



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 09:48 AM UTC

PDB ID : 1LCU / pdb_00001lcu
Title : Polylysine Induces an Antiparallel Actin Dimer that Nucleates Filament Assembly: Crystal Structure at 3.5 Å Resolution
Authors : Bubb, M.R.; Govindasamy, L.; Yarmola, E.G.; Vorobiev, S.M.; Almo, S.C.; Somasundaram, T.; Chapman, M.S.; Agbandje-Mckenna, M.; McKenna, R.
Deposited on : 2002-04-06
Resolution : 3.50 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

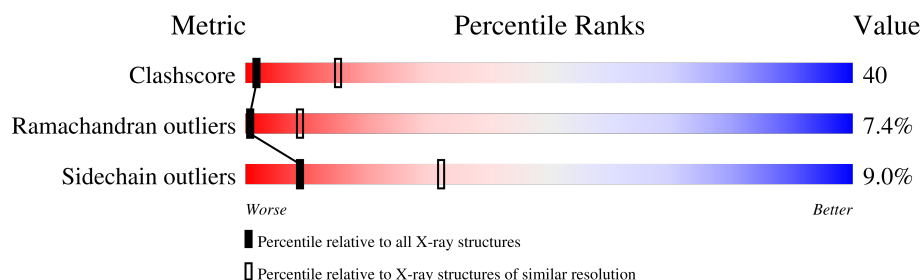
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.50 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))
Clashscore	190562	1140 (3.54-3.46)
Ramachandran outliers	187476	1113 (3.54-3.46)
Sidechain outliers	187428	1114 (3.54-3.46)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	371	
1	B	371	

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 5936 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 Actin, alpha skeletal muscle.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	361	Total	C	N	O	S	0	0	0
			2829	1794	476	540	19			
1	B	371	Total	C	N	O	S	0	0	0
			2896	1835	488	552	21			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	56	VAL	GLY	conflict	UNP P68135
A	60	GLY	LYS	conflict	UNP P68135
B	1056	VAL	GLY	conflict	UNP P68135
B	1060	GLY	LYS	conflict	UNP P68135

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

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

- Molecule 3 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

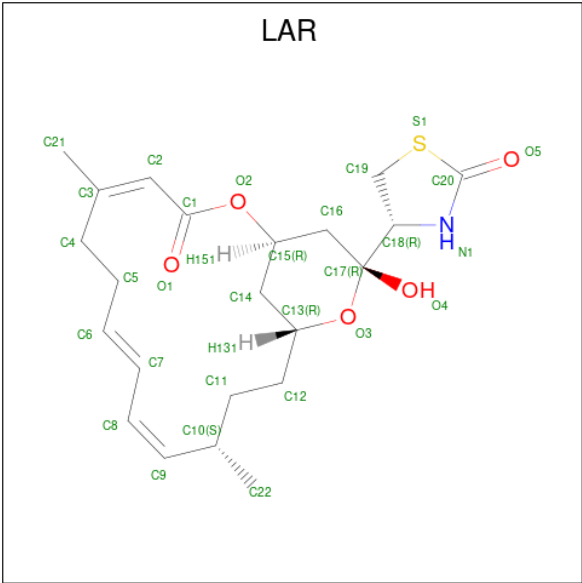
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	2	Total	Cl	0	0
			2	2		
3	B	1	Total	Cl	0	0
			1	1		

- Molecule 4 is ADENOSINE-5'-TRIPHOSPHATE (CCD ID: ATP) (formula: C₁₀H₁₆N₅O₁₃P₃).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	P	0	0
			31	10	5	13	3		
4	B	1	Total	C	N	O	P	0	0
			31	10	5	13	3		

- Molecule 5 is LATRUNCULIN A (CCD ID: LAR) (formula: $C_{22}H_{31}NO_5S$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
5	A	1	Total	C	N	O	S	0	0
			29	22	1	5	1		
5	B	1	Total	C	N	O	S	0	0
			29	22	1	5	1		

- Molecule 6 is water.

