Full wwPDB X-ray Structure Validation Report (i)

Sep 9, 2023 – 08:09 PM EDT

PDB ID	:	4HQL
Title	:	Crystal structure of magnesium-loaded Plasmodium vivax TRAP protein
Authors	:	Song, G.; Koksal, A.C.; Lu, C.; Springer, T.A.
Deposited on	:	2012-10-25
Resolution	:	2.24 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

The following versions of software and data (see references (i)) were used in the production of this report:

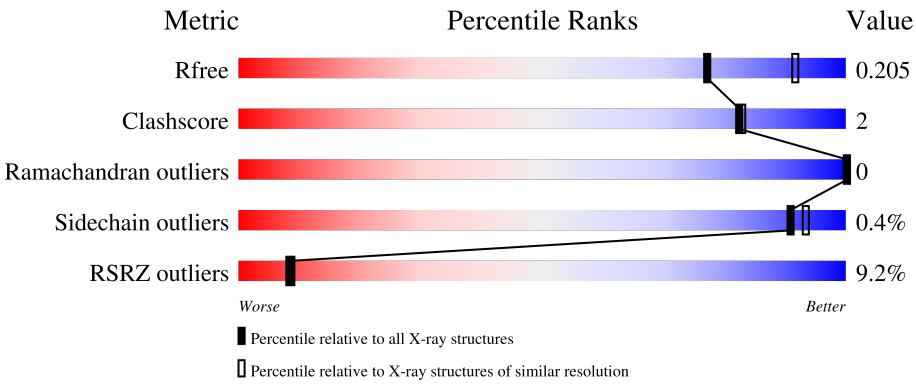
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35.1

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.24 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	2391 (2.26-2.22)
Clashscore	141614	2539 (2.26-2.22)
Ramachandran outliers	138981	2489 (2.26-2.22)
Sidechain outliers	138945	2490 (2.26-2.22)
RSRZ outliers	127900	2353 (2.26-2.22)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	266	16% 89% 6% 5%
1	B	266	2% 91% 6% •
2	C	2	50% 50%
2	D	2	50% 50%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 4613 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

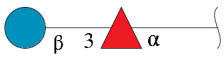
- Molecule 1 is a protein called Sporozoite surface protein 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	254	2007	1253	357	382	15	0	2	0
1	B	256	2023	1265	362	381	15	0	2	0

There are 22 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	42	GLN	SER	engineered mutation	UNP Q9TVF0
A	91	SER	ASN	engineered mutation	UNP Q9TVF0
A	128	SER	ASN	engineered mutation	UNP Q9TVF0
A	180	ARG	SER	engineered mutation	UNP Q9TVF0
A	284	HIS	-	expression tag	UNP Q9TVF0
A	285	HIS	-	expression tag	UNP Q9TVF0
A	286	HIS	-	expression tag	UNP Q9TVF0
A	287	HIS	-	expression tag	UNP Q9TVF0
A	288	HIS	-	expression tag	UNP Q9TVF0
A	289	HIS	-	expression tag	UNP Q9TVF0
A	290	ALA	-	expression tag	UNP Q9TVF0
B	42	GLN	SER	engineered mutation	UNP Q9TVF0
B	91	SER	ASN	engineered mutation	UNP Q9TVF0
B	128	SER	ASN	engineered mutation	UNP Q9TVF0
B	180	ARG	SER	engineered mutation	UNP Q9TVF0
B	284	HIS	-	expression tag	UNP Q9TVF0
B	285	HIS	-	expression tag	UNP Q9TVF0
B	286	HIS	-	expression tag	UNP Q9TVF0
B	287	HIS	-	expression tag	UNP Q9TVF0
B	288	HIS	-	expression tag	UNP Q9TVF0
B	289	HIS	-	expression tag	UNP Q9TVF0
B	290	ALA	-	expression tag	UNP Q9TVF0

- Molecule 2 is an oligosaccharide called beta-D-glucopyranose-(1-3)-alpha-L-fucopyranose.



