wwPDB X-ray Structure Validation Summary Report (i)

Sep 15, 2025 – 11:09 am BST

PDB ID	:	9GQ1 / pdb_00009gq1
Title	:	CSP1 H36A
Authors	:	Basle, A.; David, S.; Dennison, C.
Deposited on	:	2024-09-09
Resolution	:	1.90 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 (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:

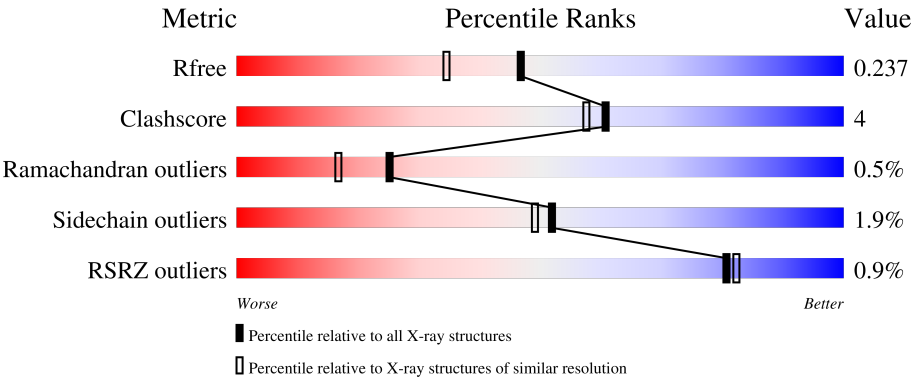
MolProbity	:	4-5-2 with Phenix2.0rc1
Xtriage (Phenix)	:	2.0rc1
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.006 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.45.1

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 1.90 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}	164625	7293 (1.90-1.90)
Clashscore	180529	8090 (1.90-1.90)
Ramachandran outliers	177936	8022 (1.90-1.90)
Sidechain outliers	177891	8022 (1.90-1.90)
RSRZ outliers	164620	7292 (1.90-1.90)

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	112	93%
1	B	112	2% 96%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 3212 atoms, of which 1514 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 Four-helix bundle copper-binding protein.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	110	Total	C	H	N	O	S	0	3	0
			1549	491	760	130	152	16			
1	B	112	Total	C	H	N	O	S	0	1	0
			1551	492	754	134	155	16			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	36	ALA	HIS	engineered mutation	UNP A0A2D2D105
B	36	ALA	HIS	engineered mutation	UNP A0A2D2D105

- Molecule 2 is COPPER (I) ION (CCD ID: CU1) (formula: Cu) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	12	Total	Cu	0	0
			12	12		
2	B	12	Total	Cu	0	0
			12	12		

- Molecule 3 is water.

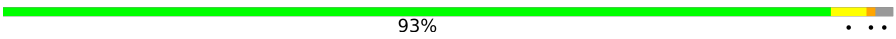
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	54	Total	O	0	0
			54	54		
3	B	34	Total	O	0	0
			34	34		

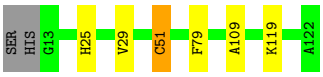
3 Residue-property plots (i)

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: Four-helix bundle copper-binding protein

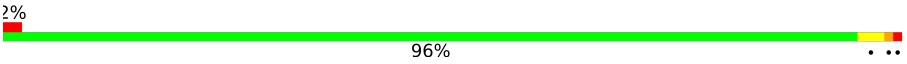
Chain A:

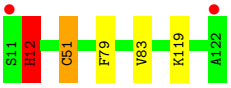




• Molecule 1: Four-helix bundle copper-binding protein

Chain B:





4 Data and refinement statistics (i)

Property	Value
Space group	C 1 2 1
Cell constants a, b, c, α, β, γ	93.21Å 42.26Å 53.03Å 90.00° 91.08° 90.00°
Resolution (Å)	38.49 – 1.90 38.49 – 1.90
% Data completeness (in resolution range)	98.9 (38.49-1.90) 98.9 (38.49-1.90)
R_{merge}	0.06
R_{sym}	(Not available)
$< I/\sigma(I) >$ [1]	1.30 (at 1.89Å)
Refinement program	REFMAC 5.8.0430 (refmacat 0.4.82), REFMAC 5.8.0430 (refmacat 0.4.
R, R_{free}	0.174 , 0.224 0.187 , 0.237
R_{free} test set	887 reflections (5.44%)
Wilson B-factor (Å^2)	26.0
Anisotropy	0.901
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.41 , 35.1
L-test for twinning[2]	$< \|L\| > = 0.52$, $< L^2 > = 0.35$
Estimated twinning fraction	0.020 for -h,-k,l
F_o,F_c correlation	0.97
Total number of atoms	3212
Average B, all atoms (Å^2)	37.0

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 11.64% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: CU1

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	0.88	0/808	1.33	3/1087 (0.3%)
1	B	0.78	0/811	1.31	4/1090 (0.4%)
All	All	0.83	0/1619	1.32	7/2177 (0.3%)

There are no bond length outliers.

