organic compounds

5-Dimethylamino-N,N-dimethyl-2-nitro-benzamide

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In the title compound, $C_{11}H_{15}N_3O_3$, one of the methyl groups attached to the benzamide unit is slightly twisted with a C—N—C—C torsion angle of 4.04 (13)°. The crystal packing is stabilized by weak intermolecular C—H⋯O hydrogen bonds together with a weak C—H⋯π interaction.

Related literature

For nitroaniline mustards, see: Brian *et al.* (1992); Rauth, (1984). For *N*-[(*N,N*-dimethylamino)ethyl]carboxamide derivatives, see: Alston *et al.* (1983); Denny & Wilson (1986); Palmer *et al.* (1990). For bond-length data, see: Allen *et al.* (1987). For the stability of the temperature controller used in the data collection, see: Cosier & Glazer (1986).
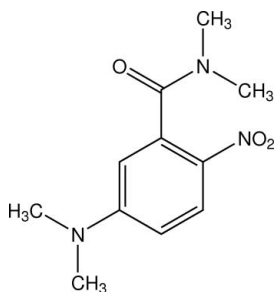
Experimental

Crystal data

$C_{11}H_{15}N_3O_3$	$a = 7.8581$ (2) Å
$M_r = 237.26$	$b = 7.2921$ (2) Å
Monoclinic, $P2_1$	$c = 10.5183$ (3) Å

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$\beta = 104.663$ (1)°	$\mu = 0.10$ mm^{-1}
$V = 583.09$ (3) Å^3	$T = 100$ K
$Z = 2$	$0.52 \times 0.45 \times 0.33$ mm
Mo $K\alpha$ radiation	

Data collection

Bruker SMART APEXII CCD area-detector diffractometer	16075 measured reflections
Absorption correction: multi-scan (*SADABS*; Bruker, 2005)	3233 independent reflections
$T_{min} = 0.949$, $T_{max} = 0.965$	3002 reflections with $I > 2\sigma(I)$
	$R_{int} = 0.027$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.038$	1 restraint
$wR(F^2) = 0.103$	H-atom parameters constrained
$S = 1.08$	$\Delta\rho_{max} = 0.64$ e Å^{-3}
3233 reflections	$\Delta\rho_{min} = -0.19$ e Å^{-3}
158 parameters	

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

D—H⋯A	D—H	H⋯A	D⋯A	D—H⋯A
C8—H8A⋯O3[i]	0.96	2.52	3.1751 (16)	126
C10—H10A⋯O2[ii]	0.96	2.59	3.5413 (14)	173
C10—H10B⋯O1[iii]	0.96	2.49	3.3920 (13)	156
C4—H4A⋯Cg1[iv]	0.93	2.81	3.3991 (11)	122

Symmetry codes: (i) $-x+1, y+\frac{1}{2}, -z+1$; (ii) $x-1, y, z$; (iii) $-x, y-\frac{1}{2}, -z$; (iv) $-x+1, y-\frac{1}{2}, -z$. Cg1 is the centroid of the C1–C6 ring.

Data collection: *APEX2* (Bruker, 2005); cell refinement: *SAINT* (Bruker, 2005); data reduction: *SAINT*; program(s) used to solve structure: *SHELXTL* (Sheldrick, 2008); program(s) used to refine structure: *SHELXTL*; molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXTL* and *PLATON* (Spek, 2009).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: DN2453).

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supplementary materials

5-Dimethylamino-*N,N*-dimethyl-2-nitrobenzamide

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Comment

Nitroaniline mustards are potential hypoxia-selective cytotoxic agents (Rauth, 1984) possessing reductive metabolism which activates the mustard nitrogen by converting the electron-withdrawing nitro group to an electron-donating hydroxylamine or amine (Brian *et al.*, 1992). *N*-[(*N,N*-dimethylamino)ethyl]carboxamide derivatives proved to have excellent aqueous solubility and improved cytotoxic potency (Denny *et al.*, 1986), but their reduction potentials, while higher than the non carboxamide compounds, were still low and have limited selectivity for hypoxic cells. (Palmer *et al.*, 1990; Alston *et al.*, 1983). These properties prompted us to synthesize the title compound.