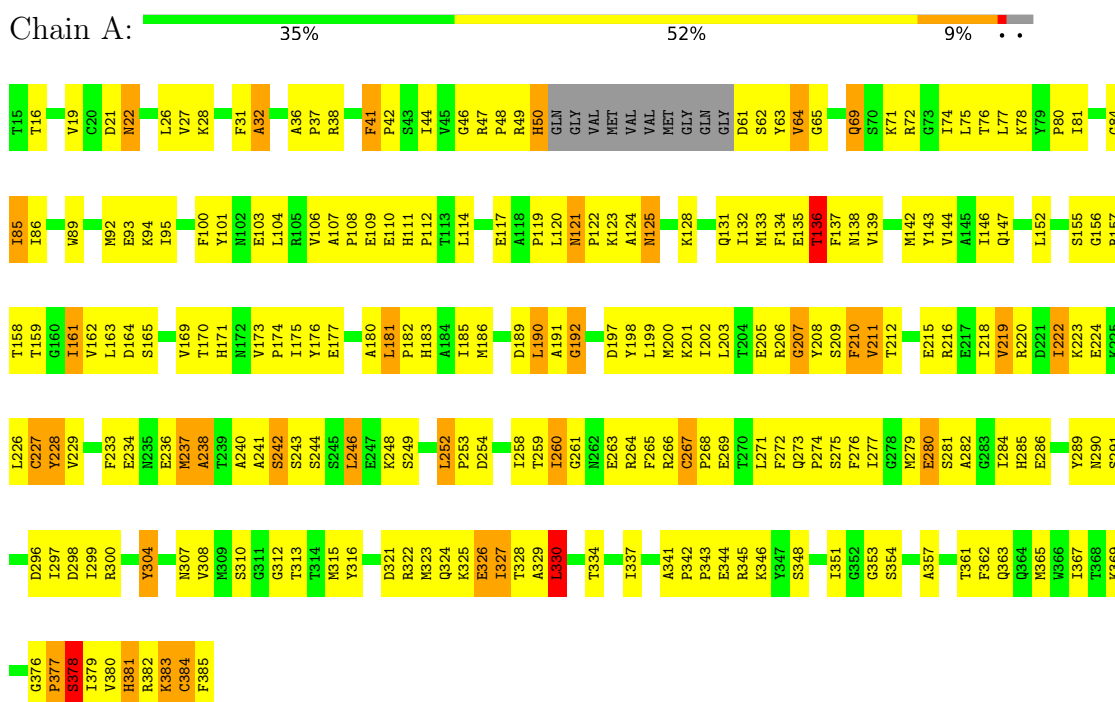
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	41	Total 41	O 41	0	0
6	B	43	Total 43	O 43	0	0

3 Residue-property plots

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. 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. 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.

Note EDS was not executed.

- Molecule 1: Actin, alpha skeletal muscle



- Molecule 1: Actin, alpha skeletal muscle



L1246	T1313	F1385
E1247	T1314	
K1248	M1315	
S1249	Y1316	
L1252	M1323	
P1253	Q1324	
D1254	R1325	
G1255	E1326	
Q1256	I1327	
V1257	T1328	
I1258	A1329	
T1259	L1330	
I1260	A1331	
G1261	P1332	
N1262		
E1263	I1337	
R1264		
F1265	I1340	
R1266	A1341	
C1267	P1342	
P1268	P1343	
E1269	E1344	
T1270	R1345	
L1271	K1346	
F1272	Y1347	
Q1273	S1348	
P1274	V1349	
S1275	W1350	
F1276	I1351	
I1277	G1352	
G1278	G1353	
M1279	S1354	
E1280	I1355	
S1281	L1356	
A1282	A1357	
G1283	S1358	
I1284		
H1285	T1361	
E1286	F1362	
T1287	Q1363	
T1288	Q1364	
	M1365	
S1291		
I1292	T1368	
	K1369	
D1296	Q1370	
I1297	E1371	
D1298	Y1372	
I1299		
R1300	G1376	
K1301	P1377	
D1302	S1378	
L1303	I1379	
Y1304	V1380	
	H1381	
N1307	R1382	
V1308	K1383	
M1309	C1384	
S1310		

4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	101.46Å 103.03Å 126.96Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 3.50	Depositor
% Data completeness (in resolution range)	88.8 (30.00-3.50)	Depositor
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.196 , 0.266	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	5936	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

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: ATP, CL, LAR, CA

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	0/2891	1.08	22/3919 (0.6%)
1	B	0.52	0/2959	1.05	17/4011 (0.4%)
All	All	0.53	0/5850	1.07	39/7930 (0.5%)

There are no bond length outliers.

