



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 07:04 AM UTC

PDB ID : 9KKV / pdb_00009kkv
Title : Structure-guided interface engineering for modifying substrate binding and catalytic activity of 2-keto-3-deoxy-D-xylonate dehydratase
Authors : Liang, B.
Deposited on : 2024-11-14
Resolution : 1.77 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 ⓘ 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 ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

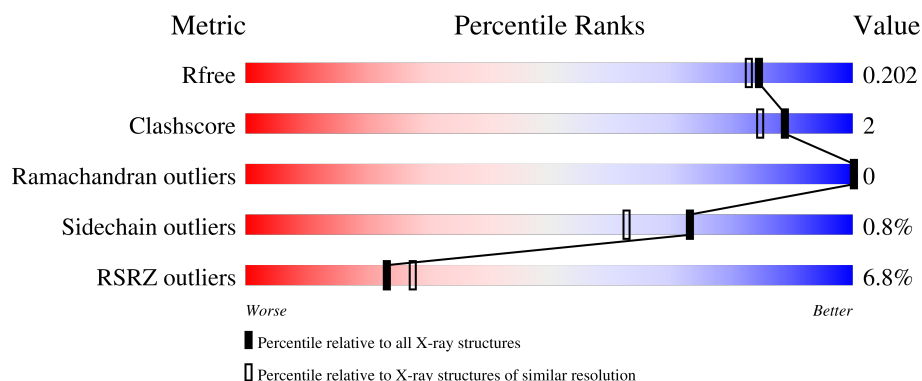
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.77 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}	180053	1365 (1.78-1.78)
Clashscore	190562	1395 (1.78-1.78)
Ramachandran outliers	187476	1382 (1.78-1.78)
Sidechain outliers	187428	1382 (1.78-1.78)
RSRZ outliers	180081	1365 (1.78-1.78)

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 $\leq 5\%$. 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	383	3% 96% .
1	B	383	11% 95% ..

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	2HP	A	404	-	-	X	-
3	NH4	A	402	-	-	X	-

2 Entry composition [i](#)

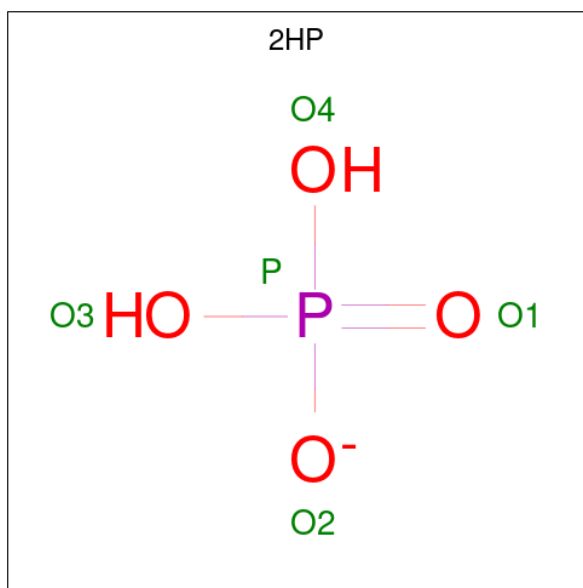
There are 4 unique types of molecules in this entry. The entry contains 6730 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Fumarylacetoacetate hydrolase family protein.

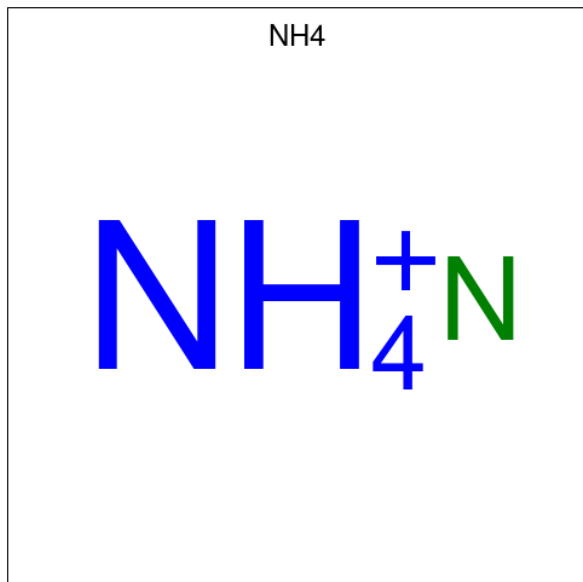
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	378	Total	C	N	O	S	0	2	0
			2850	1800	497	544	9			
1	A	383	Total	C	N	O	S	0	3	0
			2918	1840	515	554	9			

- Molecule 2 is DIHYDROGENPHOSPHATE ION (CCD ID: 2HP) (formula: $\text{H}_2\text{O}_4\text{P}$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	B	1	Total	O	P	0	0
			5	4	1		
2	A	1	Total	O	P	0	0
			5	4	1		
2	A	1	Total	O	P	0	0
			5	4	1		
2	A	1	Total	O	P	0	0
			5	4	1		

- Molecule 3 is AMMONIUM ION (CCD ID: NH4) (formula: H_4N) (labeled as "Ligand of Interest" by depositor).



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

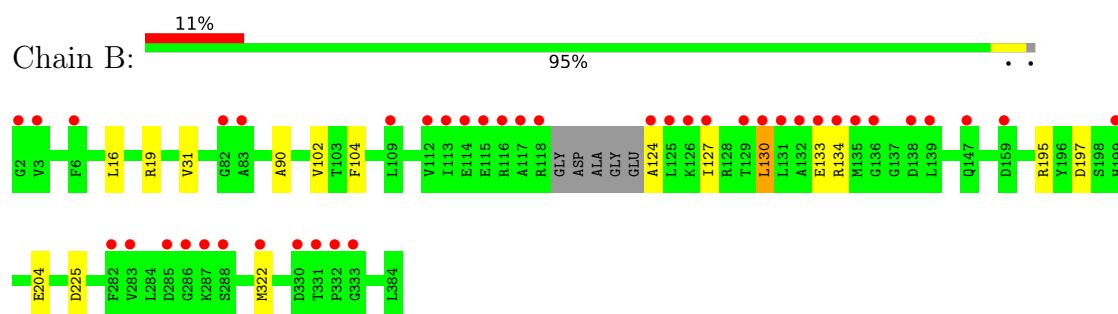
- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	B	380	Total O 380 380	0	0
4	A	559	Total O 559 559	0	0

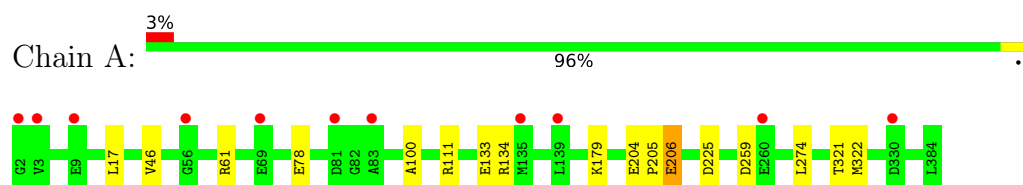
3 Residue-property plots [i](#)