In the asymmetric unit of (I), (Fig 1), one of the methyl group attached to the benzamide unit is slightly twisted as indicated by the torsion angle of C9–N1–C7–C6=4.04 (13)°. The benzene ring is essentially planar with the maximum deviation from planarity of 0.0117 (10)Å for the atom C5. The bond lengths and bond angles are normal (Allen *et al.*, 1987).

The crystal packing is stabilized by intermolecular weak C—H···O hydrogen bonds together with weak C—H···π interaction (Table 1, Fig. 2).

Experimental

5-Fluoro-2-nitrobenzoic acid (5 g, 0.0270 mol) was heated with 40% aqueous dimethyl amine solution (50 ml) at 100°C for 18 hrs. Reaction mixture was concentrated through rotovap using high vacuum pump to afford 5-(dimethylamino)-2-nitrobenzoic acid as yellow crystalline solid (4.5 g). To a solution of 5-(dimethylamino)-2-nitrobenzoic acid (4 g, 0.019 mol) in DMF(40 ml) was added 1-(3-Dimethylaminopropyl)-3-ethyl carbodiimide hydrochloride (5.4 g, 0.0285 mol), 1-hydroxy benzotriazole (0.25 g, 0.0019 mol) and *N,N*-diisopropyl ethylamine (4.9 g, 0.038 mol) and the reaction mixture was stirred at room temperature for 18 hrs. Reaction mixture was portioned between 10% sodium bicarbonate solution and ethyl acetate (25 ml). The organic layer was washed with brine and dried over anhydrous sodium sulfate and concentrated through rotovap. The concentrated product were purified by column chromatography (60–120 mesh silica gel) using hexane and ethyl acetate as eluent to afford 5-(dimethylamino)-N, *N*-dimethyl-2-nitrobenzamide (3 g, 66.6%) as yellow crystalline solid. *M*.p was found to be 458–461 K.

Refinement

H atoms were positioned geometrically [C–H = 0.93–0.96 Å] and refined using a riding model, with $U_{iso}(H) = 1.2U_{eq}(C)$ and $1.5U_{eq}$(methyl C). A rotating–group model was used for the methyl groups. Since there is no anamolous scattering effects, 2707 Friedel pairs were merged before final refinement.

The largest residual electron densities are located in the middle of some C-C bonds within the phenyl ring.
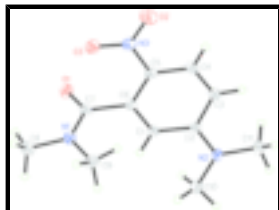
supplementary materials

Figures

Fig. 1. The molecular structure of the title compound, showing 50% probability displacement ellipsoids and the atom numbering scheme.
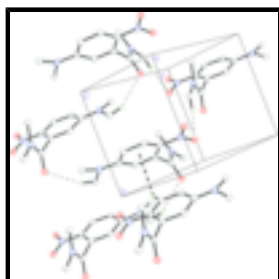

Fig. 2. The crystal packing of the title compound, viewed along the *a* axis. Dashed lines indicate the hydrogen bonding and C-H···π interactions.

(I)

Crystal data

$C_{11}H_{15}N_3O_3$	$F_{000} = 252$
$M_r = 237.26$	$D_x = 1.351$ Mg m^{-3}
Monoclinic, $P2_1$	Mo $K\alpha$ radiation $\lambda = 0.71073$ Å
Hall symbol: P 2yb	Cell parameters from 9204 reflections
$a = 7.8581$ (2) Å	$\theta = 2.7$–40.5º
$b = 7.2921$ (2) Å	$\mu = 0.10$ mm^{-1}
$c = 10.5183$ (3) Å	$T = 100$ K
$\beta = 104.6630$ (10)º	Block, yellow
$V = 583.09$ (3) Å^3	$0.52 \times 0.45 \times 0.33$ mm
$Z = 2$	

