



wwPDB X-ray Structure Validation Summary Report

Oct 3, 2014 – 03:59 AM EDT

PDB ID : 4MD2
Title : Ground state of bacteriorhodopsin from Halobacterium salinarum
Authors : Borshchevskiy, V.; Erofeev, I.; Round, E.; Weik, M.; Ishchenko, A.; Gushchin, I.; Mishin, A.; Bueldt, G.; Gordeliy, V.
Deposited on : 2013-08-22
Resolution : 1.73 Å(reported)

This is a wwPDB validation summary report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

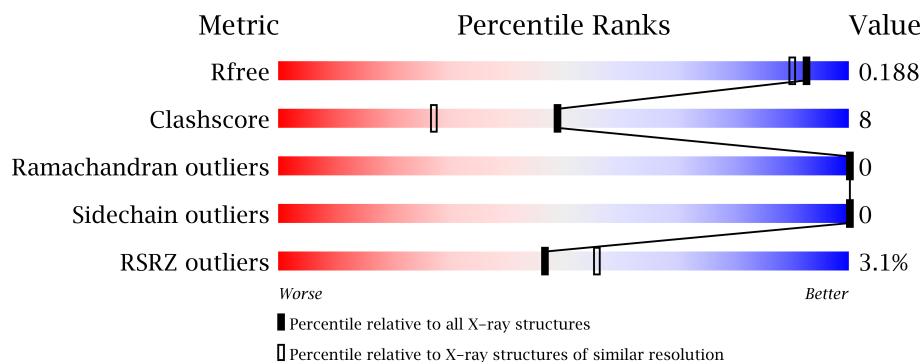
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.16 November 2013
Xtriage (Phenix) : dev-1439
EDS : stable23828
Percentile statistics : 21963
Refmac : 5.8.0049
CCP4 : 6.3.0 (Settle)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP) : stable23828

1 Overall quality at a glance

The reported resolution of this entry is 1.73 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}	66092	1657 (1.76-1.72)
Clashscore	79885	1881 (1.76-1.72)
Ramachandran outliers	78287	1859 (1.76-1.72)
Sidechain outliers	78261	1859 (1.76-1.72)
RSRZ outliers	66119	1658 (1.76-1.72)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	248	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
2	L2P	A	1001	-	X
2	L2P	A	1003	-	X
2	L2P	A	1004	-	X
2	L2P	A	1005	-	X
2	L2P	A	1006	-	X
2	L2P	A	1007	-	X
2	L2P	A	1008	-	X

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Mol	Type	Chain	Res	Geometry	Electron density
2	L2P	A	1009	-	X
2	L2P	A	1010	-	X
2	L2P	A	1011	-	X
2	L2P	A	1012	-	X
2	L2P	A	1017	-	X
2	L2P	A	1019	-	X

2 Entry composition i

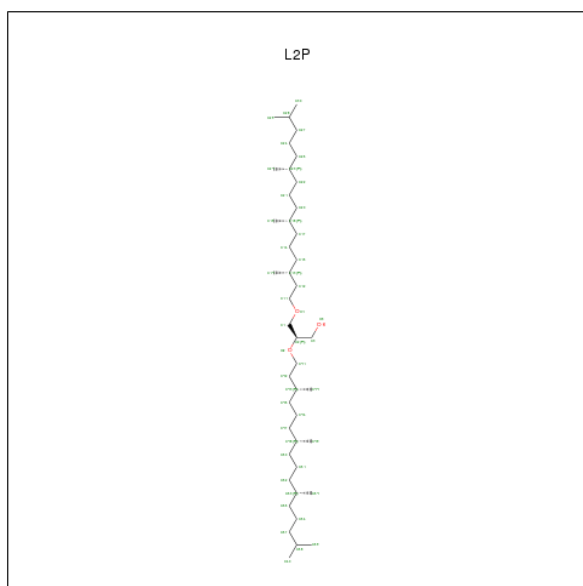
There are 4 unique types of molecules in this entry. The entry contains 2005 atoms, of which 0 are hydrogen and 0 are deuterium.

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 Bacteriorhodopsin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	224	Total	C	N	O	S	6	6	0
			1786	1211	268	298	9			

- Molecule 2 is 2,3-DI-PHYTANYL-GLYCEROL (three-letter code: L2P) (formula: $C_{43}H_{88}O_3$).