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	119	LYS	CB-CA-C	-7.58	98.21	110.79
1	A	119	LYS	CB-CA-C	-7.03	99.13	110.79
1	A	51	CYS	CB-CA-C	6.21	121.10	110.79
1	B	119	LYS	N-CA-CB	5.97	118.89	110.12
1	A	119	LYS	N-CA-CB	5.84	118.71	110.12

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	789	760	773	13	0
1	B	797	754	767	11	0
2	A	12	0	0	0	0
2	B	12	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	54	0	0	0	1
3	B	34	0	0	0	1
All	All	1698	1514	1540	13	2

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 4.

The worst 5 of 13 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:79[B]:PHE:CZ	1:B:79[B]:PHE:CZ	1.85	1.65
1:A:79[B]:PHE:CZ	1:B:79[B]:PHE:HZ	1.31	1.17
1:A:79[B]:PHE:CE1	1:B:79[B]:PHE:CZ	2.34	1.15
1:A:79[B]:PHE:HZ	1:B:79[B]:PHE:CZ	1.46	1.07
1:A:79[B]:PHE:CZ	1:B:79[B]:PHE:CE1	2.53	0.96

All (2) 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)
3:B:1124:HOH:O	3:B:1124:HOH:O[2_555]	1.83	0.37
3:A:1125:HOH:O	3:A:1125:HOH:O[2_555]	1.94	0.26

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	111/112 (99%)	110 (99%)	1 (1%)	0	100 100
1	B	111/112 (99%)	109 (98%)	1 (1%)	1 (1%)	14 7
All	All	222/224 (99%)	219 (99%)	2 (1%)	1 (0%)	25 17

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	12	HIS

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	81/80 (101%)	80 (99%)	1 (1%)	67	68
1	B	81/80 (101%)	79 (98%)	2 (2%)	42	37
All	All	162/160 (101%)	159 (98%)	3 (2%)	52	49

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	51	CYS
1	B	12	HIS
1	B	51	CYS

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)

There are no oligosaccharides in this entry.

5.6 Ligand geometry (i)

Of 24 ligands modelled in this entry, 24 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

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, 95^{th} 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	110/112 (98%)	-0.33	0 100 100	13, 32, 48, 56	3 (2%)
1	B	112/112 (100%)	0.05	2 (1%) 67 70	15, 37, 59, 104	1 (0%)
All	All	222/224 (99%)	-0.14	2 (0%) 81 82	13, 34, 54, 104	4 (1%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	11	SER	3.0
1	B	122	ALA	2.2

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

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

6.3 Carbohydrates

There are no oligosaccharides 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. The B-factors column lists the minimum, median, 95^{th} 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	CU1	B	1001	1/1	0.97	0.05	33,33,33,33	0
2	CU1	B	1003	1/1	0.97	0.04	33,33,33,33	0
2	CU1	B	1004	1/1	0.97	0.04	35,35,35,35	0

