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## Structure Reports

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**(2E)-1-(2,6-Dichloro-3-fluorophenyl)-3-(4-fluorophenyl)prop-2-en-1-one**Richard Betz,<sup>a\*</sup> Thomas Gerber,<sup>a</sup> Eric Hosten,<sup>a</sup> Aletti S. Praveen,<sup>b</sup> Hemmige S. Yathirajan<sup>b</sup> and Badiadka Narayana<sup>c</sup>

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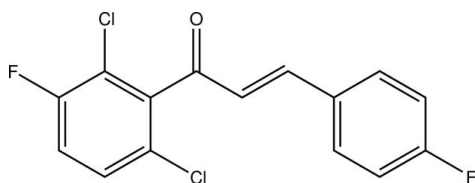
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Key indicators: single-crystal X-ray study;  $T = 200$  K; mean  $\sigma(\text{C}-\text{C}) = 0.002$  Å; disorder in main residue;  $R$  factor = 0.035;  $wR$  factor = 0.092; data-to-parameter ratio = 17.4.

In the title compound,  $\text{C}_{15}\text{H}_8\text{Cl}_2\text{F}_2\text{O}$ , the  $\text{C}=\text{C}$  double bond is in the  $E$  configuration. In the crystal,  $\text{C}-\text{H}\cdots\text{O}$  hydrogen bonds connect the molecules into chains along the  $c$  axis. A  $\pi-\pi$  interaction of 3.628 (1) Å is also observed between two polyhalogenated benzene rings. The dichlorosubstituted ring exhibits partial disorder over two sets of sites, with site-occupancy factors of 0.573 (3) and 0.427 (3).

## Related literature

For pharmaceutical background to chalcones, see: Nielsen *et al.* (2004); Modzelewska *et al.* (2006); Nowakowska (2007); Ni *et al.* (2004). For related structures, see: Yathirajan *et al.* (2006, 2007); Betz *et al.* (2011). For graph-set analysis of hydrogen bonds, see: Etter *et al.* (1990); Bernstein *et al.* (1995).



## Experimental

## Crystal data

$\text{C}_{15}\text{H}_8\text{Cl}_2\text{F}_2\text{O}$   
 $M_r = 313.11$   
Monoclinic,  $P2_1/c$   
 $a = 12.2311$  (3) Å  
 $b = 10.3115$  (2) Å

$c = 11.2468$  (3) Å  
 $\beta = 108.935$  (1)°  
 $V = 1341.70$  (6) Å<sup>3</sup>  
 $Z = 4$   
Mo  $K\alpha$  radiation

$\mu = 0.50$  mm<sup>-1</sup>  
 $T = 200$  K

0.48 × 0.34 × 0.27 mm

## Data collection

Bruker APEXII CCD diffractometer  
Absorption correction: multi-scan (SADABS; Bruker, 2008)  
 $T_{\min} = 0.825$ ,  $T_{\max} = 1.000$

12634 measured reflections  
3328 independent reflections  
2724 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.015$

## Refinement

$R[F^2 > 2\sigma(F^2)] = 0.035$   
 $wR(F^2) = 0.092$   
 $S = 1.06$   
3328 reflections

191 parameters  
H-atom parameters constrained  
 $\Delta\rho_{\text{max}} = 0.24$  e Å<sup>-3</sup>  
 $\Delta\rho_{\text{min}} = -0.25$  e Å<sup>-3</sup>

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

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{C}1-\text{H}1\cdots\text{O}1^i$	0.95	2.51	3.3982 (16)	156
$\text{C}12-\text{H}12\cdots\text{O}1^i$	0.95	2.55	3.4266 (19)	153

Symmetry code: (i)  $x, -y + \frac{1}{2}, z + \frac{1}{2}$ 

Data collection: APEX2 (Bruker, 2010); cell refinement: SAINT (Bruker, 2010); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: ORTEP-3 (Farrugia, 1997) and Mercury (Macrae *et al.*, 2008); software used to prepare material for publication: SHELXL97 and PLATON (Spek, 2009).

ASP thanks the University of Mysore for research facilities.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: WN2465).