The worst 5 of 39 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	1173	VAL	N-CA-C	10.21	119.02	107.89
1	A	101	TYR	N-CA-C	8.14	119.78	111.07
1	B	1139	VAL	CA-C-N	7.73	127.44	119.56
1	B	1139	VAL	C-N-CA	7.73	127.44	119.56
1	A	353	GLY	N-CA-C	-6.89	104.51	112.50

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	2829	0	2795	235	0
1	B	2896	0	2866	228	0
2	A	3	0	0	0	0
2	B	1	0	0	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	2	0	0	0	0
3	B	1	0	0	0	0
4	A	31	0	12	2	0
4	B	31	0	12	1	0
5	A	29	0	31	1	0
5	B	29	0	31	1	0
6	A	41	0	0	5	0
6	B	43	0	0	11	0
All	All	5936	0	5747	465	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 40.

The worst 5 of 465 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:383:LYS:HD2	1:A:384:CYS:H	0.92	1.08
1:A:383:LYS:HE2	1:A:383:LYS:H	1.23	1.02
1:A:383:LYS:HD2	1:A:384:CYS:N	1.77	0.98
1:A:197:ASP:HA	1:A:200:MET:HE3	1.43	0.96
1:B:1351:ILE:H	1:B:1351:ILE:HD12	1.32	0.93

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	357/371 (96%)	277 (78%)	58 (16%)	22 (6%)	1	12
1	B	369/371 (100%)	277 (75%)	60 (16%)	32 (9%)	0	7
All	All	726/742 (98%)	554 (76%)	118 (16%)	54 (7%)	1	9

5 of 54 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	210	PHE
1	A	211	VAL
1	A	242	SER
1	A	280	GLU
1	A	281	SER

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	307/314 (98%)	286 (93%)	21 (7%)	14	40
1	B	314/314 (100%)	279 (89%)	35 (11%)	6	25
All	All	621/628 (99%)	565 (91%)	56 (9%)	9	32

5 of 56 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	1104	LEU
1	B	1384	CYS
1	B	1172	ASN
1	B	1379	ILE
1	B	1349	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	1069	GLN
1	B	1131	GLN
1	B	1102	ASN
1	B	1171	HIS
1	A	131	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 11 ligands modelled in this entry, 7 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$
4	ATP	A	390	2	32,33,33	2.44	11 (34%)	48,52,52	3.01	17 (35%)
5	LAR	A	411	-	30,31,31	1.16	2 (6%)	32,43,43	1.61	5 (15%)
5	LAR	B	1411	-	30,31,31	1.15	3 (10%)	32,43,43	1.43	3 (9%)
4	ATP	B	1390	2	32,33,33	2.36	14 (43%)	48,52,52	2.94	14 (29%)

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
4	ATP	A	390	2	-	1/22/38/38	0/3/3/3
5	LAR	A	411	-	-	4/23/51/51	0/2/3/3
5	LAR	B	1411	-	-	4/23/51/51	0/2/3/3
4	ATP	B	1390	2	-	2/22/38/38	0/3/3/3

The worst 5 of 30 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	390	ATP	PB-O3A	6.84	1.66	1.59
4	B	1390	ATP	PB-O3A	5.87	1.65	1.59
4	A	390	ATP	C4-N3	4.75	1.43	1.34
4	B	1390	ATP	O5'-C5'	-4.42	1.27	1.44
4	A	390	ATP	O5'-C5'	-4.36	1.28	1.44

The worst 5 of 39 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	390	ATP	O5'-C5'-C4'	11.78	149.12	108.99
4	B	1390	ATP	O5'-C5'-C4'	11.72	148.89	108.99
4	A	390	ATP	O3A-PB-O1B	-8.16	86.16	110.70
4	B	1390	ATP	O3A-PB-O1B	-7.80	87.23	110.70
4	A	390	ATP	O5'-PA-O1A	-6.98	81.27	108.94

There are no chirality outliers.