Data collection

Bruker SMART APEXII CCD area-detector diffractometer	3233 independent reflections
Radiation source: fine-focus sealed tube	3002 reflections with $I > 2\sigma(I)$
Monochromator: graphite	$R_{int} = 0.027$
$T = 100$ K	$\theta_{max} = 37.5$º
φ and ω scans	$\theta_{min} = 2.7$º
Absorption correction: multi-scan (SADABS; Bruker, 2005)	$h = -13 \rightarrow 13$
$T_{min} = 0.949$, $T_{max} = 0.965$	$k = -12 \rightarrow 12$
16075 measured reflections	$l = -18 \rightarrow 18$

Refinement

Refinement on F^2	Secondary atom site location: difference Fourier map
Least-squares matrix: full	Hydrogen site location: inferred from neighbouring sites
$R[F^2 > 2\sigma(F^2)] = 0.038$	H-atom parameters constrained
$wR(F^2) = 0.103$	$w = 1/[\sigma^2(F_o^2) + (0.0716P)^2 + 0.0071P]$ where $P = (F_o^2 + 2F_c^2)/3$
$S = 1.08$	$(\Delta/\sigma)_{max} < 0.001$
3233 reflections	$\Delta\rho_{max} = 0.64$ e Å^{-3}
158 parameters	$\Delta\rho_{min} = -0.19$ e Å^{-3}
1 restraint	Extinction correction: none
Primary atom site location: structure-invariant direct methods	

Special details

Experimental. The crystal was placed in the cold stream of an Oxford Cyrosystems Cobra open-flow nitrogen cryostat (Cosier & Glazer, 1986) operating at 100.0 (1) K.

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

Refinement. Refinement of F^2 against ALL reflections. The weighted R-factor wR and goodness of fit S are based on F^2, conventional R-factors R are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R-factors(gt) *etc*. and is not relevant to the choice of reflections for refinement. R-factors based on F^2 are statistically about twice as large as those based on F, and R- factors based on ALL data will be even larger.

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

	x	y	z	$U_{iso}*/U_{eq}$
O1	0.42663 (10)	1.04274 (10)	0.31204 (7)	0.01969 (13)
O2	0.81992 (10)	0.62755 (17)	0.20077 (10)	0.0334 (2)
O3	0.71314 (10)	0.76718 (13)	0.34531 (8)	0.02322 (15)
N1	0.32548 (10)	0.78907 (13)	0.39646 (8)	0.01811 (14)
N2	0.03825 (10)	0.70383 (12)	−0.13123 (8)	0.01594 (13)
N3	0.69532 (10)	0.69824 (13)	0.23538 (9)	0.01899 (15)
C1	0.21826 (10)	0.78067 (12)	0.08485 (8)	0.01443 (13)
H1A	0.1210	0.8309	0.1072	0.017*
C2	0.19805 (10)	0.70835 (12)	−0.04364 (9)	0.01396 (13)
C3	0.35014 (11)	0.63797 (13)	−0.07614 (9)	0.01687 (15)
H3A	0.3427	0.5950	−0.1606	0.020*
C4	0.50889 (12)	0.63311 (14)	0.01717 (10)	0.01789 (16)
H4A	0.6070	0.5837	−0.0045	0.021*
C5	0.52463 (11)	0.70133 (13)	0.14373 (9)	0.01538 (14)
C6	0.37880 (10)	0.77846 (12)	0.17780 (8)	0.01392 (13)

C7	0.38381 (11)	0.87931 (13)	0.30423 (8)	0.01530 (14)
C8	0.30516 (14)	0.88622 (18)	0.51258 (10)	0.02438 (19)
H8A	0.3409	1.0116	0.5088	0.037*
H8B	0.3770	0.8290	0.5899	0.037*
H8C	0.1842	0.8822	0.5156	0.037*
C9	0.26858 (13)	0.59813 (16)	0.38621 (11)	0.02241 (18)
H9A	0.3149	0.5368	0.3215	0.034*
H9B	0.1424	0.5930	0.3606	0.034*
H9C	0.3109	0.5389	0.4698	0.034*
C10	−0.11334 (12)	0.79019 (15)	−0.10016 (10)	0.02084 (17)
H10A	−0.1220	0.7503	−0.0151	0.031*
H10B	−0.2183	0.7562	−0.1650	0.031*
H10C	−0.0997	0.9210	−0.0999	0.031*
C11	0.02302 (13)	0.65472 (17)	−0.26808 (10)	0.02261 (18)
H11A	0.0664	0.5324	−0.2724	0.034*
H11B	0.0908	0.7388	−0.3056	0.034*
H11C	−0.0982	0.6607	−0.3163	0.034*