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## supporting information

*Acta Cryst.* (2012). E68, o512 [doi:10.1107/S1600536812002589]

**(2E)-1-(2,6-Dichloro-3-fluorophenyl)-3-(4-fluorophenyl)prop-2-en-1-one**

**Richard Betz, Thomas Gerber, Eric Hosten, Aletti S. Praveen, Hemmige S. Yathirajan and Badiadka Narayana**

**S1. Comment**

Chalcones constitute an important group of natural products and some of them possess a wide range of biological activities, such as antibacterial (Nielsen *et al.*, 2004) and anticancer (Modzelewska *et al.*, 2006). A review of anti-infective and anti-inflammatory chalcones (Nowakowska, 2007) and recent advances in therapeutic chalcones have been reported (Ni *et al.*, 2004). Related crystal structures of some chalcones, *e.g.* 1-(2,4-dichloro-5-fluorophenyl)-3-(3,4-dimethoxyphenyl)prop-2-en-1-one (Yathirajan *et al.*, 2006) and (2E)-1-(2,4-dichlorophenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one (Yathirajan *et al.*, 2007) have been reported. As part of our ongoing studies on chalcones (Betz *et al.*, 2011), the title compound was synthesized and its crystal structure is reported here.

The C=C double bond of the Michael system is in the *E* configuration. The fluorine atom on the polyhalogenated phenyl ring, together with its attached carbon atom is disordered over two sites, as are the ring CH *meta* to it. The site occupancy factors refined to 0.573 (3) and 0.427 (3). The least-squares planes defined by the carbon atoms of the two rings make a dihedral angle of 82.37 (8)° (Fig. 1).

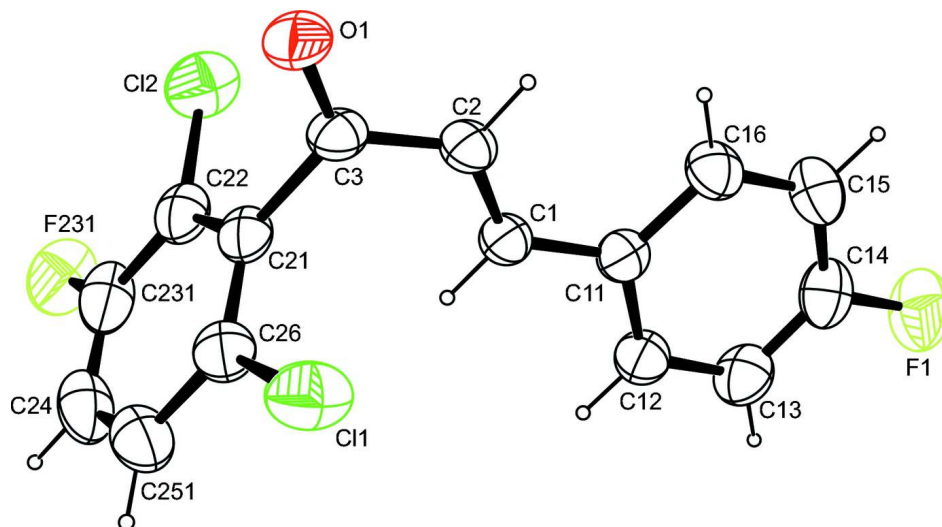
In the crystal structure, intermolecular C—H···O hydrogen bonds are observed (Table 1 and Fig. 2), forming a 6-membered chelate ring. In terms of graph-set analysis (Etter *et al.*, 1990; Bernstein *et al.*, 1995), the descriptor for this pattern is  $C^1_1(5)C^1_1(7)$  on the unitary level. Molecules are connected into chains along the crystallographic *c* axis. A  $\pi$ - $\pi$  interaction of 3.628 (1) Å is also observed between two polyhalogenated phenyl rings. The packing of the title compound in the crystal structure is shown in Fig. 3.

