



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 07:59 PM GMT

PDB ID : 4QLM  
Title : ydao riboswitch binding to c-di-AMP  
Authors : Ren, A.M.; Patel, D.J.  
Deposited on : 2014-06-12  
Resolution : 2.72 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](mailto:validation@mail.wwpdb.org)  
A user guide is available at  
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467  
Mogul : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

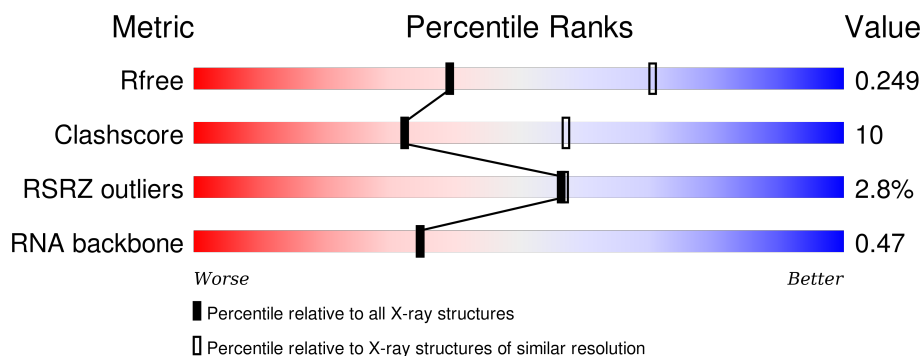
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.72 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))
$R_{free}$	91344	2439 (2.74-2.70)
Clashscore	102246	2771 (2.74-2.70)
RSRZ outliers	91569	2443 (2.74-2.70)
RNA backbone	2183	1004 (3.10-2.34)

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  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria. 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  $\leq 5\%$ . 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	125	

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 2449 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.

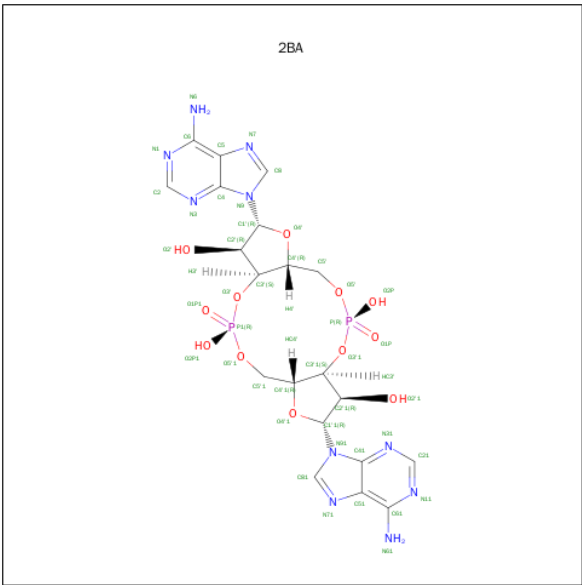
- Molecule 1 is a RNA chain called RNA (108-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
1	A	108	2316	1033	430	745	108	0	0	0

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Mg	0	0
			2	2		

- Molecule 3 is (2R,3R,3AS,5R,7AR,9R,10R,10AS,12R,14AR)-2,9-BIS(6-AMINO-9H-PURIN-9-YL)OCTAHYDRO-2H,7H-DIFURO[3,2-D:3',2'-J][1,3,7,9,2,8]TETRAOXADIPHOSPHACYCLODODECINE-3,5,10,12-TETROL 5,12-DIOXIDE (three-letter code: 2BA) (formula: C<sub>20</sub>H<sub>24</sub>N<sub>10</sub>O<sub>12</sub>P<sub>2</sub>).



