Electronic Supplementary Information for Chemical Communications

A hexagonal solvate of the neurotransmitter γ-aminobutyric acid

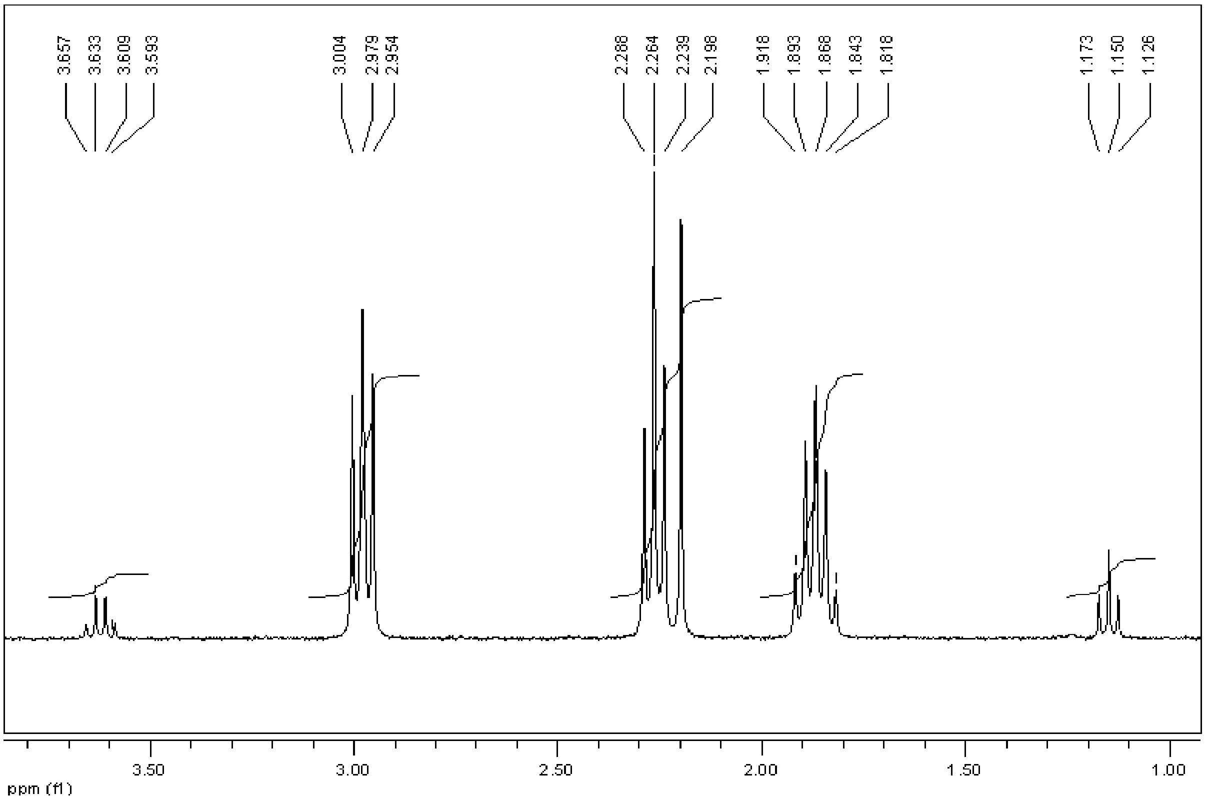
Elise J. C. de Vries,* Demetrius C. Levendis* and Hayley A. Reece

Molecular Sciences Institute, School of Chemistry, University of the Witwatersrand, PO WITS, 2050, Johannesburg, South Africa,

Email: elise.devries@wits.ac.za

(1) NMR details

In order to examine the nature of the solvent, the hexagonal GABA crystals were dried by placing them in an oven at 120°C to remove the external ethanol solvent. The relative intensities of the peaks allow for the determination of the ratio of GABA molecules to ethanol molecules present within the crystal and was found to be 1:10. ^{1}H NMR (D_2O, δ, p.p.m.): 3.62 (*q*, J_3 = 7.1 Hz, -CH_2 ethanol), 2.98 (*t*, J_3 = 7.4 Hz, N-CH_2 GABA), 2.26 (*t*, J_3 = 7.3 Hz, -CH_2 GABA), 2.19 (*s*, acetone), 1.87 (*m*, J_3 = 7.4 Hz, OOC-CH_2 GABA), 1.15 (*t*, J_3 = 7.1 Hz, -CH_3 ethanol). Please note that the acetone peak is an impurity. X-ray data was collected on the hexagonal GABA crystals. The site occupancy factors of the ethanol solvent were refined without constrains and converged to a value of 10%.