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
			Total	C	O			
2	C	2	21	12	9	0	0	0
			Total	C	O			
2	D	2	21	12	9	0	0	0

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
3	A	1	1	1	0	0
			Total	Mg		
3	B	1	1	1	0	0

- Molecule 4 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Cl		
4	A	1	1	1	0	0
			Total	Cl		
4	B	1	1	1	0	0

- Molecule 5 is water.

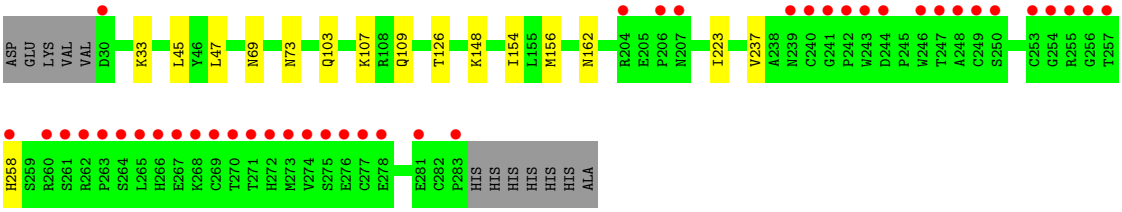
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
5	A	292	292	292	0	0
			Total	O		
5	B	245	245	245	0	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

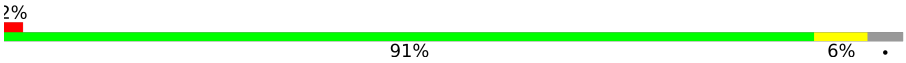
• Molecule 1: Sporozoite surface protein 2

Chain A:



• Molecule 1: Sporozoite surface protein 2

Chain B:



• Molecule 2: beta-D-glucopyranose-(1-3)-alpha-L-fucopyranose

Chain C:

• Molecule 2: beta-D-glucopyranose-(1-3)-alpha-L-fucopyranose

Chain D:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	59.60Å 97.96Å 159.25Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	41.72 – 2.24 41.72 – 2.24	Depositor EDS
% Data completeness (in resolution range)	99.5 (41.72-2.24) 95.9 (41.72-2.24)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.09	Depositor
$< I/\sigma(I) >$ [1]	3.61 (at 2.24Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.1_1168)	Depositor
R, R_{free}	0.163 , 0.204 0.164 , 0.205	Depositor DCC
R_{free} test set	2288 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å^2)	32.3	Xtriage
Anisotropy	0.756	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 54.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	4613	wwPDB-VP
Average B, all atoms (Å^2)	49.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.59% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: MG, BGC, CL, FUC

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\|>5$	RMSZ	$\#\|Z\|>5$
1	A	0.39	0/2047	0.52	0/2774
1	B	0.36	0/2066	0.51	0/2799
All	All	0.37	0/4113	0.51	0/5573

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2007	0	1988	11	0
1	B	2023	0	2019	9	0
2	C	21	0	19	0	1
2	D	21	0	19	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
5	A	292	0	0	1	0
5	B	245	0	0	0	1
All	All	4613	0	4045	20	1

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 2.

All (20) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:196[B]:ARG:HH11	1:B:205:GLU:H	1.33	0.76
1:B:196[B]:ARG:NH1	1:B:205:GLU:H	1.98	0.59
1:B:47:LEU:HD11	1:B:156:MET:HE3	1.90	0.54
1:A:103:GLN:HG2	1:A:109[B]:GLN:HB3	1.92	0.51
1:A:109[A]:GLN:NE2	5:A:692:HOH:O	2.42	0.51
1:A:103:GLN:HG2	1:A:109[A]:GLN:HB3	1.93	0.50
1:A:73:ASN:HA	1:A:107:LYS:HD2	1.93	0.49
1:A:33:LYS:HG2	1:A:237:VAL:HG12	1.97	0.47
1:B:60:TRP:HD1	1:B:61:ILE:HD12	1.81	0.44
1:B:196[B]:ARG:NH1	1:B:205:GLU:O	2.35	0.44
1:A:69:ASN:O	1:A:73:ASN:HB2	2.18	0.43
1:A:148:LYS:HB2	1:A:148:LYS:HE3	1.72	0.43
1:B:34:TYR:CE1	1:B:236:ARG:HB2	2.54	0.43
1:A:45:LEU:HD21	1:A:154:ILE:HD12	2.01	0.43
1:B:45:LEU:HD21	1:B:154:ILE:HD12	2.02	0.42
1:A:126:THR:HB	1:A:162:ASN:OD1	2.19	0.42
1:B:246:TRP:CE2	1:B:260[B]:ARG:HD2	2.55	0.42
1:B:28:VAL:O	1:B:31:GLU:HG2	2.20	0.41
1:A:47:LEU:HD11	1:A:156:MET:HE3	2.02	0.40
1:A:223:ILE:HD13	1:A:223:ILE:HA	1.89	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:C:2:BGC:O2	5:B:626:HOH:O[3_544]	2.09	0.11