**S2. Experimental**

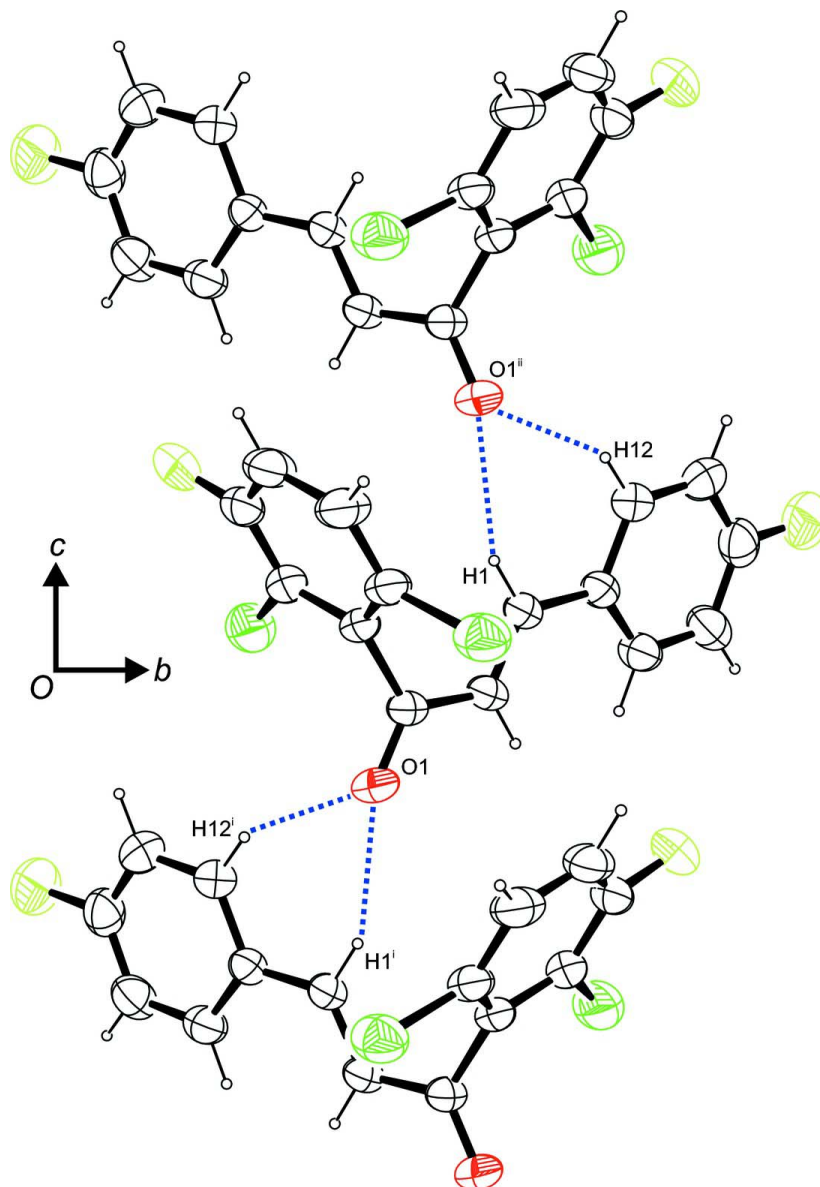
To a stirred solution of 1-(2,6-dichloro-3-fluorophenyl)ethanone (1 g, 4.8 mmol) and 4-fluorobenzaldehyde (0.59 g, 4.8 mmol) in ethanol (10 ml), powdered KOH (0.4 g 7.2 mmol) was added at 273 K. The reaction mixture was stirred at room temperature for 1 h. After completion of the reaction, the reaction mixture was poured into ice cold water and acidified with 1.5 N HCl (pH ~3). The resulting precipitate was filtered and dried to afford 1.3 g of the title compound as a pale yellow solid in 86% yield. Single crystals suitable for the diffraction study were grown from a mixture of toluene:acetone (*v:v* = 1:1) by slow evaporation at room temperature (m.p.: 421–424 K).