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: Fumarylacetoacetate hydrolase family protein



- Molecule 1: Fumarylacetoacetate hydrolase family protein



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	101.81Å 101.81Å 211.24Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.34 – 1.77 50.34 – 1.77	Depositor EDS
% Data completeness (in resolution range)	99.9 (50.34-1.77) 99.9 (50.34-1.77)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.02 (at 1.77Å)	Xtriage
Refinement program	PHENIX (1.21.1.5286)	Depositor
R, R_{free}	0.174 , 0.202 0.176 , 0.202	Depositor DCC
R_{free} test set	2000 reflections (1.84%)	wwPDB-VP
Wilson B-factor (Å ²)	17.8	Xtriage
Anisotropy	0.047	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 44.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	6730	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.88% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 2HP, NH4

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	0.34	0/2981	0.54	0/4040
1	B	0.28	0/2912	0.47	0/3954
All	All	0.31	0/5893	0.51	0/7994

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

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	2918	0	2915	10	0
1	B	2850	0	2817	8	0
2	A	15	0	0	4	0
2	B	5	0	0	1	0
3	A	2	0	0	3	0
3	B	1	0	0	1	0
4	A	559	0	0	3	0
4	B	380	0	0	0	0
All	All	6730	0	5732	22	0

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 (22) 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)
2:A:401:2HP:O2	3:A:405:NH4:N	2.21	0.73
3:A:402:NH4:N	2:A:404:2HP:O2	2.23	0.71
1:A:61[B]:ARG:NE	4:A:503:HOH:O	2.29	0.66
1:B:133:GLU:OE2	1:B:134:ARG:NH1	2.34	0.60
2:B:401:2HP:O2	3:B:402:NH4:N	2.35	0.59
3:A:402:NH4:N	2:A:403:2HP:O1	2.41	0.54
1:A:133:GLU:OE1	1:A:134:ARG:HD3	2.07	0.53
1:A:204:GLU:HB3	1:A:321:THR:HB	1.94	0.49
1:A:78:GLU:OE1	4:A:501:HOH:O	2.20	0.49
1:A:205:PRO:C	1:A:206:GLU:HG2	2.37	0.49
1:A:179:LYS:NZ	1:A:225:ASP:OD1	2.42	0.48
1:A:17:LEU:HD21	1:A:46:VAL:HG13	1.97	0.46
1:A:100:ALA:O	2:A:404:2HP:O4	2.35	0.45
1:A:205:PRO:HG3	1:A:274:LEU:HD13	2.01	0.43
1:B:124:ALA:HA	1:B:127:ILE:HD12	2.01	0.43
1:A:259:ASP:OD2	4:A:502:HOH:O	2.21	0.42
1:B:19:ARG:HD3	1:B:90:ALA:O	2.21	0.41
1:B:16:LEU:HB2	1:B:31:VAL:HB	2.02	0.41
1:B:104:PHE:CG	1:B:322:MET:HB3	2.56	0.41
1:B:195:ARG:HB3	1:B:197:ASP:OD1	2.21	0.41
1:B:130:LEU:O	1:B:133:GLU:HG3	2.21	0.40
1:B:204:GLU:HB2	1:B:225:ASP:HB3	2.02	0.40

There are no symmetry-related clashes.

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	384/383 (100%)	380 (99%)	4 (1%)	0	100	100
1	B	376/383 (98%)	371 (99%)	5 (1%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
All	All	760/766 (99%)	751 (99%)	9 (1%)	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	305/303 (101%)	302 (99%)	3 (1%)	68	55
1	B	296/303 (98%)	294 (99%)	2 (1%)	76	66
All	All	601/606 (99%)	596 (99%)	5 (1%)	73	63

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	102	VAL
1	B	130	LEU
1	A	111	ARG
1	A	206	GLU
1	A	322	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	227	ASN
1	B	356	ASN
1	A	356	ASN

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](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 7 ligands modelled in this entry, 3 are modelled with single atom - 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	$\# Z > 2$
2	2HP	B	401	-	4,4,4	0.92	0	6,6,6	0.45	0
2	2HP	A	404	-	4,4,4	1.10	0	6,6,6	0.59	0
2	2HP	A	403	-	4,4,4	0.72	0	6,6,6	0.51	0
2	2HP	A	401	-	4,4,4	0.66	0	6,6,6	0.48	0

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

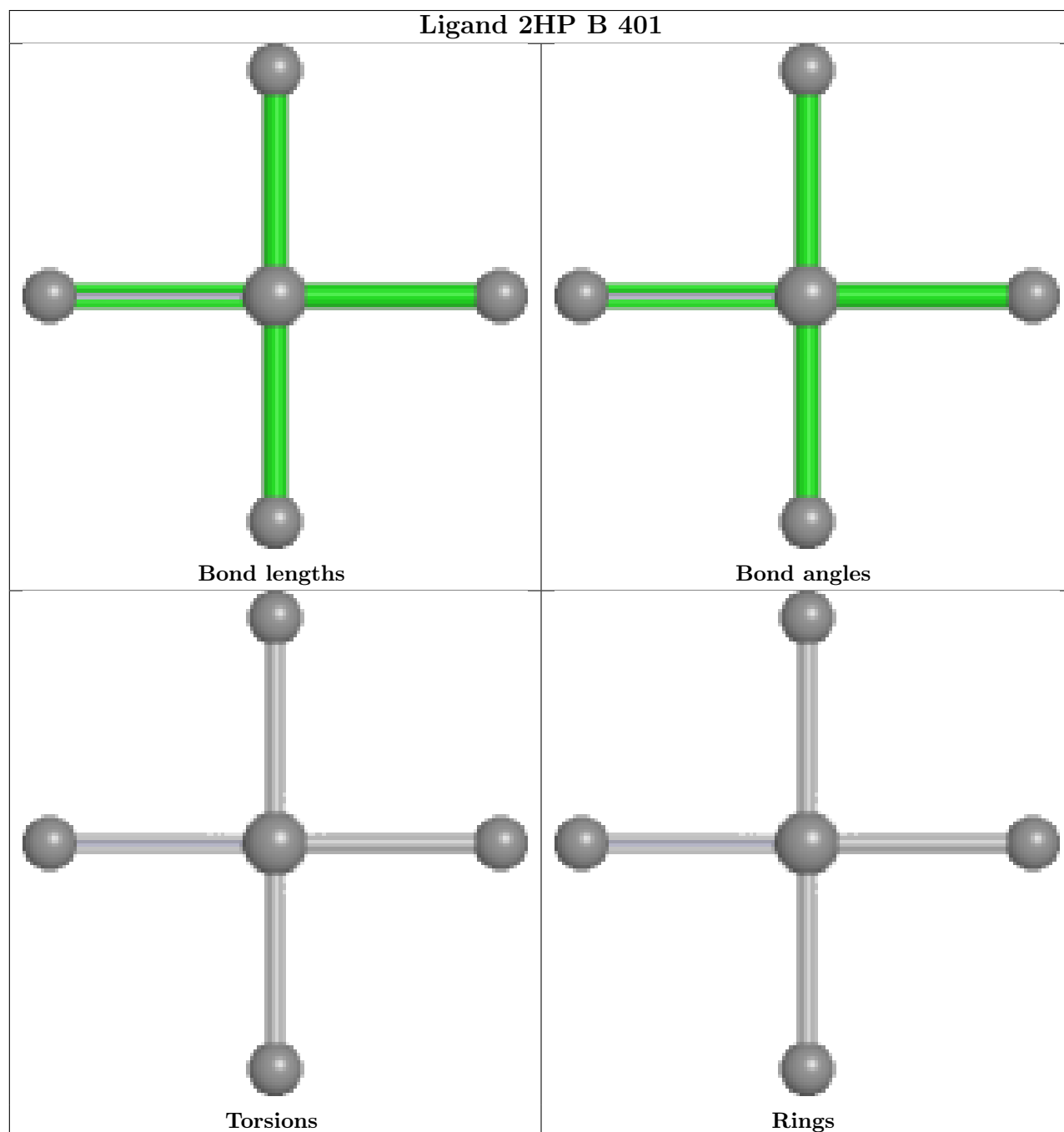
There are no ring outliers.