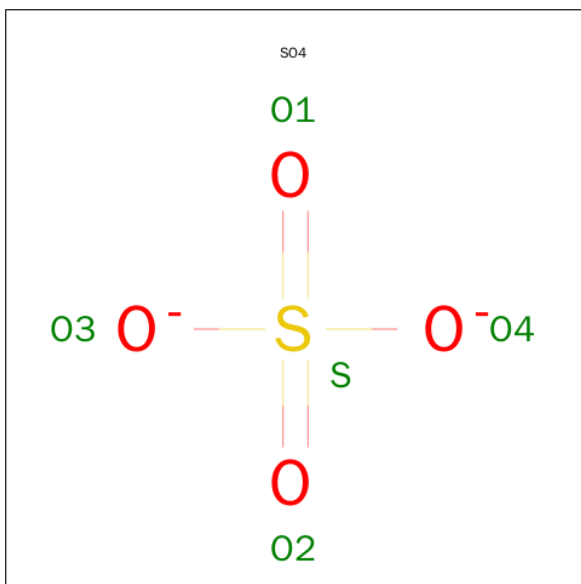
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	A	1	44	20	10	12	2	0	0

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			44	20	10	12	2		

- Molecule 4 is SULFATE ION (three-letter code: SO<sub>4</sub>) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	O	S	0	0
			5	4	1		
4	A	1	Total	O	S	0	0
			5	4	1		

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	33	Total	O	0	0
			33	33		



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	78.77Å 87.97Å 145.24Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.64 – 2.72 45.64 – 2.72	Depositor EDS
% Data completeness (in resolution range)	98.9 (45.64-2.72) 98.1 (45.64-2.72)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.57 (at 2.73Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE: 1.8.2_1309)	Depositor
R, $R_{free}$	0.213 , 0.244 0.217 , 0.249	Depositor DCC
$R_{free}$ test set	671 reflections (5.17%)	DCC
Wilson B-factor (Å <sup>2</sup> )	81.5	Xtriage
Anisotropy	0.572	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.26 , 56.6	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Outliers	1 of 13637 reflections (0.007%)	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	2449	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	91.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.34% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 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, SO4, 2BA

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	0.57	0/2590	1.11	13/4033 (0.3%)

There are no bond length outliers.

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	A	12	C	N1-C2-O2	7.88	123.63	118.90
1	A	114	C	C6-N1-C2	-7.79	117.19	120.30
1	A	94	C	C2-N1-C1'	7.33	126.86	118.80
1	A	12	C	N3-C2-O2	-7.23	116.84	121.90
1	A	114	C	N1-C2-O2	6.85	123.01	118.90
1	A	86	G	O5'-P-OP2	-6.47	99.88	105.70
1	A	114	C	N3-C2-O2	-6.21	117.55	121.90
1	A	94	C	C5-C6-N1	6.11	124.05	121.00
1	A	94	C	C6-N1-C2	-5.94	117.92	120.30
1	A	114	C	C2-N1-C1'	5.91	125.31	118.80
1	A	94	C	N1-C2-O2	5.20	122.02	118.90
1	A	114	C	C5-C6-N1	5.14	123.57	121.00
1	A	12	C	C2-N1-C1'	5.09	124.40	118.80

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	2316	0	1175	31	0
2	A	2	0	0	0	0
3	A	88	0	46	9	0
4	A	10	0	0	1	0
5	A	33	0	0	4	3
All	All	2449	0	1221	37	3

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 10.