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was

analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	254/266 (96%)	248 (98%)	6 (2%)	0	100	100
1	B	256/266 (96%)	249 (97%)	7 (3%)	0	100	100
All	All	510/532 (96%)	497 (98%)	13 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	225/234 (96%)	224 (100%)	1 (0%)	91	93
1	B	227/234 (97%)	226 (100%)	1 (0%)	91	93
All	All	452/468 (97%)	450 (100%)	2 (0%)	91	93

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	258	HIS
1	B	258	HIS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

4 monosaccharides are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	FUC	C	1	1,2	10,10,11	0.84	0	14,14,16	0.96	1 (7%)
2	BGC	C	2	2	11,11,12	0.80	1 (9%)	15,15,17	0.67	0
2	FUC	D	1	1,2	10,10,11	0.93	0	14,14,16	1.06	1 (7%)
2	BGC	D	2	2	11,11,12	0.67	0	15,15,17	0.87	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	FUC	C	1	1,2	-	-	0/1/1/1
2	BGC	C	2	2	-	0/2/19/22	0/1/1/1
2	FUC	D	1	1,2	-	-	0/1/1/1
2	BGC	D	2	2	-	0/2/19/22	0/1/1/1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	2	BGC	O5-C1	-2.05	1.40	1.43

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	C	1	FUC	O2-C2-C1	2.26	113.78	109.15
2	D	1	FUC	O5-C1-C2	2.11	114.03	110.77

There are no chirality outliers.

There are no torsion outliers.

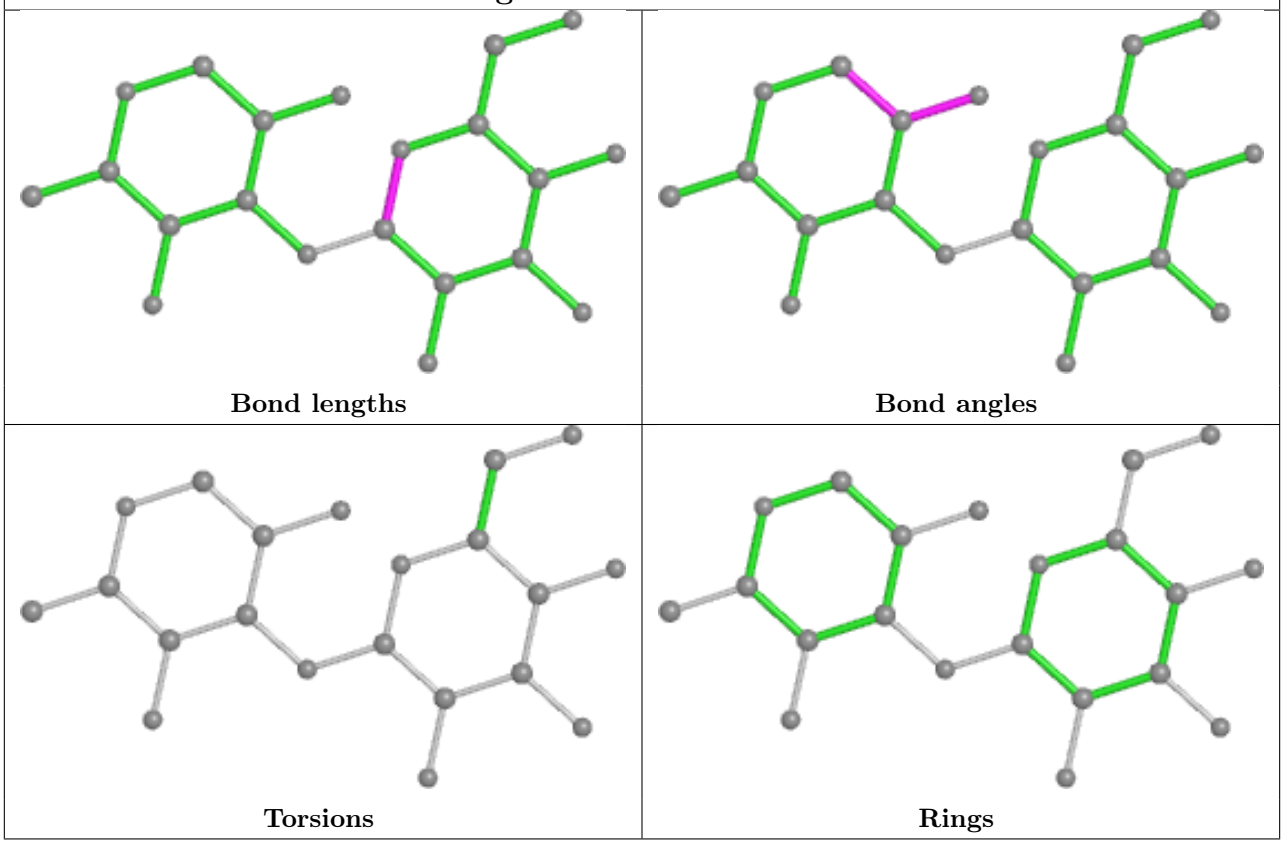
There are no ring outliers.

