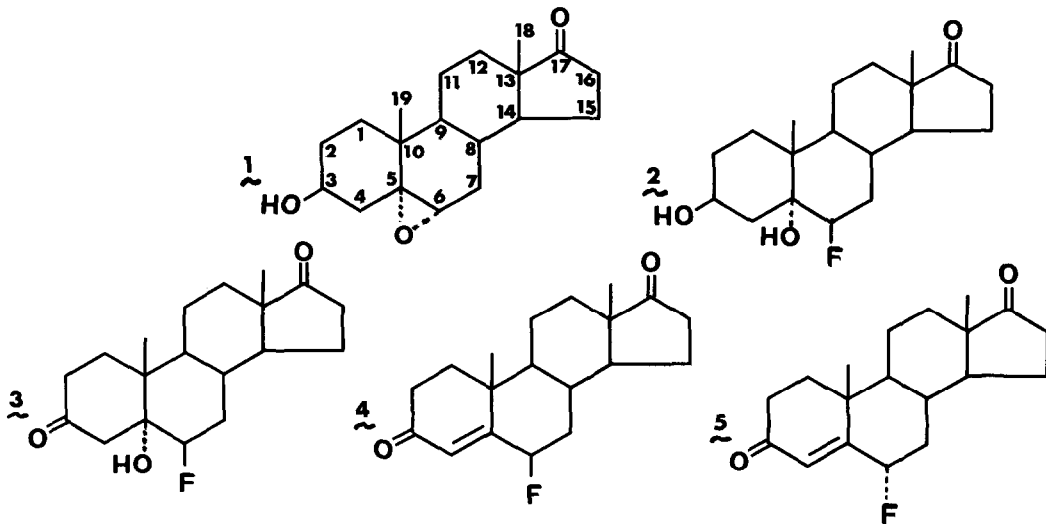
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Although many cases of long range and through space  $^1\text{H}$ - $^{19}\text{F}$  couplings are known<sup>1</sup>, and long range  $^{13}\text{C}$ - $^{19}\text{F}$  couplings in aromatic systems are common<sup>2</sup>, unambiguous cases of through space  $^{13}\text{C}$ - $^{19}\text{F}$  interaction are uncommon<sup>3,4</sup>. The steroid skeleton, by virtue of its rigidity, is ideally suited to studies of such effects, and indeed one of the first observations<sup>5</sup> of through space  $^1\text{H}$ - $^{19}\text{F}$  coupling concerned 6 $\beta$ -fluorosteroids, where the proximity of the C-6 $\beta$  fluorine and the C-19 methyl group resulted in  $^5\text{J}(^1\text{H}$ - $^{19}\text{F})$  values of 1.9-4.3 Hz. A  $^4\text{J}(^{13}\text{C}$ - $^{19}\text{F})$  value of 10 Hz for a 6 $\beta$ -fluorosteroid has been reported<sup>4</sup>, but without comment.

In the present study, the fluorosteroids **2-5**, prepared from epoxide **1** by standard procedures<sup>6</sup> have been examined by  $^1\text{H}$ - and  $^{13}\text{C}$ mr.<sup>7</sup> The anticipated<sup>5</sup> through space  $^1\text{H}$ - $^{19}\text{F}$  coupling of the C-19 methyl hydrogens to the 6 $\beta$  fluorine was observed in **2-4** by  $^1\text{H}$ mr (see Table 1).

Table 1.  $^1\text{H}$ - $^{19}\text{F}$  and  $^{13}\text{C}$ - $^{19}\text{F}$  couplings in **2-5**.

Compound	$\text{J}(\text{X}-^{19}\text{F}), \text{Hz}$										
	C-4H	C-6H	C-19H	C-3	C-4	C-5	C-6	C-7	C-8	C-10	C-19
2	--	50	4.4	0	<1	19.3	178	20	<1	1.8	9.2
3	--	49	3.6	0	<1	23	179	27	<1	1.8	9.2
4	5	50	2.2	<1	9.2	12.0	167	23	<1	2.0	<1
5	<1	49	0	<1	14.7	11.0	185	18.4	11.0	2.7	0



The assignments of the  $^{13}\text{Cmr}$  spectra of  $\lambda$ - $\xi$  were made by comparisons with published data<sup>4,8</sup>, and are shown in Table 2. The values of  $J(^{13}\text{C}-^{19}\text{F})$  for coupling to C-5, -6, and -7, (Table 1) are as expected<sup>4</sup>. Gamma couplings of ca. 2 Hz to C-10 of  $\lambda$ - $\xi$  were observed: the coupling to C-4 of  $\lambda$  and  $\xi$  is a result of the presence of the  $\Delta^4$  system, and the coupling to C-8 of  $\xi$  a result of the planarity of the F-C6-C7-C8 system and an F-C8 dihedral angle of  $180^\circ$ .

The striking feature of the  $^{13}\text{Cmr}$  spectra of  $\lambda$  and  $\xi$  was the presence of a significant  $\delta$  coupling to C-19. The magnitude of this coupling suggests the presence of a through-space contribution, an interpretation strengthened by the corresponding value of  $^4J \approx$  zero noted for  $\lambda$  and  $\xi$ . The internuclear C19-F distance, estimated from Dreiding models of  $\lambda$  and  $\xi$  is 2.5 Å; the corresponding distance in  $\lambda$  is 3.0 Å. The former distance is well within the limit established for  $^1\text{H}-^{19}\text{F}$  through space interactions, whereas the latter is close to the limiting distance over which such interactions occur<sup>9</sup>.

Table 2.  $^{13}\text{Cmr}$  resonances of  $\lambda$ - $\xi$ , ppm from TMS = 0

Carbon	Compound			
	$\lambda^*$	$\xi$	$\lambda$	$\xi$
1	30.8	33.4	37.0	36.3
2	31.3	37.8	34.2	33.7
3	65.0	211.6	199.6	198.4
4	39.8	48.9	128.8	120.0
5	72.5	76.3	161.2	165.3
6	95.1	94.8	93.1	88.0
7	30.5	30.8	36.2	37.2
8	29.8	30.1	29.8	33.1
9	44.2	45.3	53.4	53.7
10	37.7	38.8	37.9	39.2
11	19.8	20.5	20.3	20.2
12	31.3	31.5	31.3	31.1
13	47.2	47.8	47.7	47.5
14	50.2	50.9	50.9	50.5
15	21.2	21.7	21.7	21.7
16	35.2	35.8	35.7	35.6
17	219.5	220.7	219.8	219.5
18	13.4	13.8	13.8	13.7
19	15.4	15.5	18.5	18.1

\* solvent DMSO  $d_6$

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