**S3. Refinement**

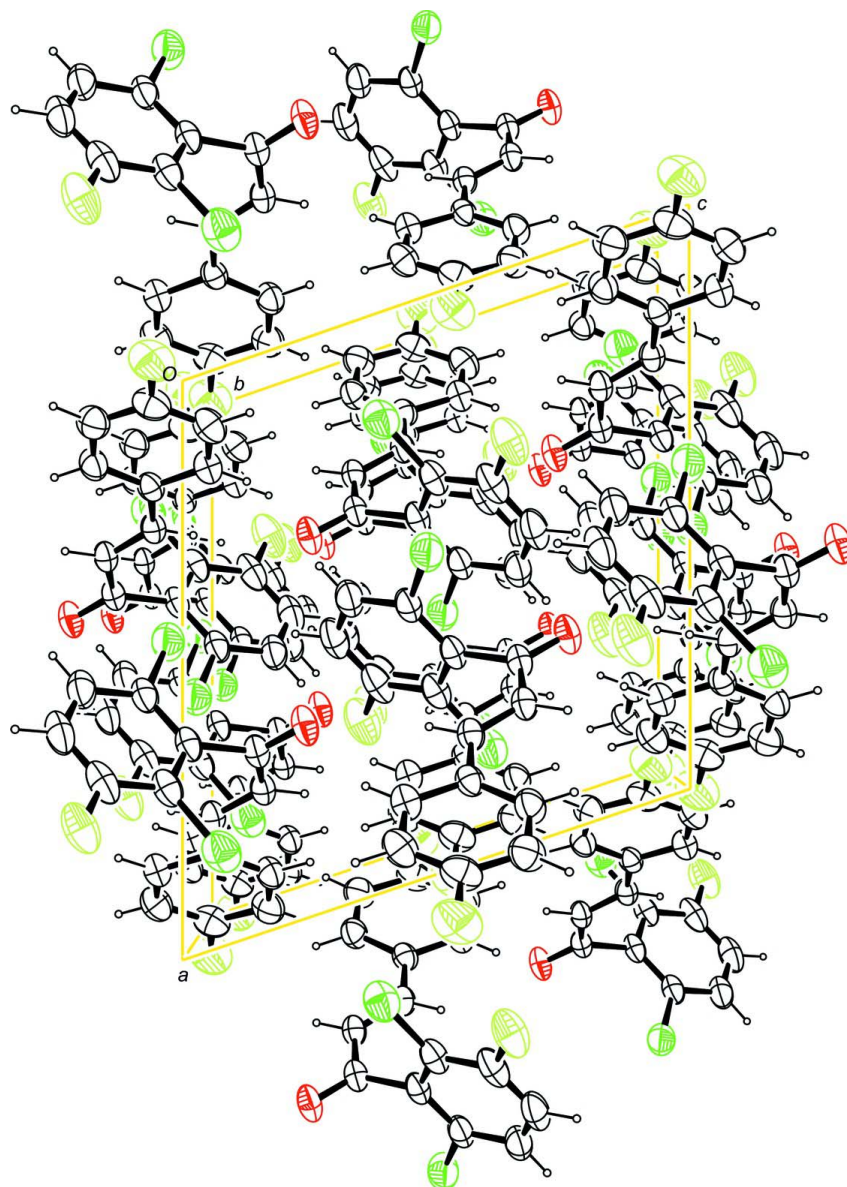
H atoms were placed in calculated positions (C—H = 0.95 Å) and were included in the refinement in the riding model approximation, with  $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$ .

**Figure 1**

The molecular structure of the title compound, with anisotropic displacement ellipsoids drawn at the 50% probability level. For clarity, only the major component of the disorder model is depicted.

**Figure 2**

Intermolecular contacts, viewed along  $[-1\ 0\ 0]$ . For clarity, only the major component of the disorder model is depicted. Symmetry operators: <sup>i</sup> $x, -y + 1/2, z - 1/2$ ; <sup>ii</sup> $x, -y + 1/2, z + 1/2$ . Dashed lines indicate hydrogen bonds.



**Figure 3**

Molecular packing of the title compound, viewed along [0 1 0]. Anisotropic displacement ellipsoids are drawn at the 50% probability level. For clarity, only the major component of the disorder model is depicted.

**(2E)-1-(2,6-Dichloro-3-fluorophenyl)-3-(4-fluorophenyl)prop-2-en-1-one**

*Crystal data*

$C_{15}H_8Cl_2F_2O$

$M_r = 313.11$

Monoclinic,  $P2_1/c$

Hall symbol:  $-P 2_1/c$

$a = 12.2311 (3) \text{ \AA}$

$b = 10.3115 (2) \text{ \AA}$

$c = 11.2468 (3) \text{ \AA}$

$\beta = 108.935 (1)^\circ$

$V = 1341.70 (6) \text{ \AA}^3$

$Z = 4$

$F(000) = 632$

$D_x = 1.550 \text{ Mg m}^{-3}$

Melting point = 421–424 K

Mo  $K\alpha$  radiation,  $\lambda = 0.71073 \text{ \AA}$

Cell parameters from 7019 reflections

$\theta = 2.7\text{--}28.2^\circ$

$\mu = 0.50 \text{ mm}^{-1}$   
 $T = 200 \text{ K}$

Block, colourless  
 $0.48 \times 0.34 \times 0.27 \text{ mm}$

*Data collection*

Bruker APEXII CCD  
 diffractometer  
 Radiation source: fine-focus sealed tube  
 Graphite monochromator  
 $\varphi$  and  $\omega$  scans  
 Absorption correction: multi-scan  
 (SADABS; Bruker, 2008)  
 $T_{\min} = 0.825$ ,  $T_{\max} = 1.000$