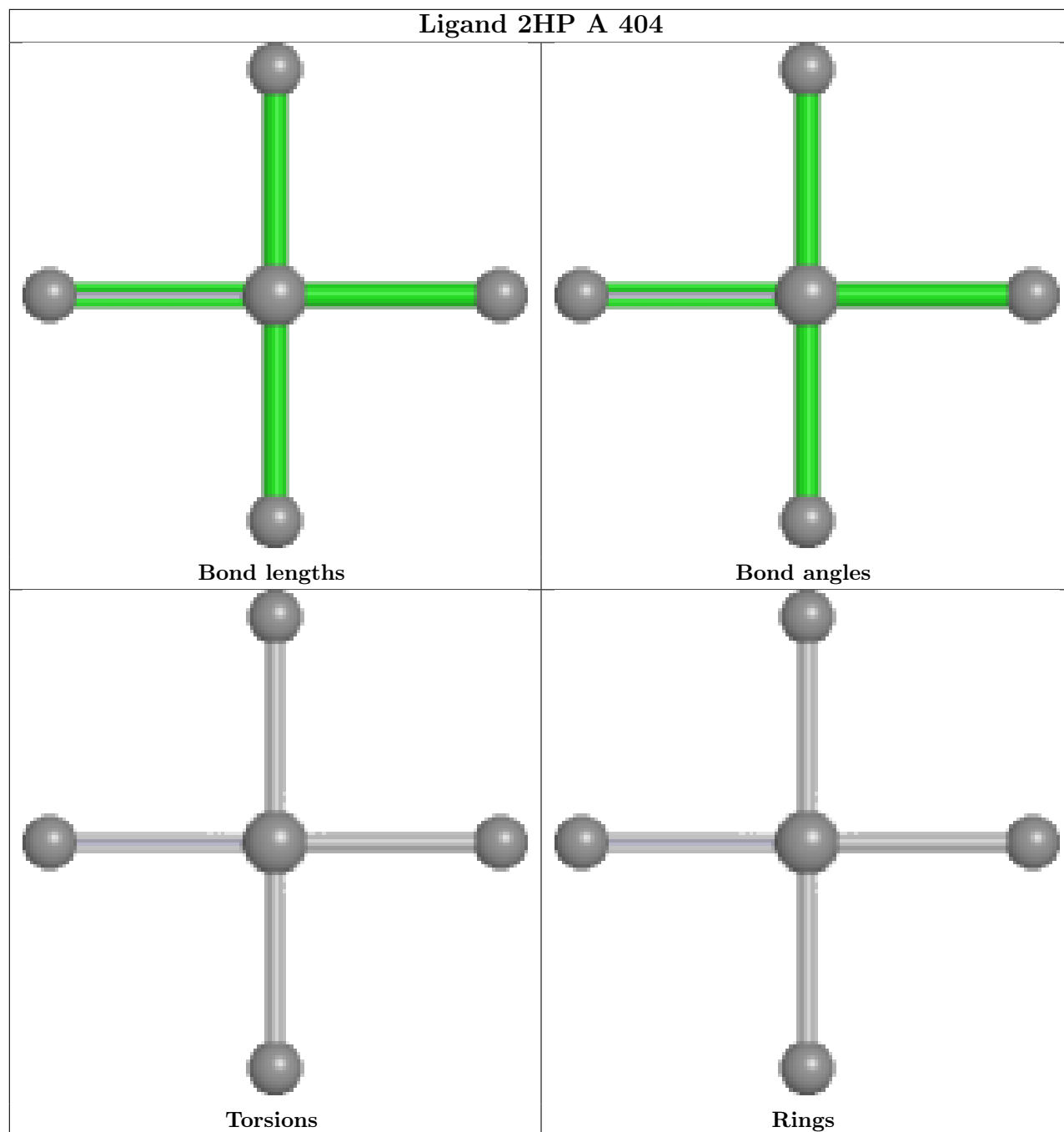
4 monomers are involved in 5 short contacts:

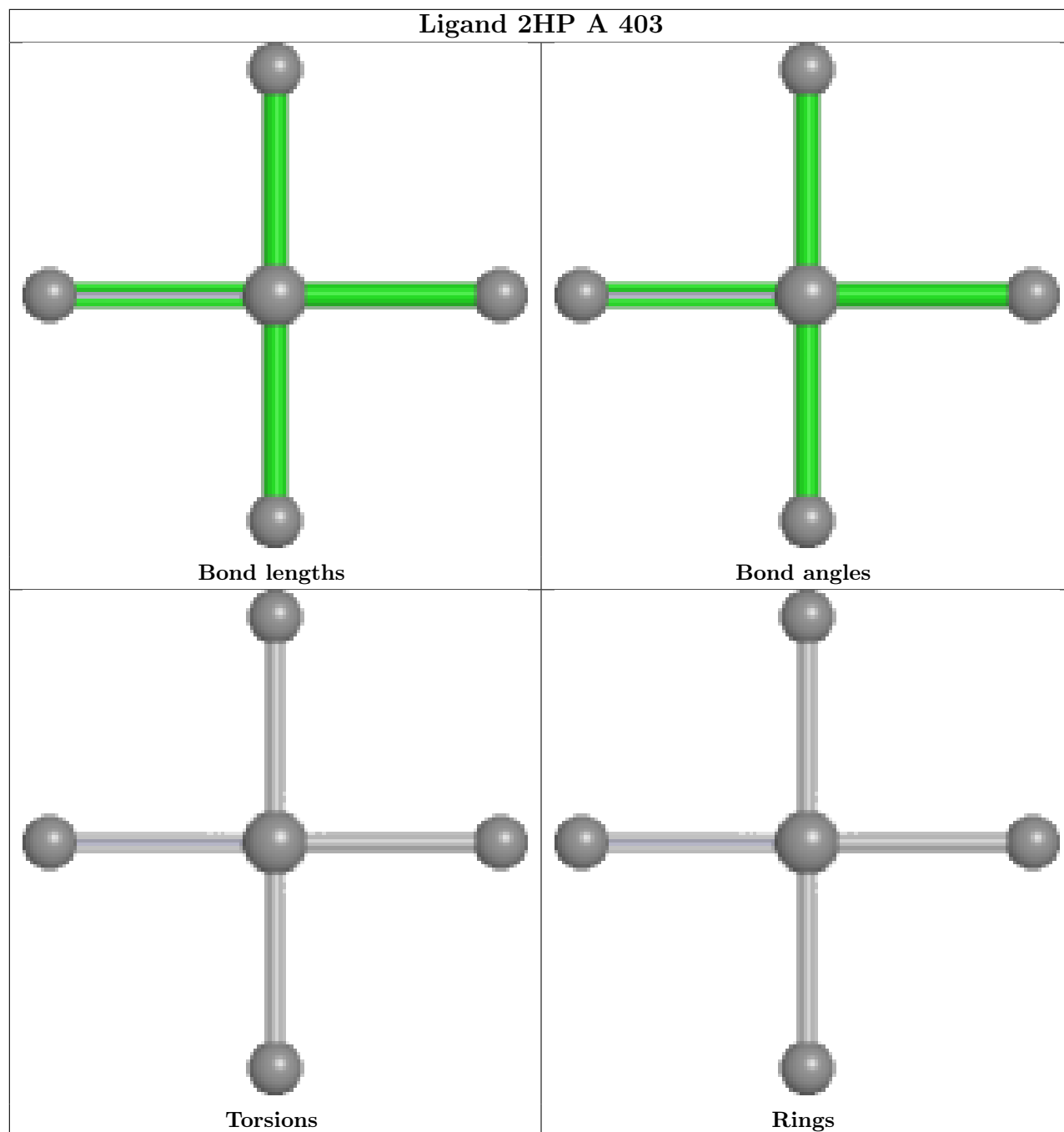
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	401	2HP	1	0
2	A	404	2HP	2	0
2	A	403	2HP	1	0
2	A	401	2HP	1	0

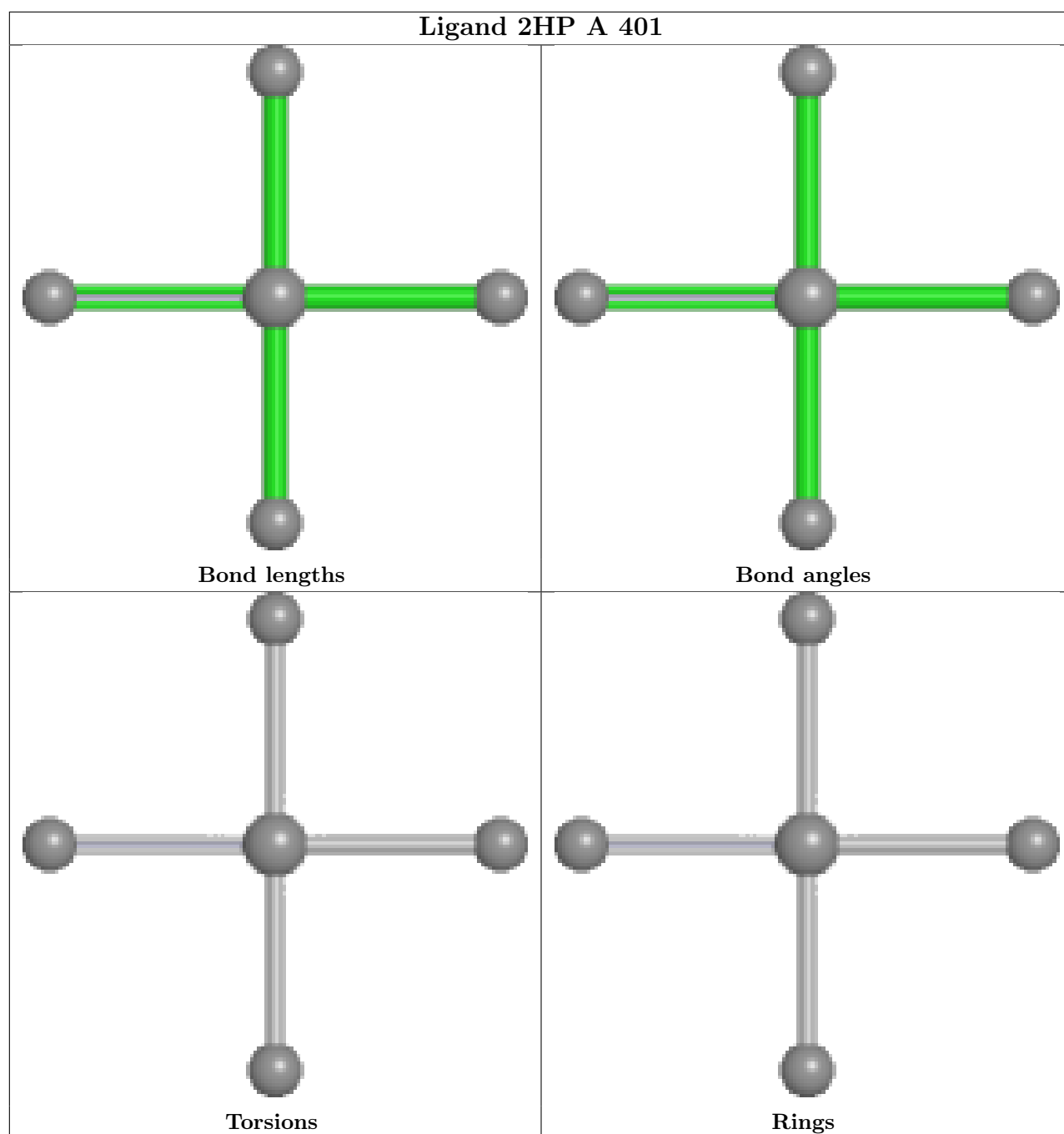
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths,

bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.