5 of 11 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	411	LAR	O3-C17-C18-C19
5	B	1411	LAR	O3-C17-C18-C19
5	A	411	LAR	C3-C4-C5-C6
4	A	390	ATP	PG-O3B-PB-O2B
4	B	1390	ATP	PG-O3B-PB-O2B

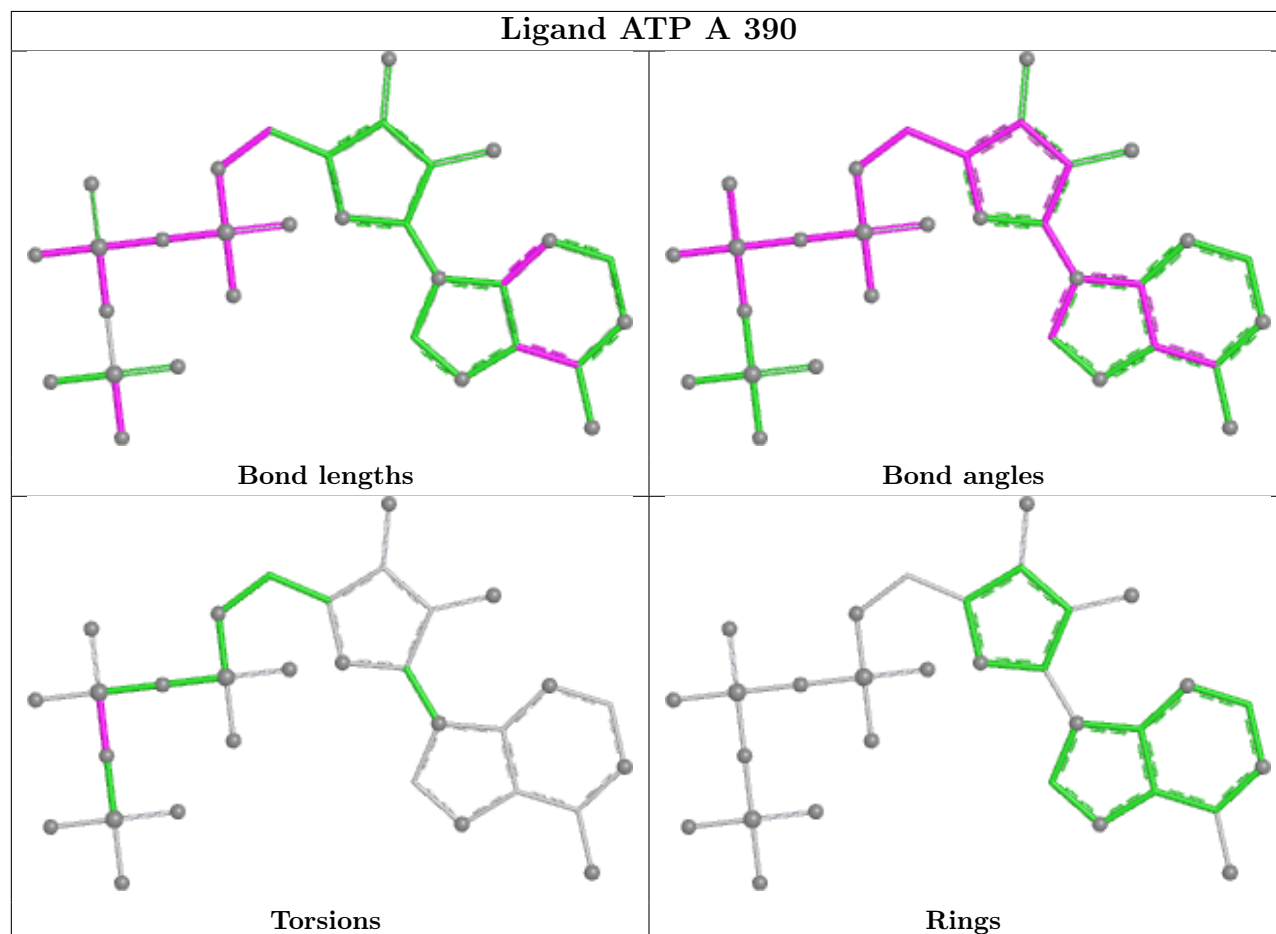
There are no ring outliers.