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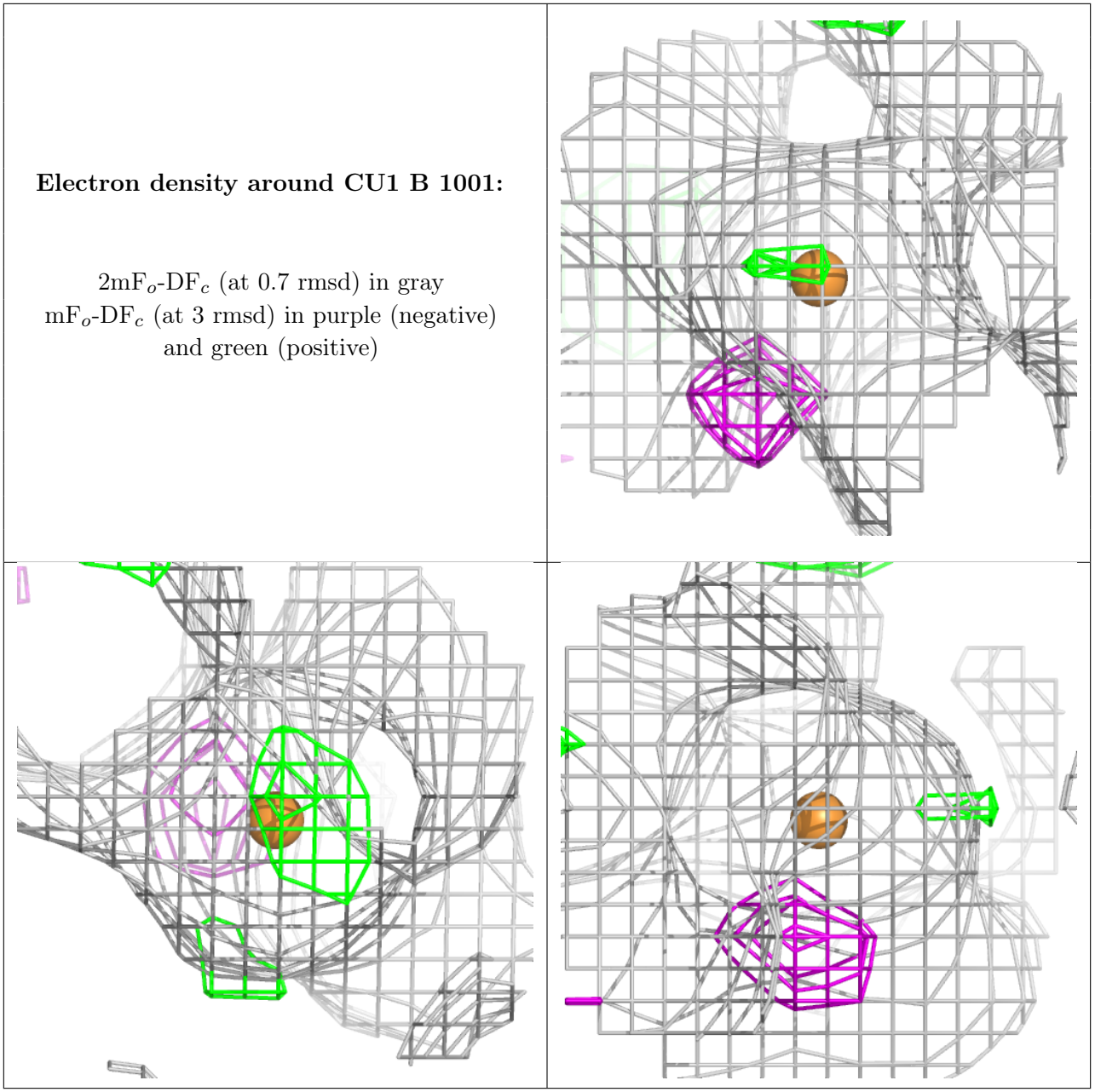
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	CU1	A	1003	1/1	0.98	0.04	27,27,27,27	0
2	CU1	B	1005	1/1	0.98	0.04	34,34,34,34	0
2	CU1	B	1006	1/1	0.98	0.04	37,37,37,37	0
2	CU1	B	1008	1/1	0.98	0.04	37,37,37,37	0
2	CU1	A	1009	1/1	0.99	0.05	34,34,34,34	0
2	CU1	A	1010	1/1	0.99	0.03	32,32,32,32	0
2	CU1	A	1011	1/1	0.99	0.04	34,34,34,34	0
2	CU1	A	1012	1/1	0.99	0.03	34,34,34,34	0
2	CU1	A	1002	1/1	0.99	0.03	29,29,29,29	0
2	CU1	B	1002	1/1	0.99	0.03	34,34,34,34	0
2	CU1	A	1001	1/1	0.99	0.02	29,29,29,29	0
2	CU1	A	1004	1/1	0.99	0.03	31,31,31,31	0
2	CU1	A	1005	1/1	0.99	0.02	27,27,27,27	0
2	CU1	A	1006	1/1	0.99	0.04	28,28,28,28	0
2	CU1	B	1007	1/1	0.99	0.03	36,36,36,36	0
2	CU1	A	1007	1/1	0.99	0.04	28,28,28,28	0
2	CU1	B	1009	1/1	0.99	0.04	40,40,40,40	0
2	CU1	B	1010	1/1	0.99	0.04	43,43,43,43	0
2	CU1	B	1011	1/1	0.99	0.03	45,45,45,45	0
2	CU1	B	1012	1/1	0.99	0.03	41,41,41,41	0
2	CU1	A	1008	1/1	1.00	0.03	29,29,29,29	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.