(2) Figures

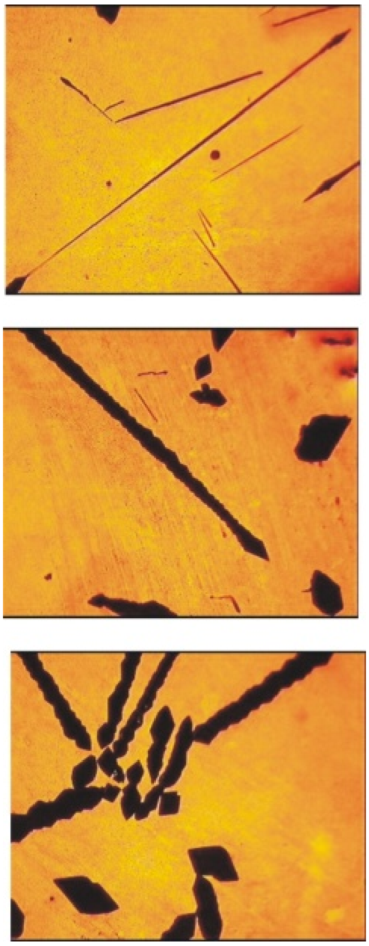


Figure 1. A visual indication of the attempt to include iodine molecules in the hexagonal channels using a saturated solution of iodine in toluene (in which the hexagonal GABA solvated crystals were placed). Iodine appears to be absorbed as the crystals change from transparent to a dark red colour.

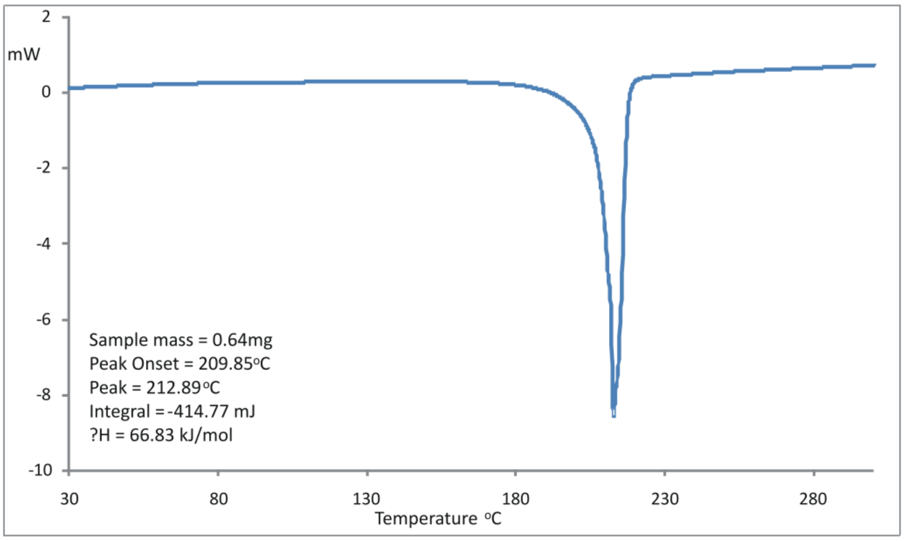


Figure 2. DSC curve of heat flow (mW) vs. temperature (°C) for the hexagonal GABA solvate. The compound is remarkably stable, with solvent release only occurring upon decomposition of the crystals at 212°C.