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.0221 (3)	0.0166 (3)	0.0198 (3)	−0.0026 (2)	0.0044 (2)	−0.0016 (2)
O2	0.0152 (3)	0.0482 (6)	0.0356 (4)	0.0109 (3)	0.0039 (3)	−0.0048 (4)
O3	0.0180 (3)	0.0286 (4)	0.0212 (3)	−0.0001 (3)	0.0016 (2)	0.0009 (3)
N1	0.0175 (3)	0.0211 (4)	0.0163 (3)	−0.0025 (3)	0.0053 (2)	0.0010 (3)
N2	0.0142 (3)	0.0169 (3)	0.0162 (3)	0.0002 (2)	0.0029 (2)	−0.0020 (3)
N3	0.0132 (3)	0.0199 (3)	0.0232 (3)	0.0010 (3)	0.0033 (2)	0.0028 (3)
C1	0.0119 (3)	0.0156 (3)	0.0163 (3)	0.0001 (2)	0.0045 (2)	−0.0015 (3)
C2	0.0134 (3)	0.0125 (3)	0.0162 (3)	−0.0006 (2)	0.0042 (2)	−0.0005 (3)
C3	0.0154 (3)	0.0165 (3)	0.0198 (4)	0.0002 (3)	0.0065 (3)	−0.0033 (3)
C4	0.0142 (3)	0.0175 (4)	0.0230 (4)	0.0013 (3)	0.0065 (3)	−0.0022 (3)
C5	0.0117 (3)	0.0151 (3)	0.0191 (3)	0.0008 (3)	0.0036 (2)	0.0010 (3)
C6	0.0128 (3)	0.0134 (3)	0.0159 (3)	−0.0007 (2)	0.0043 (2)	0.0011 (3)
C7	0.0131 (3)	0.0175 (3)	0.0150 (3)	−0.0004 (3)	0.0029 (2)	0.0003 (3)
C8	0.0253 (4)	0.0322 (5)	0.0174 (4)	0.0020 (4)	0.0086 (3)	0.0002 (4)
C9	0.0205 (4)	0.0228 (4)	0.0232 (4)	−0.0045 (3)	0.0041 (3)	0.0059 (3)
C10	0.0145 (3)	0.0253 (4)	0.0214 (4)	0.0033 (3)	0.0020 (3)	−0.0045 (4)
C11	0.0208 (4)	0.0303 (5)	0.0164 (3)	−0.0019 (3)	0.0040 (3)	−0.0045 (3)

Geometric parameters (Å, °)

O1—C7	1.2354 (12)	C4—C5	1.3969 (13)
O2—N3	1.2400 (12)	C4—H4A	0.9300
O3—N3	1.2358 (12)	C5—C6	1.4021 (11)
N1—C7	1.3450 (12)	C6—C7	1.5115 (13)
N1—C8	1.4553 (13)	C8—H8A	0.9600
N1—C9	1.4580 (14)	C8—H8B	0.9600
N2—C2	1.3569 (11)	C8—H8C	0.9600
N2—C10	1.4558 (12)	C9—H9A	0.9600