12634 measured reflections  
 3328 independent reflections  
 2724 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.015$   
 $\theta_{\max} = 28.3^\circ$ ,  $\theta_{\min} = 2.7^\circ$   
 $h = -16 \rightarrow 16$   
 $k = -12 \rightarrow 13$   
 $l = -13 \rightarrow 14$

*Refinement*

Refinement on  $F^2$   
 Least-squares matrix: full  
 $R[F^2 > 2\sigma(F^2)] = 0.035$   
 $wR(F^2) = 0.092$   
 $S = 1.06$   
 3328 reflections  
 191 parameters  
 0 restraints  
 Primary atom site location: structure-invariant  
 direct methods

Secondary atom site location: difference Fourier  
 map  
 Hydrogen site location: inferred from  
 neighbouring sites  
 H-atom parameters constrained  
 $w = 1/[\sigma^2(F_o^2) + (0.0346P)^2 + 0.5003P]$   
 where  $P = (F_o^2 + 2F_c^2)/3$   
 $(\Delta/\sigma)_{\max} < 0.001$   
 $\Delta\rho_{\max} = 0.24 \text{ e } \text{\AA}^{-3}$   
 $\Delta\rho_{\min} = -0.25 \text{ e } \text{\AA}^{-3}$

*Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters ( $\text{\AA}^2$ )*

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$	Occ. (<1)
C11	0.55532 (4)	0.18042 (5)	0.01581 (4)	0.05973 (14)	
C12	0.18584 (5)	0.50107 (5)	-0.10590 (5)	0.06391 (15)	
F1	-0.02753 (11)	-0.32385 (11)	-0.03660 (13)	0.0767 (4)	
O1	0.33883 (11)	0.32276 (11)	-0.25385 (9)	0.0498 (3)	
C1	0.23362 (12)	0.10980 (13)	-0.06621 (12)	0.0366 (3)	
H1	0.2685	0.1527	0.0117	0.044*	
C2	0.25296 (12)	0.16144 (14)	-0.16699 (12)	0.0378 (3)	
H2	0.2198	0.1204	-0.2462	0.045*	
C3	0.32232 (13)	0.27733 (14)	-0.16076 (12)	0.0380 (3)	
C11	0.16497 (12)	-0.00496 (13)	-0.06298 (13)	0.0362 (3)	
C12	0.16714 (14)	-0.05235 (15)	0.05394 (14)	0.0435 (3)	
H12	0.2129	-0.0095	0.1282	0.052*	
C13	0.10377 (16)	-0.16073 (16)	0.06360 (16)	0.0522 (4)	
H13	0.1068	-0.1939	0.1434	0.063*	
C14	0.03673 (15)	-0.21884 (16)	-0.04488 (18)	0.0522 (4)	
C15	0.03053 (15)	-0.17524 (16)	-0.16235 (17)	0.0515 (4)	
H15	-0.0173	-0.2177	-0.2358	0.062*	
C16	0.09524 (14)	-0.06845 (15)	-0.17128 (14)	0.0449 (3)	
H16	0.0925	-0.0375	-0.2518	0.054*	
C21	0.37356 (13)	0.34472 (13)	-0.03476 (12)	0.0388 (3)	
C22	0.31594 (15)	0.44789 (15)	-0.00230 (14)	0.0448 (3)	
C24	0.46503 (18)	0.47039 (18)	0.19724 (16)	0.0586 (5)	
H24	0.4956	0.5126	0.2762	0.070*	

C26	0.47854 (14)	0.30709 (15)	0.05110 (13)	0.0434 (3)	
C231	0.36195 (18)	0.50942 (16)	0.11341 (16)	0.0545 (5)	0.573 (3)
F231	0.3031 (2)	0.60294 (18)	0.14524 (19)	0.0723 (7)	0.573 (3)
C251	0.52385 (16)	0.36950 (18)	0.16607 (15)	0.0541 (5)	0.573 (3)
H251	0.5959	0.3423	0.2235	0.065*	0.573 (3)
C232	0.36195 (18)	0.50942 (16)	0.11341 (16)	0.0545 (5)	0.427 (3)
H252	0.3212	0.5795	0.1344	0.065*	0.427 (3)
C252	0.52385 (16)	0.36950 (18)	0.16607 (15)	0.0541 (5)	0.427 (3)
F232	0.6202 (2)	0.3318 (3)	0.2413 (2)	0.0763 (10)	0.427 (3)