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

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	383/383 (100%)	-0.17	11 (2%)	53 61	10, 17, 31, 56	6 (1%)
1	B	378/383 (98%)	0.49	41 (10%)	11 12	12, 25, 63, 85	3 (0%)
All	All	761/766 (99%)	0.16	52 (6%)	23 27	10, 20, 51, 85	9 (1%)

All (52) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	124	ALA	5.7
1	A	2	GLY	5.0
1	B	125	LEU	4.8
1	B	118	ARG	4.6
1	B	2	GLY	4.5
1	B	127	ILE	4.4
1	B	332	PRO	4.3
1	B	288	SER	4.3
1	B	109	LEU	4.0
1	A	139	LEU	4.0
1	B	130	LEU	3.9
1	B	287	LYS	3.9
1	B	126	LYS	3.6
1	B	131	LEU	3.6
1	B	132	ALA	3.5
1	B	331	THR	3.4
1	B	117	ALA	3.3
1	B	285	ASP	3.2
1	B	3	VAL	3.0
1	B	286	GLY	3.0
1	B	139	LEU	2.9
1	A	260	GLU	2.9
1	B	113	ILE	2.8
1	B	133	GLU	2.8

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Mol	Chain	Res	Type	RSRZ
1	B	159	ASP	2.8
1	A	83	ALA	2.7
1	B	138	ASP	2.7
1	B	147	GLN	2.6
1	B	282	PHE	2.6
1	A	3	VAL	2.6
1	B	115	GLU	2.6
1	B	129	THR	2.6
1	B	116	ARG	2.6
1	B	6	PHE	2.5
1	B	135	MET	2.5
1	A	81	ASP	2.4
1	A	9	GLU	2.4
1	B	112	VAL	2.4
1	B	134	ARG	2.3
1	B	136	GLY	2.3
1	B	322	MET	2.3
1	A	69	GLU	2.3
1	B	82	GLY	2.3
1	B	333	GLY	2.3
1	B	83	ALA	2.2
1	B	330	ASP	2.2
1	B	283	VAL	2.2
1	A	135	MET	2.2
1	A	330	ASP	2.1
1	B	114	GLU	2.1
1	A	56	GLY	2.0
1	B	199	HIS	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](#)

There are no oligosaccharides 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. The B-factors column lists the minimum,

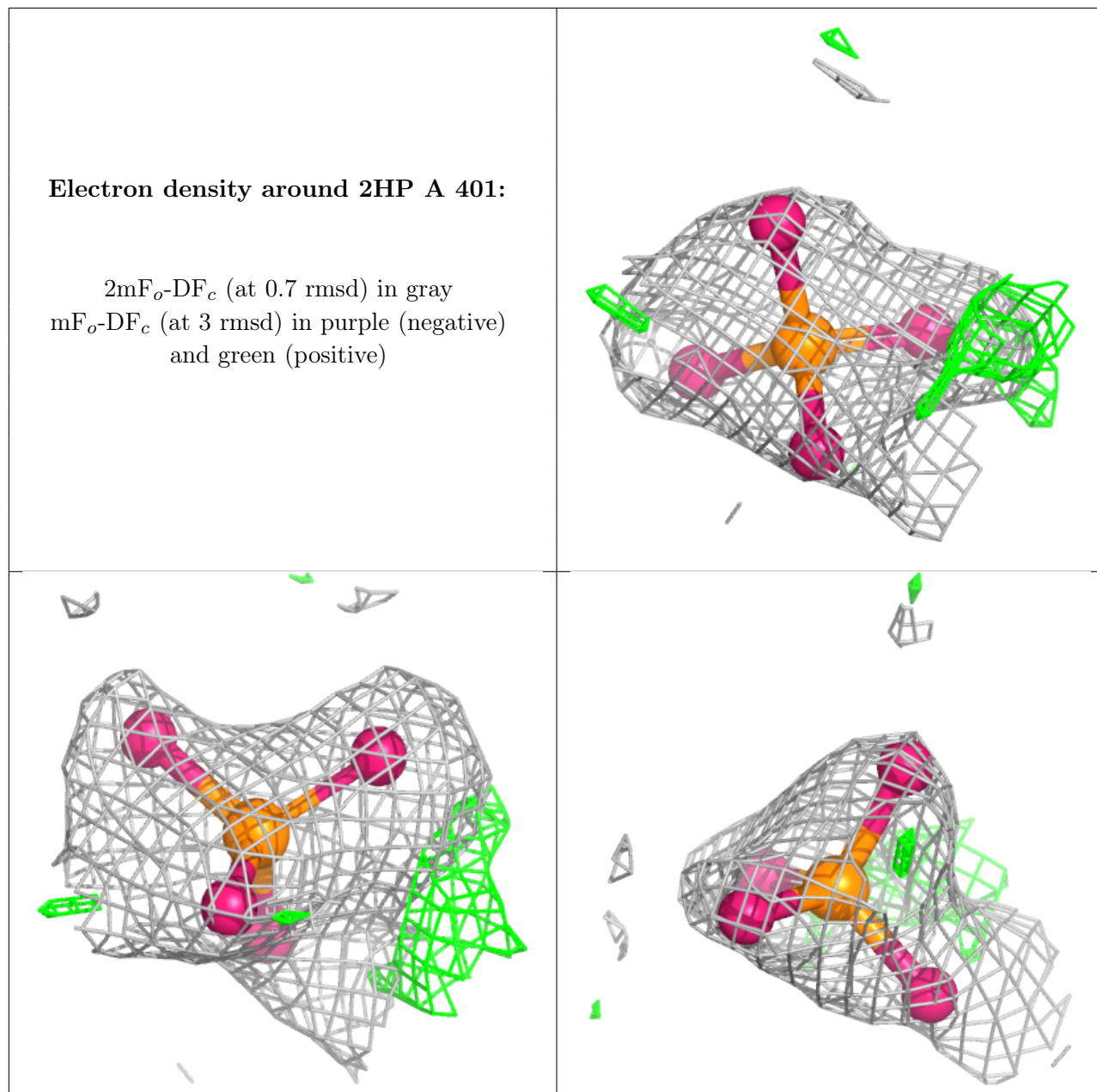
median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	2HP	A	401	5/5	0.82	0.15	31,33,36,37	5
3	NH4	A	405	1/1	0.82	0.16	29,29,29,29	0
3	NH4	B	402	1/1	0.85	0.17	32,32,32,32	0
2	2HP	B	401	5/5	0.87	0.20	25,26,29,30	5
2	2HP	A	404	5/5	0.91	0.13	15,21,23,26	5
2	2HP	A	403	5/5	0.93	0.13	21,24,28,28	5
3	NH4	A	402	1/1	0.94	0.11	20,20,20,20	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