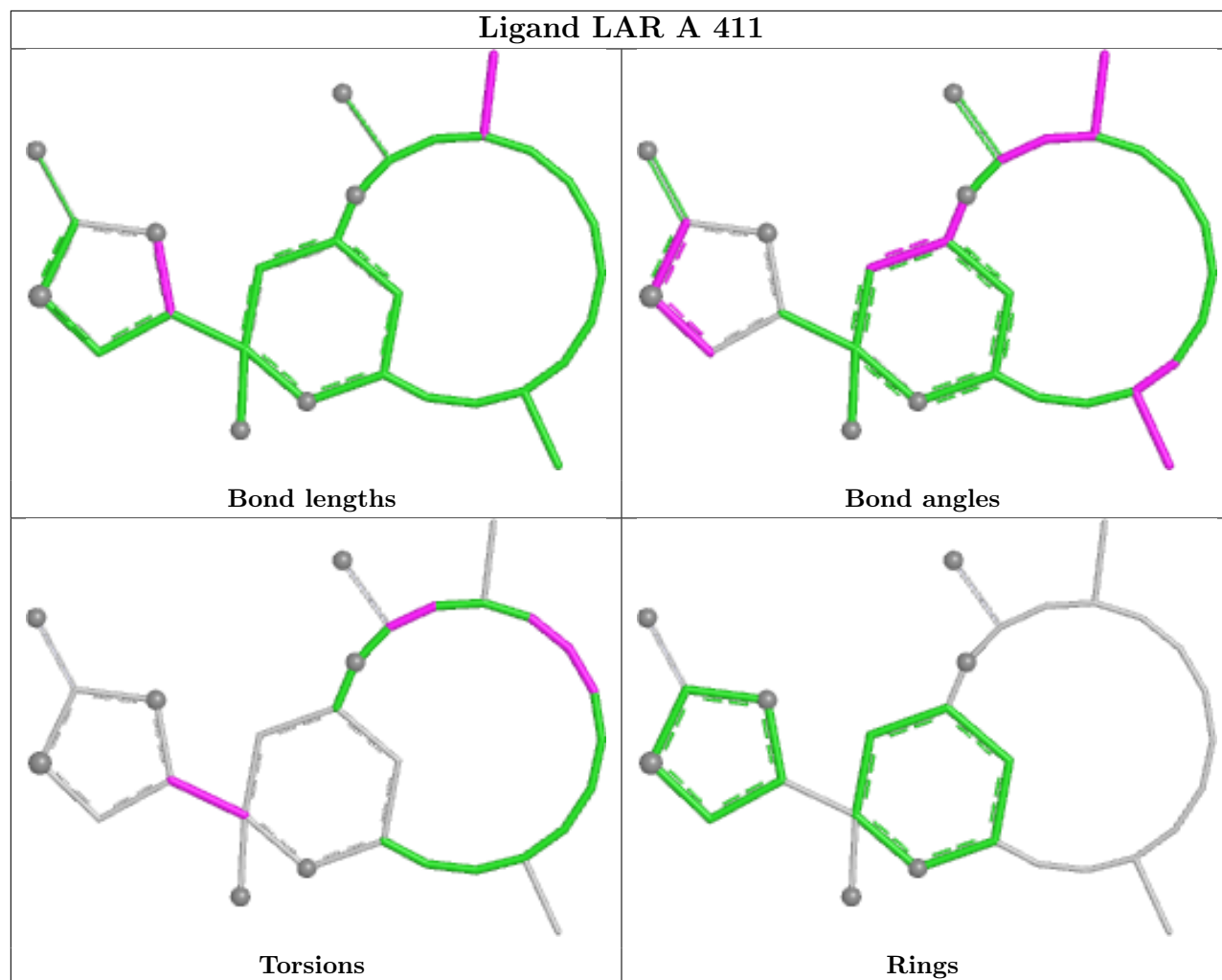
4 monomers are involved in 5 short contacts:

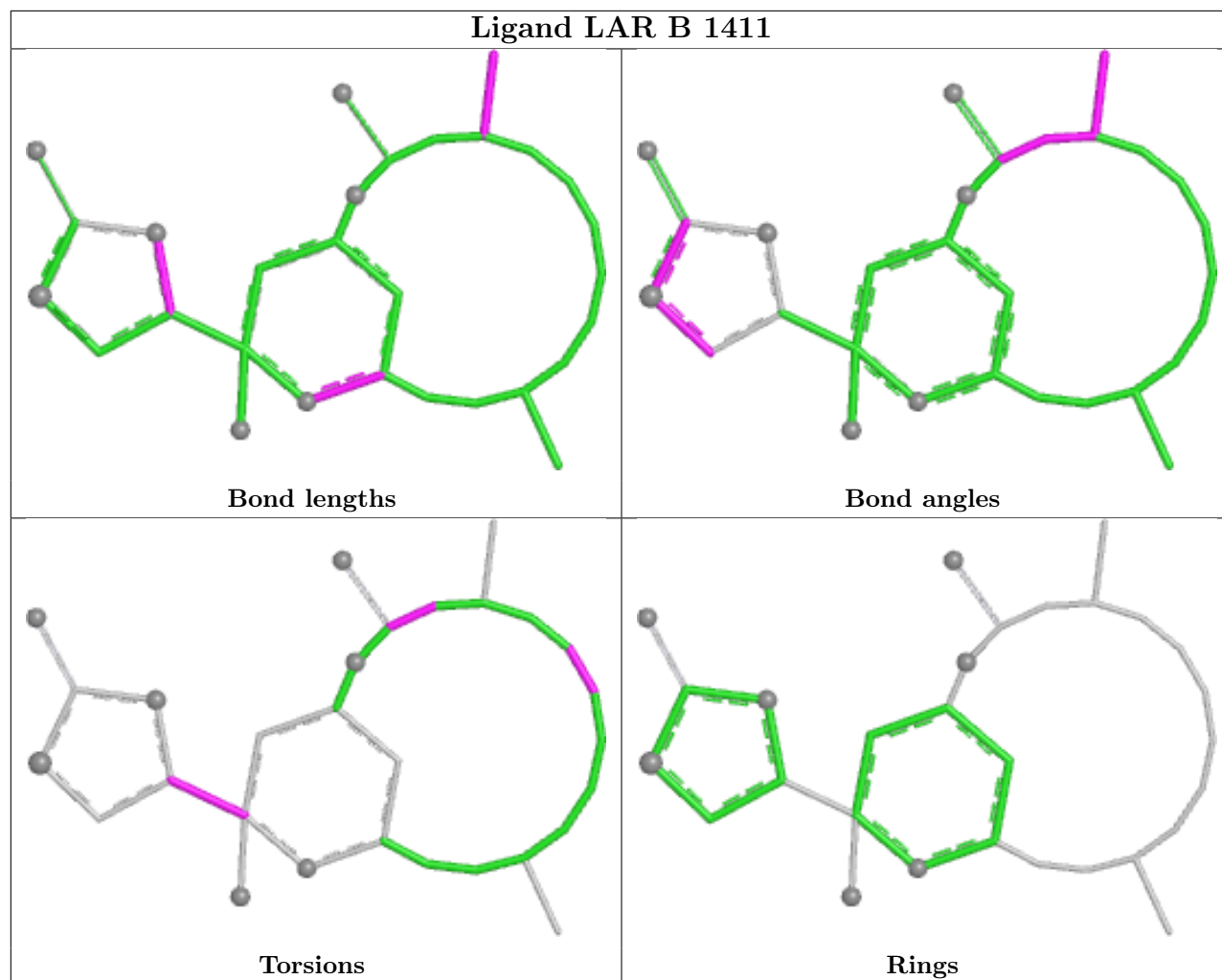
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	390	ATP	2	0
5	A	411	LAR	1	0
5	B	1411	LAR	1	0
4	B	1390	ATP	1	0