N2—C11	1.4585 (12)	C9—H9B	0.9600
N3—C5	1.4403 (12)	C9—H9C	0.9600
C1—C6	1.3868 (11)	C10—H10A	0.9600
C1—C2	1.4216 (12)	C10—H10B	0.9600
C1—H1A	0.9300	C10—H10C	0.9600
C2—C3	1.4197 (11)	C11—H11A	0.9600
C3—C4	1.3787 (12)	C11—H11B	0.9600
C3—H3A	0.9300	C11—H11C	0.9600
C7—N1—C8	119.80 (9)	O1—C7—N1	124.11 (9)
C7—N1—C9	124.61 (8)	O1—C7—C6	118.29 (8)
C8—N1—C9	115.48 (8)	N1—C7—C6	117.31 (8)
C2—N2—C10	120.41 (7)	N1—C8—H8A	109.5
C2—N2—C11	120.45 (7)	N1—C8—H8B	109.5
C10—N2—C11	117.41 (8)	H8A—C8—H8B	109.5
O3—N3—O2	122.21 (9)	N1—C8—H8C	109.5
O3—N3—C5	119.06 (8)	H8A—C8—H8C	109.5
O2—N3—C5	118.74 (9)	H8B—C8—H8C	109.5
C6—C1—C2	121.92 (7)	N1—C9—H9A	109.5
C6—C1—H1A	119.0	N1—C9—H9B	109.5
C2—C1—H1A	119.0	H9A—C9—H9B	109.5
N2—C2—C3	121.23 (8)	N1—C9—H9C	109.5
N2—C2—C1	121.07 (7)	H9A—C9—H9C	109.5
C3—C2—C1	117.69 (7)	H9B—C9—H9C	109.5
C4—C3—C2	120.20 (8)	N2—C10—H10A	109.5
C4—C3—H3A	119.9	N2—C10—H10B	109.5
C2—C3—H3A	119.9	H10A—C10—H10B	109.5
C3—C4—C5	121.00 (8)	N2—C10—H10C	109.5
C3—C4—H4A	119.5	H10A—C10—H10C	109.5
C5—C4—H4A	119.5	H10B—C10—H10C	109.5
C4—C5—C6	120.36 (8)	N2—C11—H11A	109.5
C4—C5—N3	118.37 (7)	N2—C11—H11B	109.5
C6—C5—N3	121.20 (8)	H11A—C11—H11B	109.5
C1—C6—C5	118.75 (8)	N2—C11—H11C	109.5
C1—C6—C7	115.54 (7)	H11A—C11—H11C	109.5
C5—C6—C7	125.39 (7)	H11B—C11—H11C	109.5
C10—N2—C2—C3	−174.89 (9)	C2—C1—C6—C5	−0.44 (13)
C11—N2—C2—C3	−10.25 (14)	C2—C1—C6—C7	173.36 (8)
C10—N2—C2—C1	6.32 (14)	C4—C5—C6—C1	1.86 (13)
C11—N2—C2—C1	170.96 (9)	N3—C5—C6—C1	178.85 (8)
C6—C1—C2—N2	176.85 (9)	C4—C5—C6—C7	−171.28 (9)
C6—C1—C2—C3	−1.98 (13)	N3—C5—C6—C7	5.71 (14)
N2—C2—C3—C4	−175.78 (9)	C8—N1—C7—O1	1.74 (14)
C1—C2—C3—C4	3.05 (13)	C9—N1—C7—O1	177.67 (9)
C2—C3—C4—C5	−1.73 (15)	C8—N1—C7—C6	−171.90 (8)
C3—C4—C5—C6	−0.79 (15)	C9—N1—C7—C6	4.04 (13)
C3—C4—C5—N3	−177.86 (9)	C1—C6—C7—O1	−91.10 (10)
O3—N3—C5—C4	176.11 (9)	C5—C6—C7—O1	82.24 (12)
O2—N3—C5—C4	−3.35 (14)	C1—C6—C7—N1	82.91 (10)

| O3—N3—C5—C6 | −0.94 (14) | C5—C6—C7—N1 | −103.75 (10) |
| O2—N3—C5—C6 | 179.61 (10) | | |

Hydrogen-bond geometry (Å, °)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C8—H8A···O3[i]	0.96	2.52	3.1751 (16)	126
C10—H10A···O2[ii]	0.96	2.59	3.5413 (14)	173
C10—H10B···O1[iii]	0.96	2.49	3.3920 (13)	156
C4—H4A···Cg1[iv]	0.93	2.81	3.3991 (11)	122

Symmetry codes: (i) −*x*+1, *y*+1/2, −*z*+1; (ii) *x*−1, *y*, *z*; (iii) −*x*, *y*−1/2, −*z*; (iv) −*x*+1, *y*−1/2, −*z*.

Fig. 1

Fig. 2