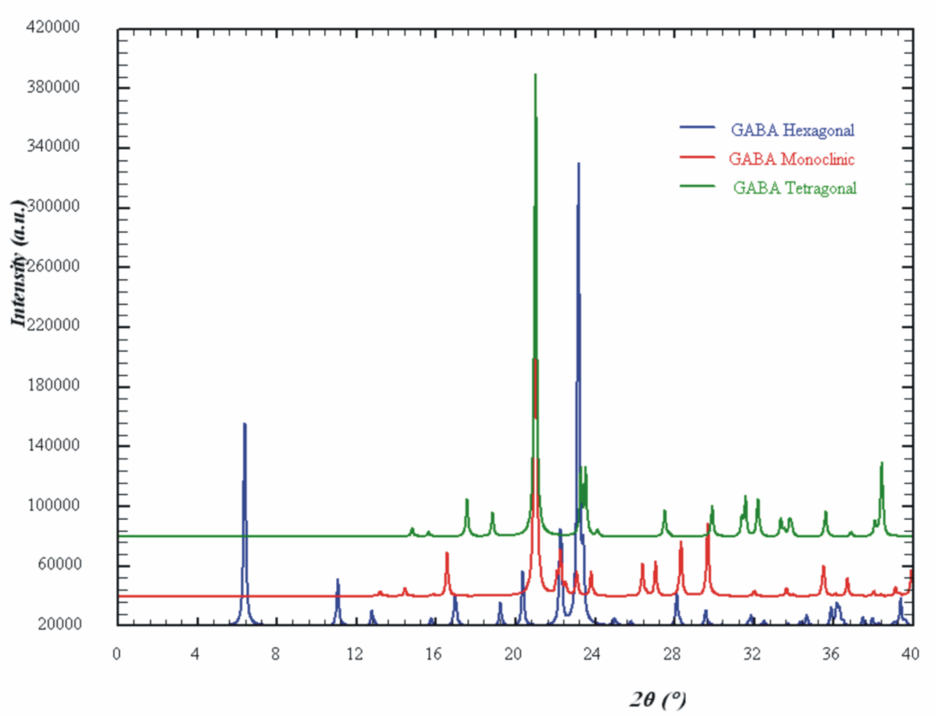
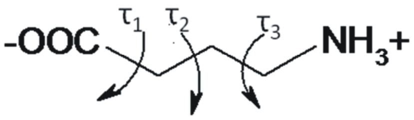
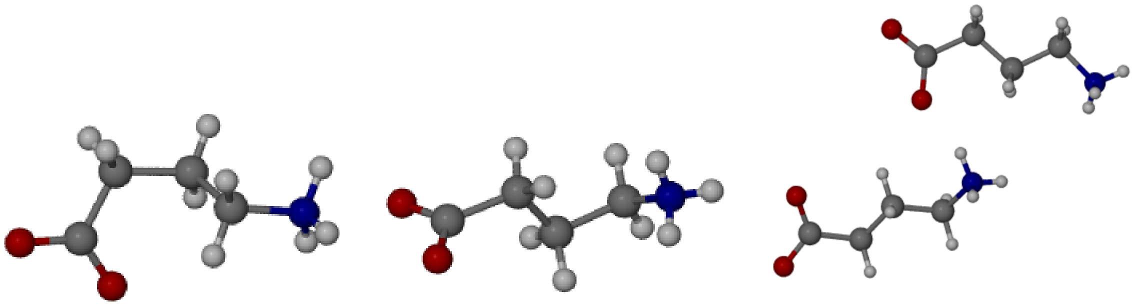


Figure 3. X-ray powder diffraction patterns of the GABA hexagonal solvated as well as the GABA monoclinic and tetragonal polymorphs.