1 monomer is involved in 1 short contact:

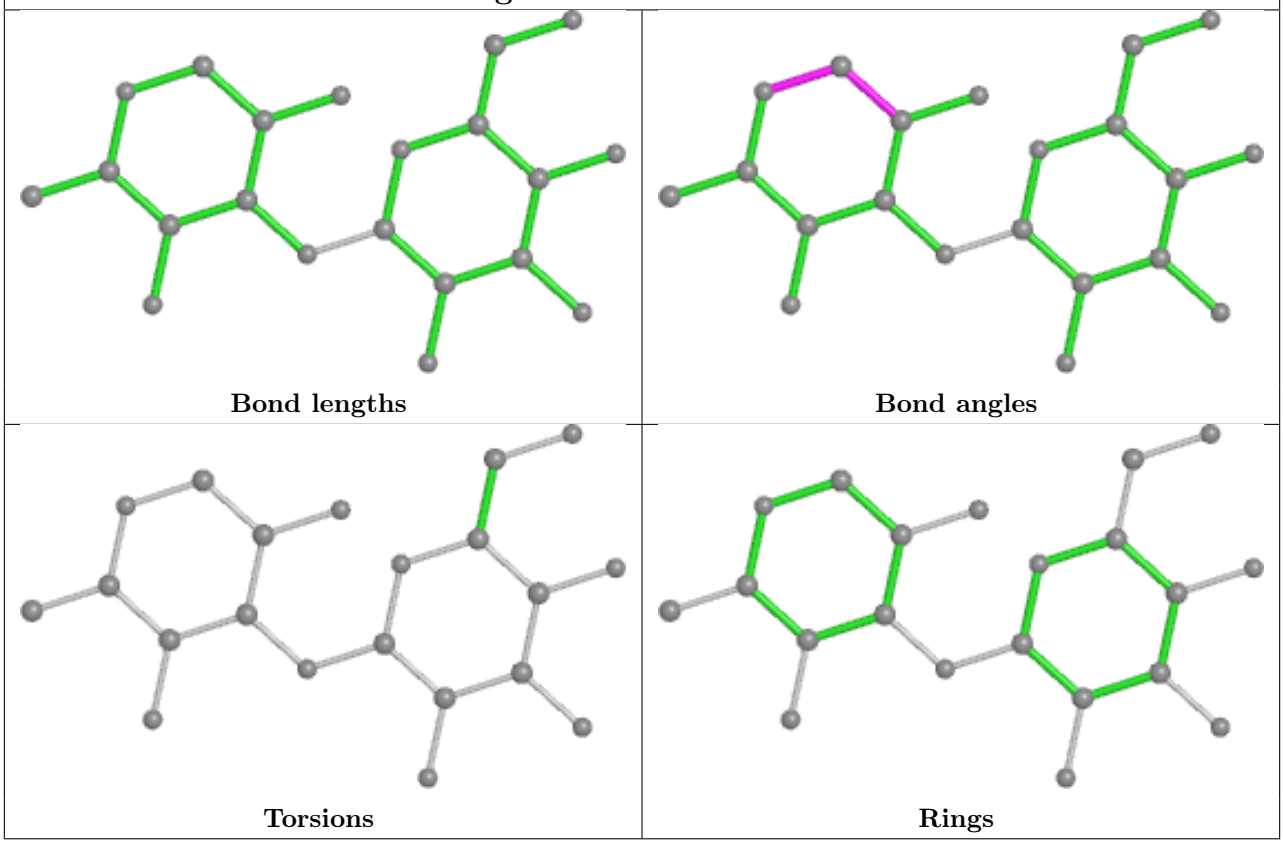
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	2	BGC	0	1