All (37) 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:A:22:G:O2'	1:A:23:C:H5'	1.58	1.04
3:A:203:2BA:H8	3:A:203:2BA:H5'	1.51	0.90
1:A:11:A:OP2	5:A:301:HOH:O	2.02	0.78
1:A:90:C:O2	3:A:204:2BA:O2'1	2.04	0.74
4:A:206:SO4:O4	5:A:302:HOH:O	2.08	0.69
1:A:9:G:H2'	5:A:301:HOH:O	1.96	0.66
1:A:84:C:O2	3:A:203:2BA:O2'	2.16	0.64
1:A:110:C:O2	3:A:203:2BA:O2'1	2.17	0.63
1:A:104:C:O2	3:A:204:2BA:O2'	2.17	0.61
1:A:22:G:H2'	1:A:23:C:C6	2.35	0.61
1:A:23:C:O2'	1:A:24:G:O5'	2.13	0.57
1:A:40:G:H2'	1:A:41:G:O4'	2.06	0.56
1:A:76:C:H2'	1:A:77:C:H6	1.72	0.55
1:A:92:G:H1'	1:A:94:C:H41	1.72	0.54
1:A:56:A:H2'	1:A:57:A:O4'	2.08	0.54
3:A:203:2BA:C5'1	3:A:203:2BA:HC8	2.38	0.54
1:A:10:A:H3'	5:A:301:HOH:O	2.07	0.53
1:A:107:A:H2'	1:A:108:A:O4'	2.10	0.52
1:A:99:A:H2'	1:A:100:A:C8	2.44	0.52
3:A:203:2BA:HC5A	3:A:203:2BA:HC8	1.91	0.51
1:A:22:G:C2'	1:A:23:C:H5'	2.39	0.51
1:A:52:U:H2'	1:A:53:C:C6	2.45	0.51
1:A:39:G:C2	1:A:93:U:H1'	2.47	0.50
1:A:87:A:H2'	1:A:88:G:O4'	2.11	0.50
1:A:76:C:H2'	1:A:77:C:C6	2.46	0.50
1:A:23:C:H2'	1:A:24:G:H8	1.77	0.49
1:A:99:A:H2'	1:A:100:A:H8	1.79	0.47
1:A:113:C:H2'	1:A:114:C:O4'	2.16	0.45
3:A:203:2BA:H8	3:A:203:2BA:C5'	2.35	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:50:C:H2'	1:A:51:U:H6	1.82	0.43
1:A:122:A:C2	1:A:123:A:H1'	2.52	0.43
1:A:55:G:H5''	1:A:56:A:OP2	2.18	0.43
1:A:33:A:H5''	1:A:34:G:H5''	1.99	0.43
1:A:100:A:H2'	1:A:101:C:O4'	2.19	0.42
3:A:203:2BA:C8	3:A:203:2BA:H5'	2.36	0.42
1:A:94:C:H2'	1:A:95:A:C8	2.55	0.41
1:A:23:C:C2'	1:A:24:G:O5'	2.69	0.41

All (3) 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)
5:A:311:HOH:O	5:A:319:HOH:O 3_554	2.05	0.15
5:A:323:HOH:O	5:A:326:HOH:O 3_554	2.10	0.10
5:A:327:HOH:O	5:A:330:HOH:O 3_554	2.14	0.06

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

There are no protein molecules in this entry.

### 5.3.2 Protein sidechains [i](#)

There are no protein molecules in this entry.

### 5.3.3 RNA [i](#)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	105/125 (84%)	19 (18%)	0

All (19) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	6	G
1	A	12	C
1	A	23	C

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Mol	Chain	Res	Type
1	A	24	G
1	A	33	A
1	A	41	G
1	A	53	C
1	A	55	G
1	A	63	G
1	A	73	A
1	A	74	C
1	A	84	C
1	A	88	G
1	A	92	G
1	A	93	U
1	A	95	A
1	A	114	C
1	A	115	G
1	A	123	A

There are no RNA pucker outliers to report.

## 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](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 2 are monoatomic - leaving 4 for Mogul analysis.

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
3	2BA	A	203	-	40,50,50	4.04	15 (37%)	44,78,78	3.27	11 (25%)
3	2BA	A	204	-	40,50,50	3.98	15 (37%)	44,78,78	2.96	10 (22%)
4	SO4	A	205	-	4,4,4	0.12	0	6,6,6	0.16	0
4	SO4	A	206	-	4,4,4	0.17	0	6,6,6	0.14	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
3	2BA	A	203	-	-	0/22/62/62	0/6/7/7
3	2BA	A	204	-	-	0/22/62/62	0/6/7/7
4	SO4	A	205	-	-	0/0/0/0	0/0/0/0
4	SO4	A	206	-	-	0/0/0/0	0/0/0/0