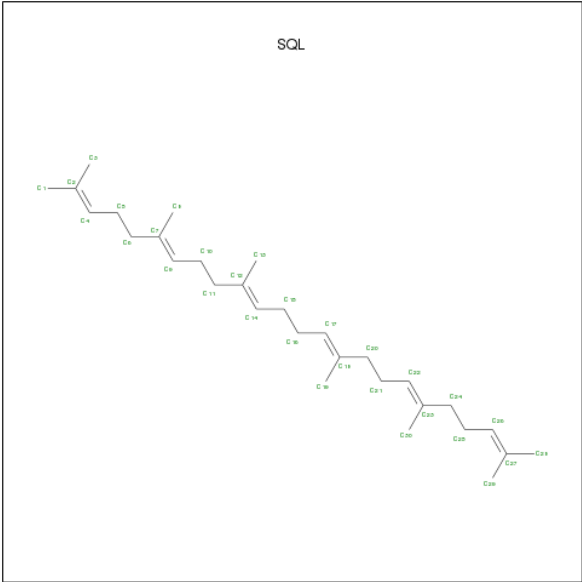
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	C	0	0
			8	8		
2	A	1	Total	C	0	0
			9	9		
2	A	1	Total	C	0	0
			9	9		
2	A	1	Total	C	0	0
			8	8		
2	A	1	Total	C	0	0
			10	10		

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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C 5 5	0	0
2	A	1	Total C 7 7	0	0
2	A	1	Total C 7 7	0	0
2	A	1	Total C 10 10	0	0
2	A	1	Total C 11 11	0	0
2	A	1	Total C 12 12	0	0
2	A	1	Total C 10 10	0	0
2	A	1	Total C 5 5	0	0
2	A	1	Total C 5 5	0	0
2	A	1	Total C 5 5	0	0
2	A	1	Total C 5 5	0	0
2	A	1	Total C 7 7	0	0
2	A	1	Total C O 19 18 1	0	0

- Molecule 3 is (6E,10E,14E,18E)-2,6,10,15,19,23-HEXAMETHYLTETRACOSA-2,6,10,14,18,22-HEXAENE (three-letter code: SQL) (formula: C₃₀H₅₀).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C 17 17	0	0

- Molecule 4 is water.

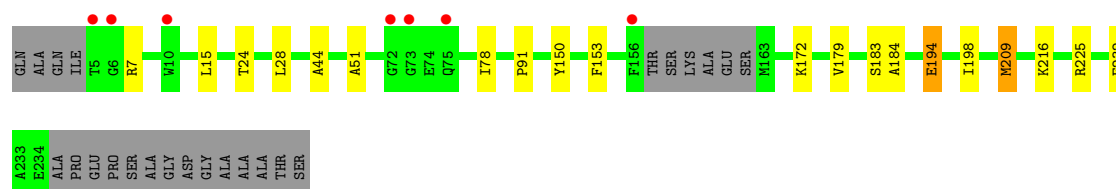
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	50	Total O 50 50	0	0

3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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: Bacteriorhodopsin

Chain A: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 63	Depositor
Cell constants a, b, c, α , β , γ	60.91Å 60.91Å 110.09Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	23.44 – 1.73 23.44 – 1.73	Depositor EDS
% Data completeness (in resolution range)	93.4 (23.44-1.73) 93.4 (23.44-1.73)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.66 (at 1.73Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8_1069)	Depositor
R, R_{free}	0.139 , 0.188 0.139 , 0.188	Depositor DCC
R_{free} test set	1160 reflections (5.15%)	DCC
Wilson B-factor (Å ²)	19.5	Xtriage
Anisotropy	0.291	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.42 , 80.4	EDS
Estimated twinning fraction	0.056 for h,-h-k,-l	Xtriage
L-test for twinning	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	0 of 22537 reflections	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2005	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.66% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: L2P, LYR, SQL

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	0.54	1/1821 (0.1%)	0.76	1/2486 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	194	GLU	CD-OE2	-5.27	1.19	1.25

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	209	MET	CG-SD-CE	-7.86	87.62	100.20

There are no chirality outliers.

There are no planarity outliers.