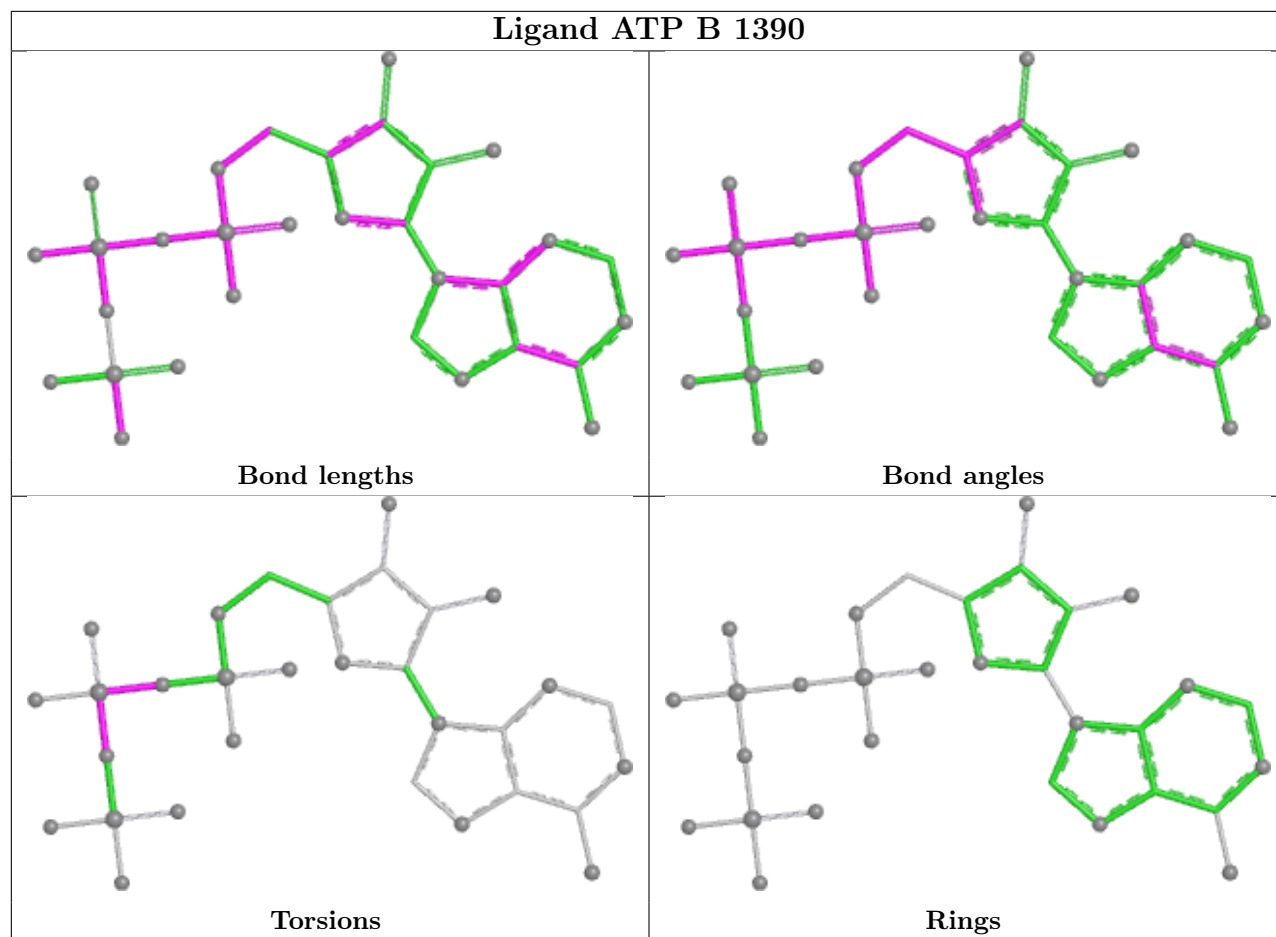
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.