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.

Oligosaccharide Chain C



Oligosaccharide Chain D



5.6 Ligand geometry (i)

Of 4 ligands modelled in this entry, 4 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data (i)

6.1 Protein, DNA and RNA chains (i)

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å^2)	Q<0.9
1	A	254/266 (95%)	0.34	42 (16%) 1 1	17, 33, 111, 144	0
1	B	256/266 (96%)	-0.35	5 (1%) 65 66	18, 47, 77, 121	0
All	All	510/532 (95%)	-0.01	47 (9%) 9 8	17, 41, 103, 144	0

All (47) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	28	VAL	5.6
1	B	204	ARG	5.3
1	A	278	GLU	5.1
1	A	255	ARG	4.9
1	A	275	SER	4.8
1	A	274	VAL	4.7
1	A	265	LEU	4.3
1	A	253	CYS	4.2
1	A	246	TRP	4.2
1	A	264	SER	4.1
1	A	263	PRO	4.0
1	A	242	PRO	4.0
1	A	206	PRO	3.8
1	A	258	HIS	3.6
1	A	276	GLU	3.5
1	A	277	CYS	3.5
1	A	243	TRP	3.5
1	A	273	MET	3.4
1	A	204	ARG	3.3
1	A	244	ASP	3.3
1	A	281	GLU	3.3
1	A	250	SER	3.2
1	B	108	ARG	3.2
1	A	207	ASN	3.2

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Mol	Chain	Res	Type	RSRZ
1	A	271	THR	3.1
1	A	239	ASN	3.1
1	A	261	SER	2.9
1	A	266	HIS	2.8
1	A	269	CYS	2.8
1	A	270	THR	2.8
1	A	240	CYS	2.8
1	A	254	GLY	2.7
1	A	283	PRO	2.7
1	A	249	CYS	2.7
1	A	241	GLY	2.7
1	A	248	ALA	2.6
1	A	268	LYS	2.6
1	A	272	HIS	2.6
1	A	257	THR	2.6
1	B	29	VAL	2.5
1	A	267	GLU	2.5
1	A	260	ARG	2.4
1	A	262	ARG	2.3
1	A	256	GLY	2.2
1	A	30	ASP	2.1
1	B	119	LYS	2.1
1	A	247	THR	2.0

6.2 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates (i)