*Atomic displacement parameters (Å<sup>2</sup>)*

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
C11	0.0634 (3)	0.0683 (3)	0.0456 (2)	0.0139 (2)	0.01502 (18)	0.00247 (19)
C12	0.0770 (3)	0.0586 (3)	0.0613 (3)	0.0189 (2)	0.0295 (2)	0.0032 (2)
F1	0.0894 (8)	0.0584 (7)	0.0933 (9)	-0.0277 (6)	0.0450 (7)	-0.0037 (6)
O1	0.0714 (7)	0.0513 (6)	0.0305 (5)	-0.0051 (5)	0.0216 (5)	0.0038 (4)
C1	0.0447 (7)	0.0352 (7)	0.0304 (6)	0.0025 (6)	0.0129 (5)	-0.0027 (5)
C2	0.0467 (7)	0.0392 (7)	0.0282 (6)	0.0018 (6)	0.0131 (5)	-0.0042 (5)
C3	0.0492 (8)	0.0386 (7)	0.0281 (6)	0.0042 (6)	0.0148 (5)	0.0012 (5)
C11	0.0419 (7)	0.0353 (7)	0.0345 (6)	0.0049 (5)	0.0165 (6)	-0.0011 (5)
C12	0.0533 (8)	0.0427 (8)	0.0367 (7)	0.0006 (7)	0.0178 (6)	-0.0004 (6)
C13	0.0643 (10)	0.0490 (9)	0.0503 (9)	-0.0021 (8)	0.0282 (8)	0.0066 (7)
C14	0.0563 (9)	0.0412 (8)	0.0672 (10)	-0.0065 (7)	0.0313 (8)	-0.0042 (7)
C15	0.0550 (9)	0.0502 (9)	0.0529 (9)	-0.0085 (7)	0.0226 (7)	-0.0146 (7)
C16	0.0520 (8)	0.0474 (8)	0.0379 (7)	-0.0026 (7)	0.0182 (6)	-0.0062 (6)
C21	0.0541 (8)	0.0370 (7)	0.0301 (6)	-0.0070 (6)	0.0202 (6)	0.0002 (5)
C22	0.0640 (9)	0.0382 (7)	0.0395 (7)	-0.0061 (7)	0.0267 (7)	-0.0007 (6)
C24	0.0836 (13)	0.0601 (10)	0.0386 (8)	-0.0307 (10)	0.0289 (9)	-0.0147 (7)
C26	0.0552 (9)	0.0471 (8)	0.0319 (7)	-0.0070 (7)	0.0198 (6)	0.0007 (6)
C231	0.0868 (13)	0.0428 (8)	0.0477 (9)	-0.0151 (8)	0.0407 (9)	-0.0105 (7)
F231	0.1165 (18)	0.0509 (11)	0.0629 (12)	0.0040 (10)	0.0478 (12)	-0.0140 (8)
C251	0.0628 (10)	0.0656 (11)	0.0349 (8)	-0.0214 (8)	0.0175 (7)	-0.0026 (7)
C232	0.0868 (13)	0.0428 (8)	0.0477 (9)	-0.0151 (8)	0.0407 (9)	-0.0105 (7)
C252	0.0628 (10)	0.0656 (11)	0.0349 (8)	-0.0214 (8)	0.0175 (7)	-0.0026 (7)
F232	0.0659 (17)	0.113 (2)	0.0383 (13)	-0.0239 (16)	0.0011 (11)	-0.0047 (13)

*Geometric parameters (Å, °)*

C11—C26	1.7284 (16)	C13—H13	0.9500
C12—C22	1.7284 (18)	C14—C15	1.374 (2)
F1—C14	1.3588 (18)	C15—C16	1.379 (2)
O1—C3	1.2220 (16)	C15—H15	0.9500
C1—C2	1.3410 (19)	C16—H16	0.9500
C1—C11	1.4582 (19)	C21—C26	1.388 (2)
C1—H1	0.9500	C21—C22	1.389 (2)
C2—C3	1.454 (2)	C22—C231	1.392 (2)
C2—H2	0.9500	C24—C231	1.367 (3)