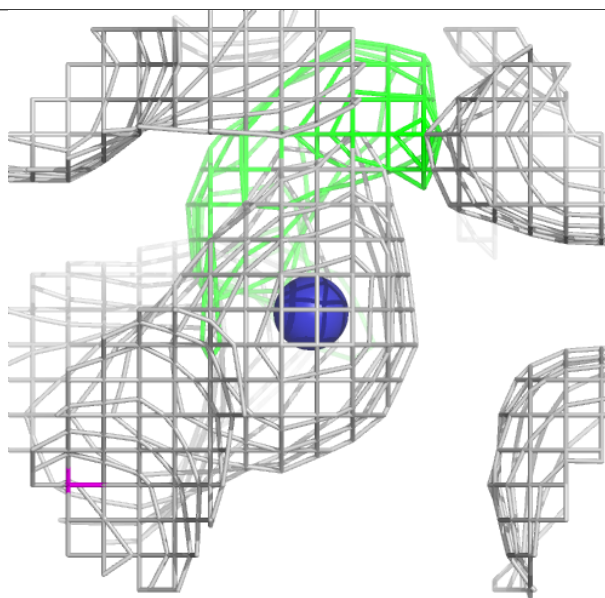
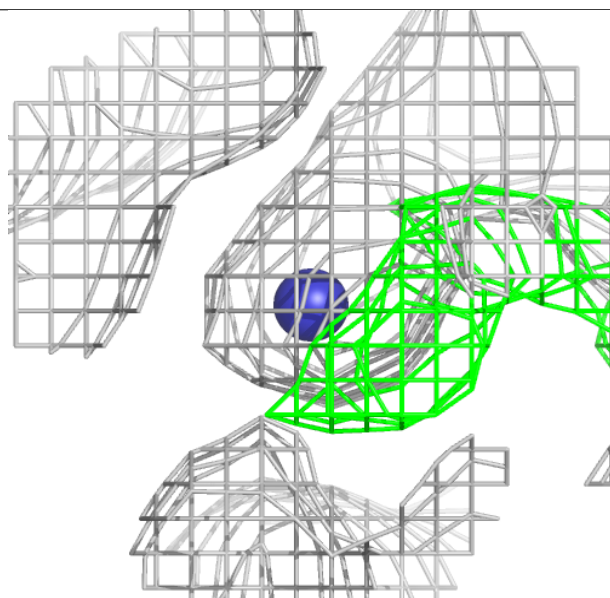
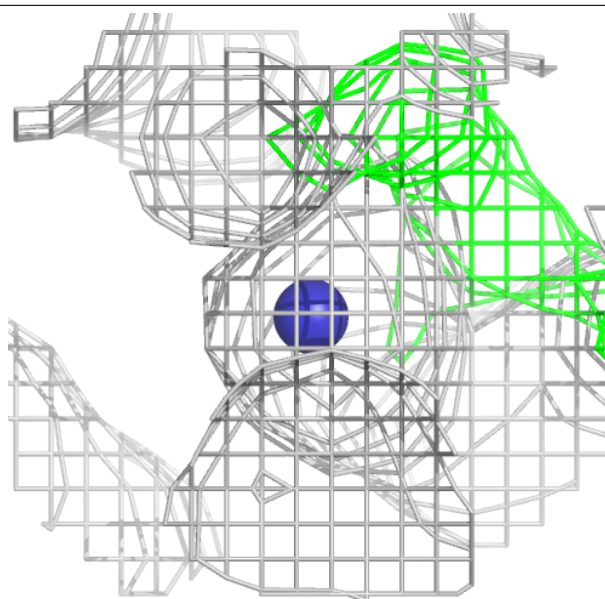
Electron density around 2HP A 401:

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



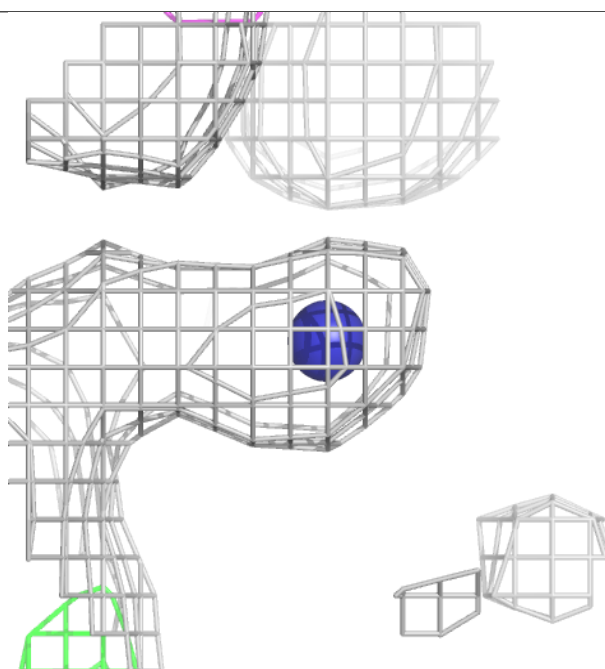
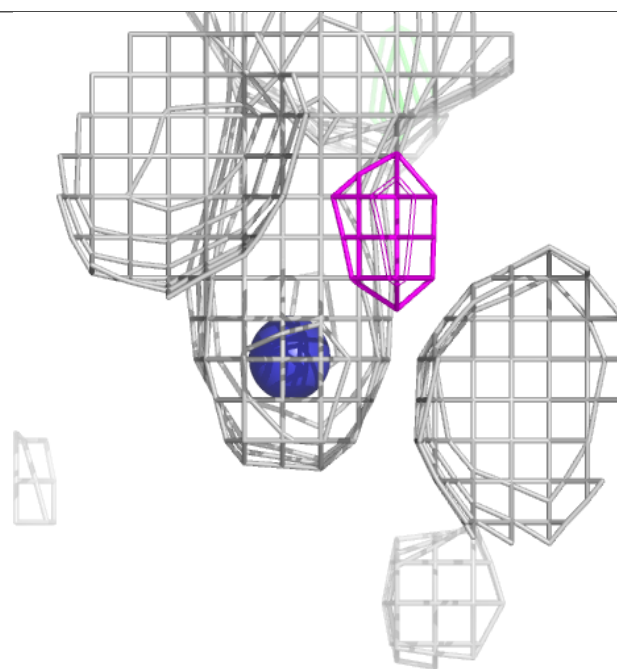
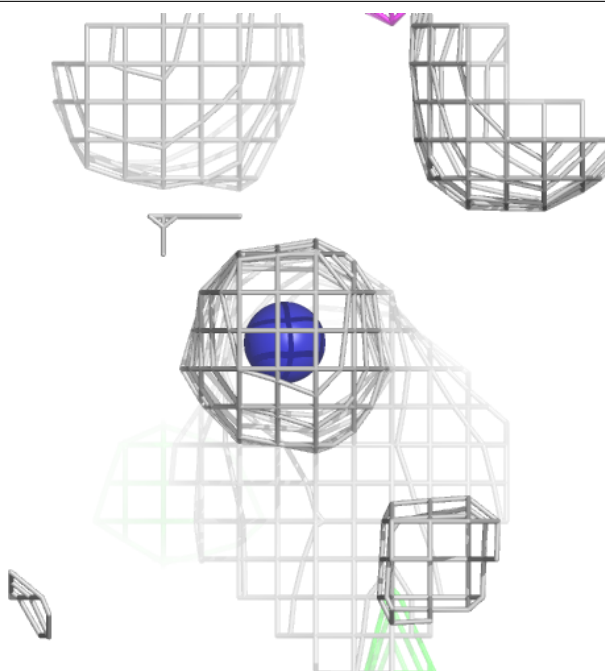
Electron density around NH4 A 405:

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



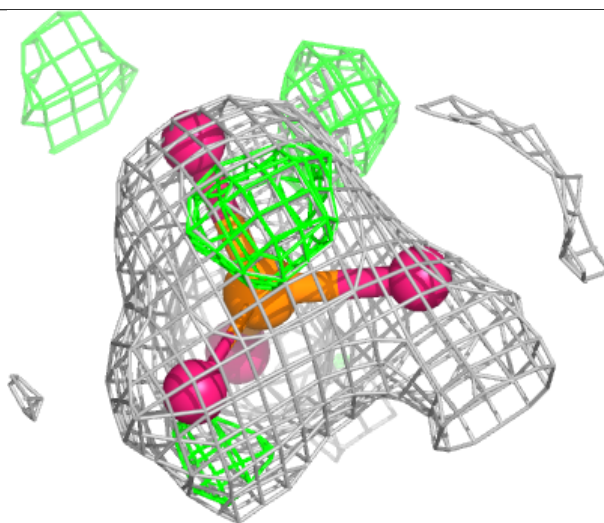
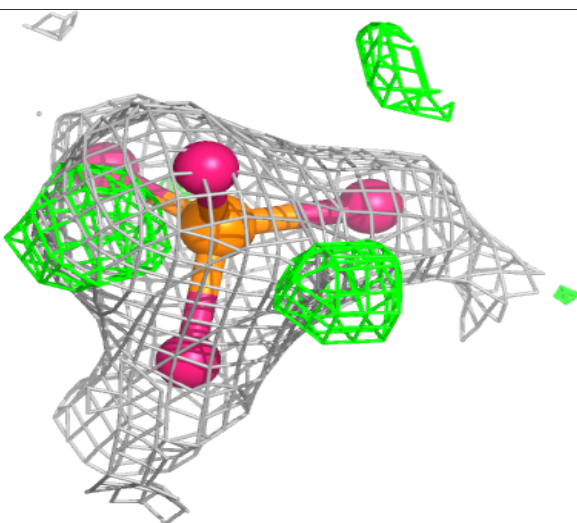
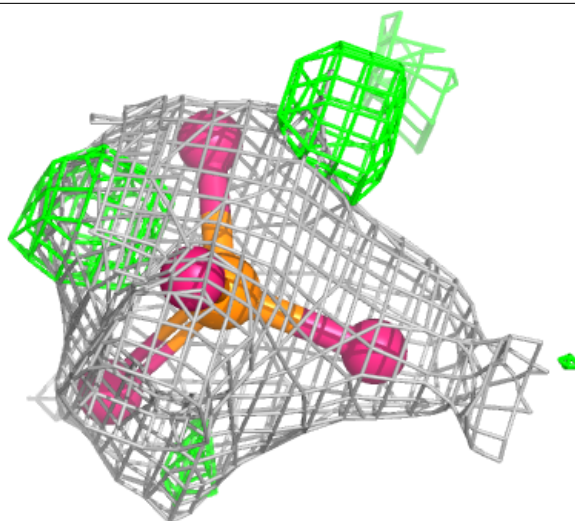
Electron density around NH4 B 402:

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



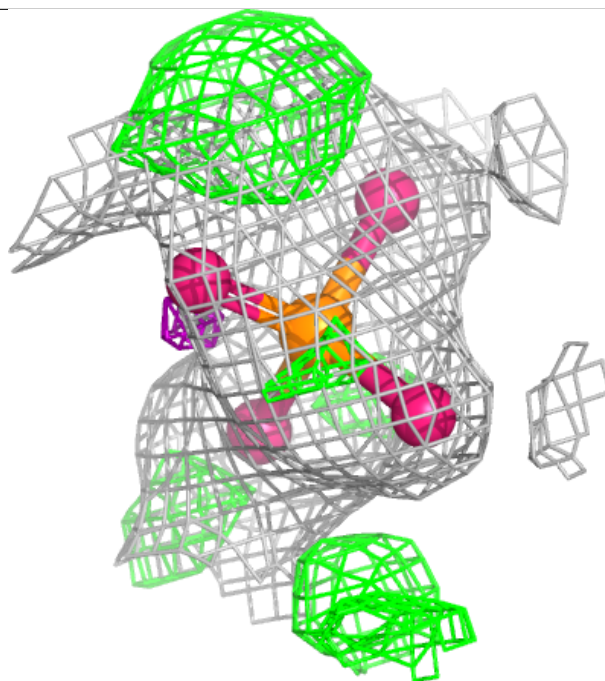
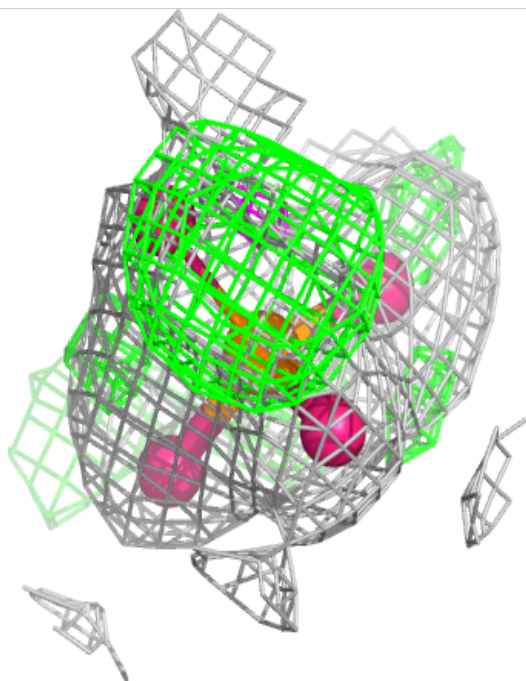
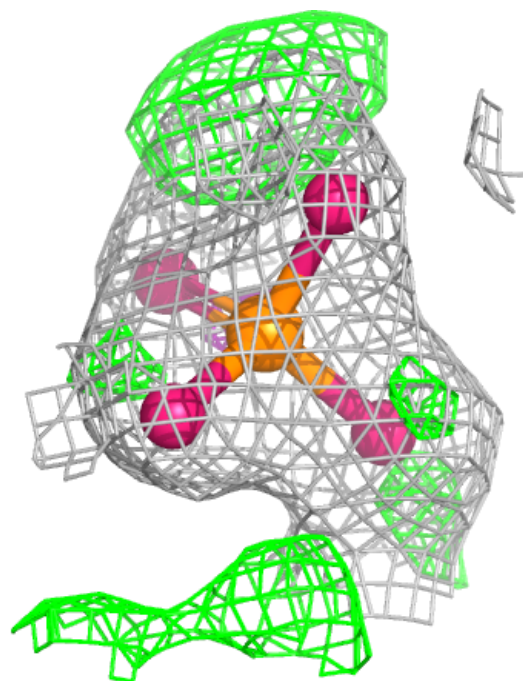
Electron density around 2HP B 401:

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



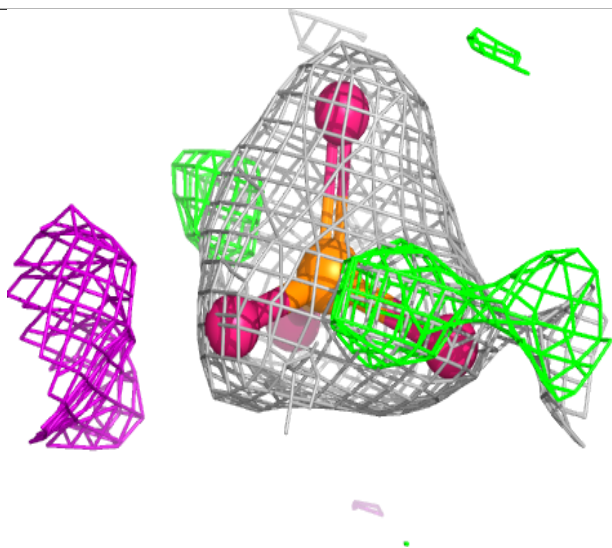
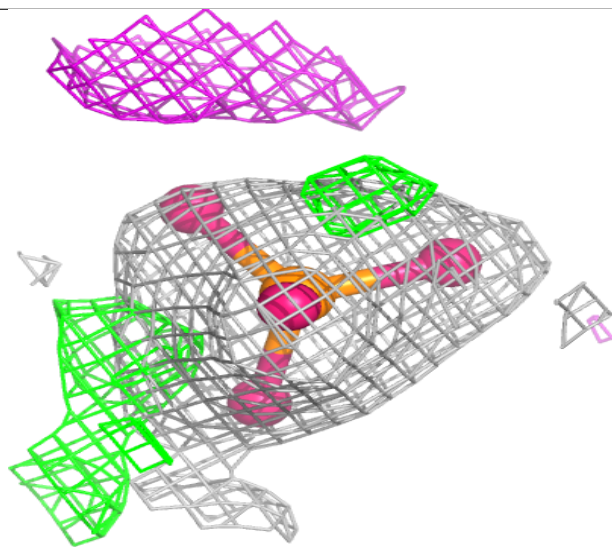
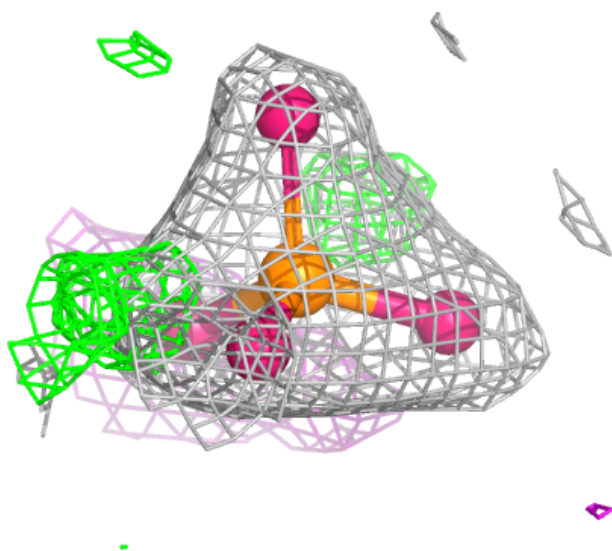
Electron density around 2HP A 404:

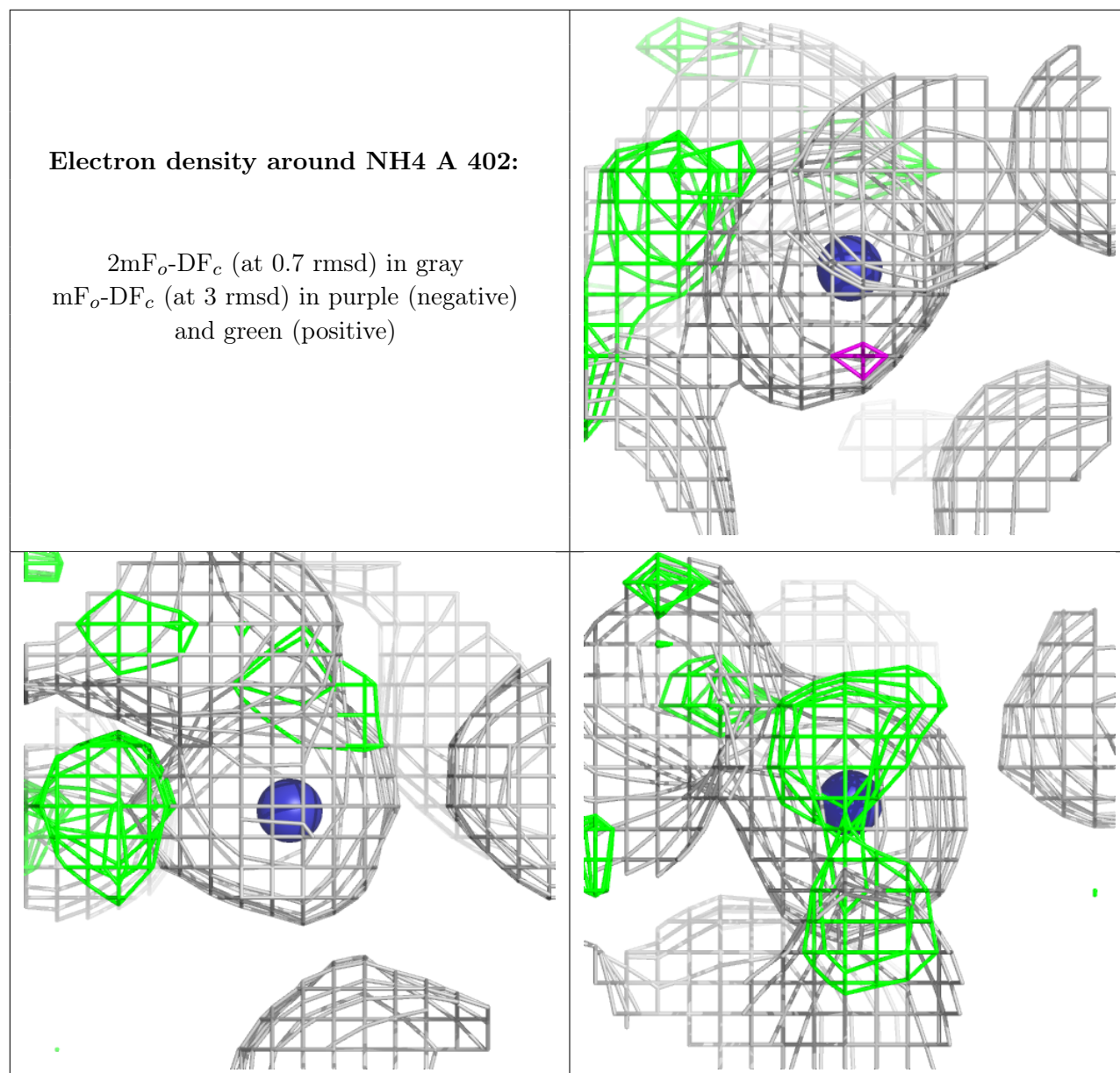
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around 2HP A 403:

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





6.5 Other polymers ⓘ

There are no such residues in this entry.