5.2 Close contacts

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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	1786	0	1867	31	0
2	A	152	0	204	17	0
3	A	17	0	15	2	0
4	A	50	0	0	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	2005	0	2086	31	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 8.

The worst 5 of 31 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:150:TYR:CE2	2:A:1012:L2P:H272	1.98	0.97
1:A:7[A]:ARG:CZ	4:A:1135:HOH:O	2.21	0.88
1:A:44:ALA:HA	2:A:1019:L2P:H122	1.57	0.87
1:A:216:LYR:H182	1:A:216:LYR:H9	1.65	0.76
1:A:232:GLU:OE2	4:A:1149:HOH:O	2.08	0.72

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone ⓘ

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	225/248 (91%)	225 (100%)	0	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	184/193 (95%)	184 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

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

5.3.3 RNA ⓘ

There are no RNA chains in this entry.

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

1 non-standard protein/DNA/RNA residue is 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
1	LYR	A	216	1	29,29,30	3.77	6 (20%)	35,37,39	1.98	13 (37%)

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
1	LYR	A	216	1	-	0/21/40/42	0/1/1/1

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	216	LYR	O-C	18.22	1.24	1.11
1	A	216	LYR	C7-C80	3.99	1.41	1.35
1	A	216	LYR	C5-C3	-3.32	1.38	1.45
1	A	216	LYR	C16-C15	-3.03	1.44	1.52
1	A	216	LYR	C10-C9	2.66	1.40	1.32

The worst 5 of 13 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	216	LYR	C1-NZ-CE	4.38	120.68	113.56
1	A	216	LYR	C14-C12-C11	3.51	127.49	122.86
1	A	216	LYR	C17-C11-C10	3.44	125.23	115.69
1	A	216	LYR	C19-C17-C11	-3.25	104.94	110.33
1	A	216	LYR	C7-C6-C5	-3.08	112.89	123.23

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

5.6 Ligand geometry ⓘ

19 ligands 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	L2P	A	1001	-	6,7,45	1.55	1 (16%)	3,6,53	1.96	1 (33%)
3	SQL	A	1002	-	7,14,29	4.15	4 (57%)	1,11,34	0.67	0
2	L2P	A	1003	-	8,8,45	1.75	1 (12%)	4,7,53	0.61	0
2	L2P	A	1004	-	8,8,45	1.35	1 (12%)	4,7,53	0.86	0
2	L2P	A	1005	-	6,7,45	2.14	1 (16%)	3,6,53	2.51	1 (33%)
2	L2P	A	1006	-	7,9,45	0.44	0	4,8,53	2.60	2 (50%)
2	L2P	A	1007	-	4,4,45	2.36	1 (25%)	2,3,53	0.47	0
2	L2P	A	1008	-	5,6,45	2.24	1 (20%)	2,5,53	3.65	1 (50%)
2	L2P	A	1009	-	5,6,45	0.79	0	2,5,53	6.94	1 (50%)
2	L2P	A	1010	-	7,9,45	0.43	0	4,8,53	3.61	3 (75%)
2	L2P	A	1011	-	9,10,45	1.75	1 (11%)	4,9,53	2.44	2 (50%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
2	L2P	A	1012	-	10,11,45	0.85	0	5,10,53	2.06	2 (40%)
2	L2P	A	1013	-	9,9,45	2.52	2 (22%)	4,8,53	1.35	0
2	L2P	A	1014	-	4,4,45	1.56	1 (25%)	2,3,53	3.09	1 (50%)
2	L2P	A	1015	-	4,4,45	2.68	1 (25%)	2,3,53	0.40	0
2	L2P	A	1016	-	4,4,45	2.53	1 (25%)	2,3,53	0.70	0
2	L2P	A	1017	-	4,4,45	4.13	1 (25%)	2,3,53	2.55	2 (100%)
2	L2P	A	1018	-	5,6,45	1.58	1 (20%)	2,5,53	3.36	1 (50%)
2	L2P	A	1019	-	18,18,45	0.65	0	15,19,53	1.50	4 (26%)