All (30) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	204	2BA	O4'1-C4'1	-7.59	1.27	1.45
3	A	203	2BA	O4'1-C4'1	-7.54	1.27	1.45
3	A	204	2BA	O4'-C4'	-6.44	1.30	1.45
3	A	203	2BA	O4'-C4'	-5.75	1.31	1.45
3	A	204	2BA	O3'1-C3'1	-3.19	1.34	1.44
3	A	203	2BA	O3'-C3'	-2.75	1.35	1.44
3	A	204	2BA	C5-C4	-2.67	1.34	1.40
3	A	203	2BA	O3'1-C3'1	-2.54	1.36	1.44
3	A	204	2BA	O3'-C3'	-2.50	1.36	1.44
3	A	203	2BA	C51-C41	-2.35	1.35	1.40
3	A	204	2BA	C51-C41	-2.31	1.35	1.40
3	A	203	2BA	C5-C4	-2.23	1.35	1.40
3	A	204	2BA	C6-N6	2.07	1.41	1.34
3	A	204	2BA	P-O3'1	2.13	1.66	1.60
3	A	203	2BA	C6-N6	2.14	1.41	1.34
3	A	203	2BA	C21-N31	2.49	1.36	1.32
3	A	203	2BA	O2'-C2'	2.51	1.49	1.43
3	A	204	2BA	O2'-C2'	2.61	1.49	1.43
3	A	203	2BA	P-O3'1	2.74	1.68	1.60
3	A	204	2BA	C21-N31	2.77	1.37	1.32
3	A	203	2BA	C2-N3	2.89	1.37	1.32
3	A	204	2BA	O2'1-C2'1	3.06	1.50	1.43
3	A	204	2BA	C2-N3	3.07	1.37	1.32

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	203	2BA	C61-N61	3.08	1.44	1.34
3	A	204	2BA	C61-N61	3.10	1.44	1.34
3	A	203	2BA	O2'1-C2'1	3.17	1.50	1.43
3	A	204	2BA	O4'-C1'	14.08	1.59	1.41
3	A	203	2BA	O4'1-C1'1	15.08	1.60	1.41
3	A	204	2BA	O4'1-C1'1	15.27	1.60	1.41
3	A	203	2BA	O4'-C1'	15.41	1.60	1.41

All (21) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	203	2BA	N31-C21-N11	-12.93	119.00	128.89
3	A	204	2BA	N31-C21-N11	-12.15	119.59	128.89
3	A	203	2BA	N3-C2-N1	-12.02	119.69	128.89
3	A	204	2BA	N3-C2-N1	-10.07	121.18	128.89
3	A	204	2BA	N61-C61-N11	-3.69	111.29	119.20
3	A	203	2BA	C2'-C1'-N9	-3.38	109.13	114.29
3	A	203	2BA	N61-C61-N11	-2.81	113.17	119.20
3	A	204	2BA	C2'-C1'-N9	-2.51	110.46	114.29
3	A	204	2BA	C41-C51-N71	-2.26	107.40	109.48
3	A	204	2BA	N6-C6-N1	-2.26	114.35	119.20
3	A	203	2BA	C4'-O4'-C1'	-2.03	107.49	109.72
3	A	204	2BA	C3'1-C2'1-C1'1	2.07	104.94	99.98
3	A	203	2BA	C3'1-C2'1-C1'1	2.48	105.94	99.98
3	A	204	2BA	C1'1-N91-C41	2.50	130.70	126.94
3	A	203	2BA	O2P-P-O3'1	2.53	116.67	106.49
3	A	204	2BA	C3'-C2'-C1'	2.78	106.65	99.98
3	A	203	2BA	C3'-C2'-C1'	2.92	106.98	99.98
3	A	203	2BA	O2P1-P1-O3'	3.42	120.21	106.49
3	A	203	2BA	O4'-C1'-N9	5.62	119.85	108.10
3	A	203	2BA	C1'-N9-C4	5.90	135.83	126.94
3	A	204	2BA	C1'-N9-C4	7.52	138.29	126.94

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

3 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	203	2BA	7	0
3	A	204	2BA	2	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	206	SO4	1	0

## 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	108/125 (86%)	0.82	3 (2%) 56 57	61, 87, 130, 168	0

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	3	A	3.8
1	A	112	U	2.2
1	A	55	G	2.1

### 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](#)

There are no carbohydrates in this entry.

### 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. 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, 95<sup>th</sup> 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	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
3	2BA	A	203	44/44	0.95	0.24	0.44	57,73,94,100	0
3	2BA	A	204	44/44	0.97	0.22	0.35	61,71,76,81	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
2	MG	A	202	1/1	0.66	0.17	-1.78	69,69,69,69	0
2	MG	A	201	1/1	0.94	0.10	-4.38	88,88,88,88	0
4	SO4	A	205	5/5	0.72	0.19	-	174,175,180,181	0
4	SO4	A	206	5/5	0.85	0.19	-	158,160,161,167	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.