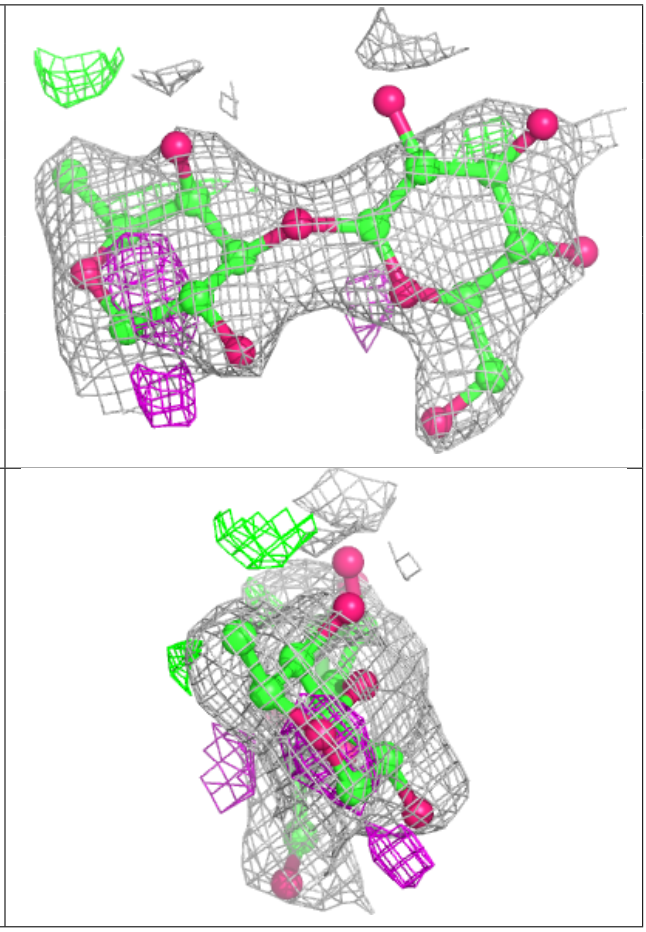
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	FUC	C	1	10/11	0.81	0.20	58,69,72,80	0
2	BGC	C	2	11/12	0.87	0.21	92,95,97,97	0
2	BGC	D	2	11/12	0.97	0.08	29,34,40,43	0
2	FUC	D	1	10/11	0.99	0.09	27,32,35,35	0

The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

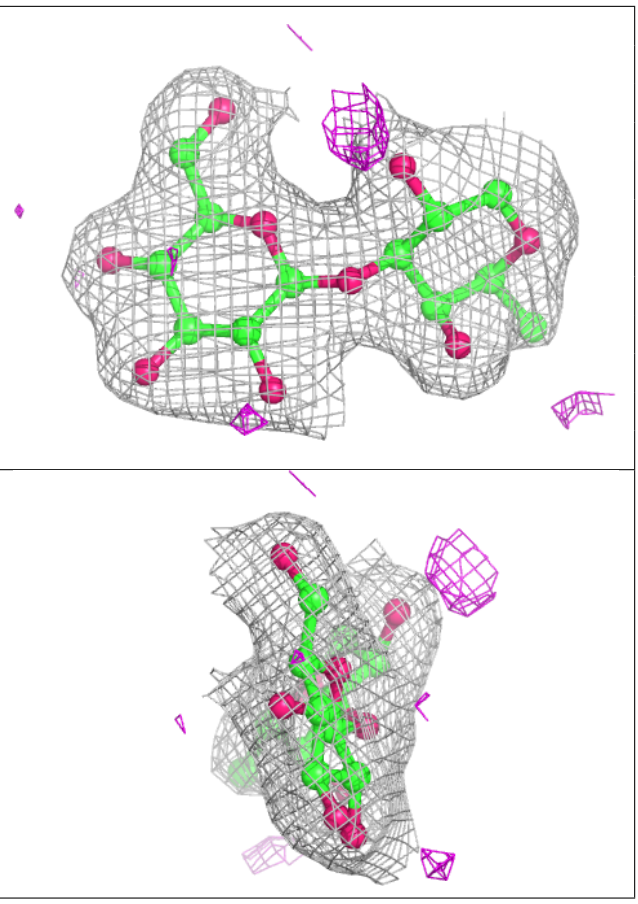
Electron density around Chain C:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



Electron density around Chain D:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



6.4 Ligands (i)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	MG	B	301	1/1	0.98	0.08	34,34,34,34	0
3	MG	A	301	1/1	0.99	0.10	19,19,19,19	0
4	CL	B	304	1/1	0.99	0.08	32,32,32,32	0
4	CL	A	304	1/1	1.00	0.14	23,23,23,23	0

6.5 Other polymers (i)

There are no such residues in this entry.