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	L2P	A	1001	-	-	0/5/5/51	0/0/0/0
3	SQL	A	1002	-	-	0/3/8/31	0/0/0/0
2	L2P	A	1003	-	-	0/5/6/51	0/0/0/0
2	L2P	A	1004	-	-	0/5/6/51	0/0/0/0
2	L2P	A	1005	-	-	0/5/5/51	0/0/0/0
2	L2P	A	1006	-	-	0/6/7/51	0/0/0/0
2	L2P	A	1007	-	-	0/1/2/51	0/0/0/0
2	L2P	A	1008	-	-	0/4/4/51	0/0/0/0
2	L2P	A	1009	-	-	0/4/4/51	0/0/0/0
2	L2P	A	1010	-	-	0/6/7/51	0/0/0/0
2	L2P	A	1011	-	-	0/8/8/51	0/0/0/0
2	L2P	A	1012	-	-	0/9/9/51	0/0/0/0
2	L2P	A	1013	-	-	0/7/7/51	0/0/0/0
2	L2P	A	1014	-	-	0/1/2/51	0/0/0/0
2	L2P	A	1015	-	-	0/1/2/51	0/0/0/0
2	L2P	A	1016	-	-	0/1/2/51	0/0/0/0
2	L2P	A	1017	-	-	0/1/2/51	0/0/0/0
2	L2P	A	1018	-	-	0/4/4/51	0/0/0/0
2	L2P	A	1019	-	-	0/17/17/51	0/0/0/0

The worst 5 of 18 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1017	L2P	C25-C26	-8.20	1.51	1.55
3	A	1002	SQL	C10-C11	-6.10	1.52	1.55

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	1002	SQL	C11-C12	6.02	1.53	1.46
3	A	1002	SQL	C20-C18	5.90	1.53	1.46
2	A	1013	L2P	C11-C12	-5.90	1.52	1.55

The worst 5 of 21 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	1009	L2P	C27-C26-C25	-9.82	100.69	113.58
2	A	1010	L2P	C27-C26-C25	-6.01	105.69	113.58
2	A	1008	L2P	C27-C26-C25	-5.04	106.96	113.58
2	A	1018	L2P	C27-C26-C25	4.73	119.79	113.58
2	A	1006	L2P	C27-C26-C25	-4.51	107.66	113.58

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

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	223/248 (89%)	-0.18	7 (3%) 47 56	7, 15, 37, 55	3 (1%)

The worst 5 of 7 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	5	THR	5.0
1	A	6	GLY	4.9
1	A	156	PHE	4.7
1	A	73	GLY	3.6
1	A	72	GLY	2.7

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

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	RSR	LLDF	B-factors(Å ²)	Q<0.9
1	LYR	A	216	29/30	0.10	1.45	8,10,13,14	0

6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

6.4 Ligands ⓘ

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	RSR	LLDF	B-factors(Å ²)	Q<0.9
2	L2P	A	1011	11/46	0.19	22.68	41,47,61,75	0
2	L2P	A	1019	19/46	0.25	13.39	19,40,72,82	0
2	L2P	A	1005	8/46	0.15	10.56	35,52,66,76	0
2	L2P	A	1006	10/46	0.14	9.89	30,35,48,60	0
2	L2P	A	1009	7/46	0.19	9.44	36,52,60,70	0
2	L2P	A	1010	10/46	0.15	6.18	37,42,61,63	0
2	L2P	A	1008	7/46	0.13	5.51	35,37,44,49	0
2	L2P	A	1001	8/46	0.11	4.30	23,31,45,50	0
2	L2P	A	1003	9/46	0.12	3.90	26,30,41,45	0
2	L2P	A	1004	9/46	0.12	3.73	32,46,58,78	0
2	L2P	A	1017	5/46	0.20	2.97	44,53,68,83	0
2	L2P	A	1012	12/46	0.14	2.34	36,46,61,68	0
2	L2P	A	1007	5/46	0.11	2.11	33,38,43,55	0
3	SQL	A	1002	17/30	0.12	1.98	33,40,49,58	0
2	L2P	A	1015	5/46	0.12	1.85	31,43,46,50	0
2	L2P	A	1014	5/46	0.14	1.66	37,46,54,62	0
2	L2P	A	1018	7/46	0.11	1.60	36,42,48,54	0
2	L2P	A	1013	10/46	0.12	1.45	32,43,53,60	0
2	L2P	A	1016	5/46	0.10	0.55	33,39,40,52	0

6.5 Other polymers ⓘ

There are no such residues in this entry.