C3—C21	1.5190 (19)	C24—C251	1.373 (3)
C11—C12	1.3950 (19)	C24—H24	0.9500
C11—C16	1.402 (2)	C26—C251	1.389 (2)
C12—C13	1.384 (2)	C231—F231	1.321 (2)
C12—H12	0.9500	C251—H251	0.9500
C13—C14	1.368 (3)		
C2—C1—C11	127.18 (13)	C16—C15—H15	120.7
C2—C1—H1	116.4	C15—C16—C11	120.76 (14)
C11—C1—H1	116.4	C15—C16—H16	119.6
C1—C2—C3	123.09 (13)	C11—C16—H16	119.6
C1—C2—H2	118.5	C26—C21—C22	117.71 (13)
C3—C2—H2	118.5	C26—C21—C3	121.98 (13)
O1—C3—C2	121.99 (13)	C22—C21—C3	120.31 (14)
O1—C3—C21	119.41 (13)	C21—C22—C231	120.61 (16)
C2—C3—C21	118.59 (11)	C21—C22—C12	120.04 (12)
C12—C11—C16	118.39 (13)	C231—C22—C12	119.35 (13)
C12—C11—C1	118.21 (13)	C231—C24—C251	119.29 (15)
C16—C11—C1	123.38 (13)	C231—C24—H24	120.4
C13—C12—C11	121.12 (14)	C251—C24—H24	120.4
C13—C12—H12	119.4	C21—C26—C251	121.18 (15)
C11—C12—H12	119.4	C21—C26—C11	120.02 (11)
C14—C13—C12	118.20 (15)	C251—C26—C11	118.79 (14)
C14—C13—H13	120.9	F231—C231—C24	119.34 (17)
C12—C13—H13	120.9	F231—C231—C22	119.7 (2)
F1—C14—C13	118.73 (16)	C24—C231—C22	120.88 (16)
F1—C14—C15	118.28 (16)	C24—C251—C26	120.32 (17)
C13—C14—C15	122.98 (15)	C24—C251—H251	119.8
C14—C15—C16	118.52 (15)	C26—C251—H251	119.8
C14—C15—H15	120.7		
C11—C1—C2—C3	179.51 (13)	C2—C3—C21—C22	-94.75 (16)
C1—C2—C3—O1	180.00 (14)	C26—C21—C22—C231	-0.9 (2)
C1—C2—C3—C21	-1.2 (2)	C3—C21—C22—C231	179.49 (13)
C2—C1—C11—C12	172.16 (14)	C26—C21—C22—C12	179.08 (11)
C2—C1—C11—C16	-9.1 (2)	C3—C21—C22—C12	-0.51 (18)
C16—C11—C12—C13	1.1 (2)	C22—C21—C26—C251	0.7 (2)
C1—C11—C12—C13	179.87 (14)	C3—C21—C26—C251	-179.74 (13)
C11—C12—C13—C14	-1.4 (2)	C22—C21—C26—C11	-179.36 (11)
C12—C13—C14—F1	-178.78 (15)	C3—C21—C26—C11	0.22 (19)
C12—C13—C14—C15	0.7 (3)	C251—C24—C231—F231	177.32 (16)
F1—C14—C15—C16	179.77 (15)	C251—C24—C231—C22	0.3 (2)
C13—C14—C15—C16	0.3 (3)	C21—C22—C231—F231	-176.54 (16)
C14—C15—C16—C11	-0.6 (2)	C12—C22—C231—F231	3.5 (2)
C12—C11—C16—C15	-0.1 (2)	C21—C22—C231—C24	0.4 (2)
C1—C11—C16—C15	-178.78 (14)	C12—C22—C231—C24	-179.57 (13)
O1—C3—C21—C26	-95.46 (17)	C231—C24—C251—C26	-0.6 (2)
C2—C3—C21—C26	85.68 (17)	C21—C26—C251—C24	0.1 (2)



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O1—C3—C21—C22	84.11 (18)	C11—C26—C251—C24	-179.89 (12)
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*Hydrogen-bond geometry (Å, °)*

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<i>D</i> —H $\cdots$ <i>A</i>	<i>D</i> —H	H $\cdots$ <i>A</i>	<i>D</i> $\cdots$ <i>A</i>	<i>D</i> —H $\cdots$ <i>A</i>
C1—H1 $\cdots$ O1 <sup>i</sup>	0.95	2.51	3.3982 (16)	156
C12—H12 $\cdots$ O1 <sup>i</sup>	0.95	2.55	3.4266 (19)	153

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Symmetry code: (i)  $x, -y+1/2, z+1/2$ .