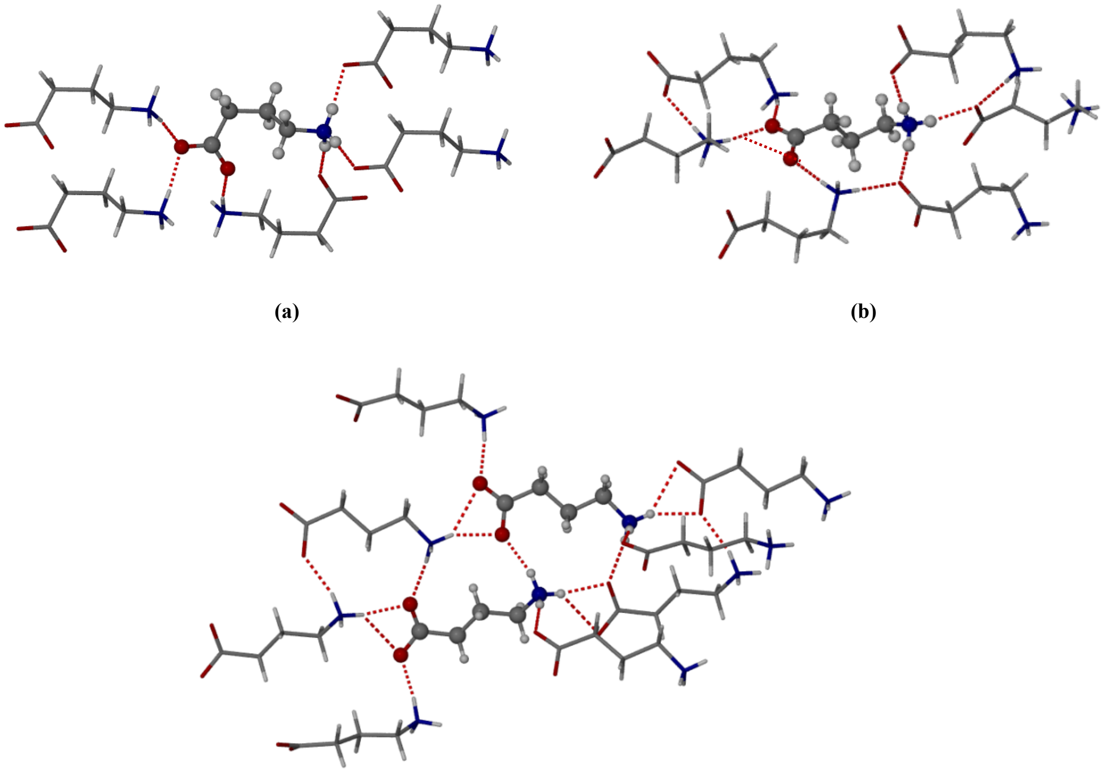
(a)



(b) **(c)** **(d)**

Torsion angle (°)	Hexagonal A	Hexagonal B	Monoclinic	Tetragonal
τ_1	172.3	-163.0	170.5	-84.3
τ_2	-179.1	-175.7	-73.2	174.6
τ_3	178.0	-170.8	175.2	62.1

Figure 4. (a) Molecular scheme of γ-aminobutyric acid, zwitterion representation with selected torsion angles shown, (b) the molecular conformation of GABA in the monoclinic (c) tetragonal and (d) hexagonal forms (molecule A is located above molecule B). A table of the selected torsion angles shown in the molecular scheme is included.



(a)

(b)

(c)

Figure 5. Shows the hydrogen bonding network found (a) the monoclinic polymorph (b) the tetragonal polymorph and (c) the solvated hexagonal form, with molecule **A** located above molecule **B**.

Table 1. Bond distances (Å)

O1A	C1A	1.248(4)
N1A	C4A	1.470(4)
N1A	H1A	0.9100
N1A	H1C	0.9100
N1A	H1B	0.9100
C1A	O2A	1.246(4)
C1A	C2A	1.524(4)
C2A	C3A	1.493(4)
C2A	H2A	0.9900
C2A	H2B	0.9900
C3A	C4A	1.514(4)
C3A	H3A	0.9900
C3A	H3B	0.9900
C4A	H4A	0.9900
C4A	H4B	0.9900
O1B	C1B	1.255(3)
N1B	C4B	1.489(4)
N1B	H1E	0.9100
N1B	H1F	0.9100
N1B	H1D	0.9100
C1B	O2B	1.249(4)
C1B	C2B	1.523(4)
C2B	C3B	1.497(4)
C2B	H2D	0.9900
C2B	H2E	0.9900
C3B	C4B	1.510(4)
C3B	H3D	0.9900
C3B	H3E	0.9900
C4B	H4D	0.9900
C4B	H4E	0.9900
O1X	C1X	1.44(2)
C1X	C2X	1.53(2)

Table 2. Bond angles (^{o})

C4A	N1A	H1A	109.5
C4A	N1A	H1C	109.5
H1A	N1A	H1C	109.5
C4A	N1A	H1B	109.5
H1A	N1A	H1B	109.5
H1C	N1A	H1B	109.5
O2A	C1A	O1A	122.9(3)
O2A	C1A	C2A	118.1(3)
O1A	C1A	C2A	119.0(3)
C3A	C2A	C1A	114.4(2)
C3A	C2A	H2A	108.7
C1A	C2A	H2A	108.6
C3A	C2A	H2B	108.6
C1A	C2A	H2B	108.7
H2A	C2A	H2B	107.6
C2A	C3A	C4A	113.7(2)
C2A	C3A	H3A	108.8
C4A	C3A	H3A	108.8
C2A	C3A	H3B	108.8

C4A	C3A	H3B	108.8
H3A	C3A	H3B	107.7
N1A	C4A	C3A	109.6(2)
N1A	C4A	H4A	109.8
C3A	C4A	H4A	109.8
N1A	C4A	H4B	109.8
C3A	C4A	H4B	109.7
H4A	C4A	H4B	108.2
C4B	N1B	H1E	109.5
C4B	N1B	H1F	109.5
H1E	N1B	H1F	109.5
C4B	N1B	H1D	109.5
H1E	N1B	H1D	109.5
H1F	N1B	H1D	109.5
O2B	C1B	O1B	124.1(3)
O2B	C1B	C2B	118.8(3)
O1B	C1B	C2B	117.1(3)
C3B	C2B	C1B	115.5(3)
C3B	C2B	H2D	108.4
C1B	C2B	H2D	108.4
C3B	C2B	H2E	108.4
C1B	C2B	H2E	108.4
H2D	C2B	H2E	107.5
C2B	C3B	C4B	113.8(2)
C2B	C3B	H3D	108.8
C4B	C3B	H3D	108.8
C2B	C3B	H3E	108.8
C4B	C3B	H3E	108.8
H3D	C3B	H3E	107.7
N1B	C4B	C3B	110.0(2)
N1B	C4B	H4D	109.7
C3B	C4B	H4D	109.7
N1B	C4B	H4E	109.6
C3B	C4B	H4E	109.7
H4D	C4B	H4E	108.2
O1X	C1X	C2X	135(4)

Table 3. Torsion angles (^{o})

O2A	C1A	C2A	C3A	172.3(3)
O1A	C1A	C2A	C3A	-8.6(4)
C1A	C2A	C3A	C4A	-179.1(3)
C2A	C3A	C4A	N1A	177.9(2)
O2B	C1B	C2B	C3B	16.8(5)
O1B	C1B	C2B	C3B	-163.0(3)
C1B	C2B	C3B	C4B	-175.7(3)
C2B	C3B	C4B	N1B	-170.8(3)

Table 4 Hydrogen bonding distances (Å) and angles (^{o})

D-H	A	H•••A	D•••A	D-H•••A
N(1A) - H(1A) •••	O(2A)^{i}	1.79	2.695(5)	173
N(1A) - H(1B) •••	O(2B)^{ii}	1.94	2.815(4)	161
N(1A) - H(1C) •••	O(1A)^{ii}	2.02	2.885(3)	158
N(1A) - H(1C) •••	O(2A)^{ii}	2.32	3.093(4)	142
N(1B) - H(1D) •••	O(1B)^{iii}	1.80	2.694(4)	166
N(1B) - H(1E) •••	O(1A)	1.91	2.802(5)	165
N(1B) - H(1F) •••	O(1B)^{ii}	2.49	3.203(4)	135
N(1B) - H(1F) •••	O(2B)^{ii}	1.96	2.847(3)	165

Symmetry operation (i) y, -x+y, $^{2}/_{3}$+z; (ii) x, y, 1+z; (iii) 1-y, x-y, $^{2}/_{3}$+z