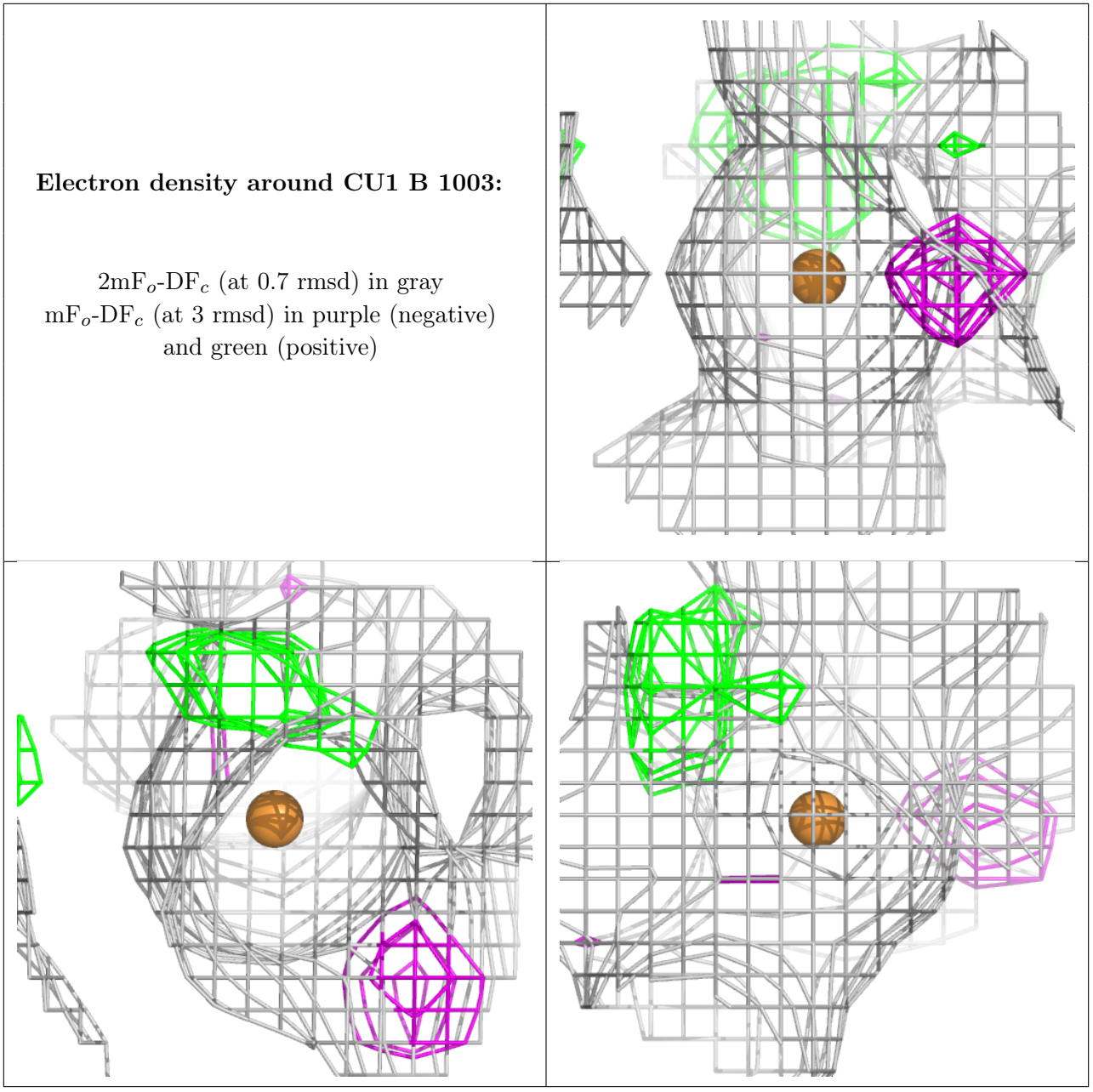
Electron density around CU1 B 1001:

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



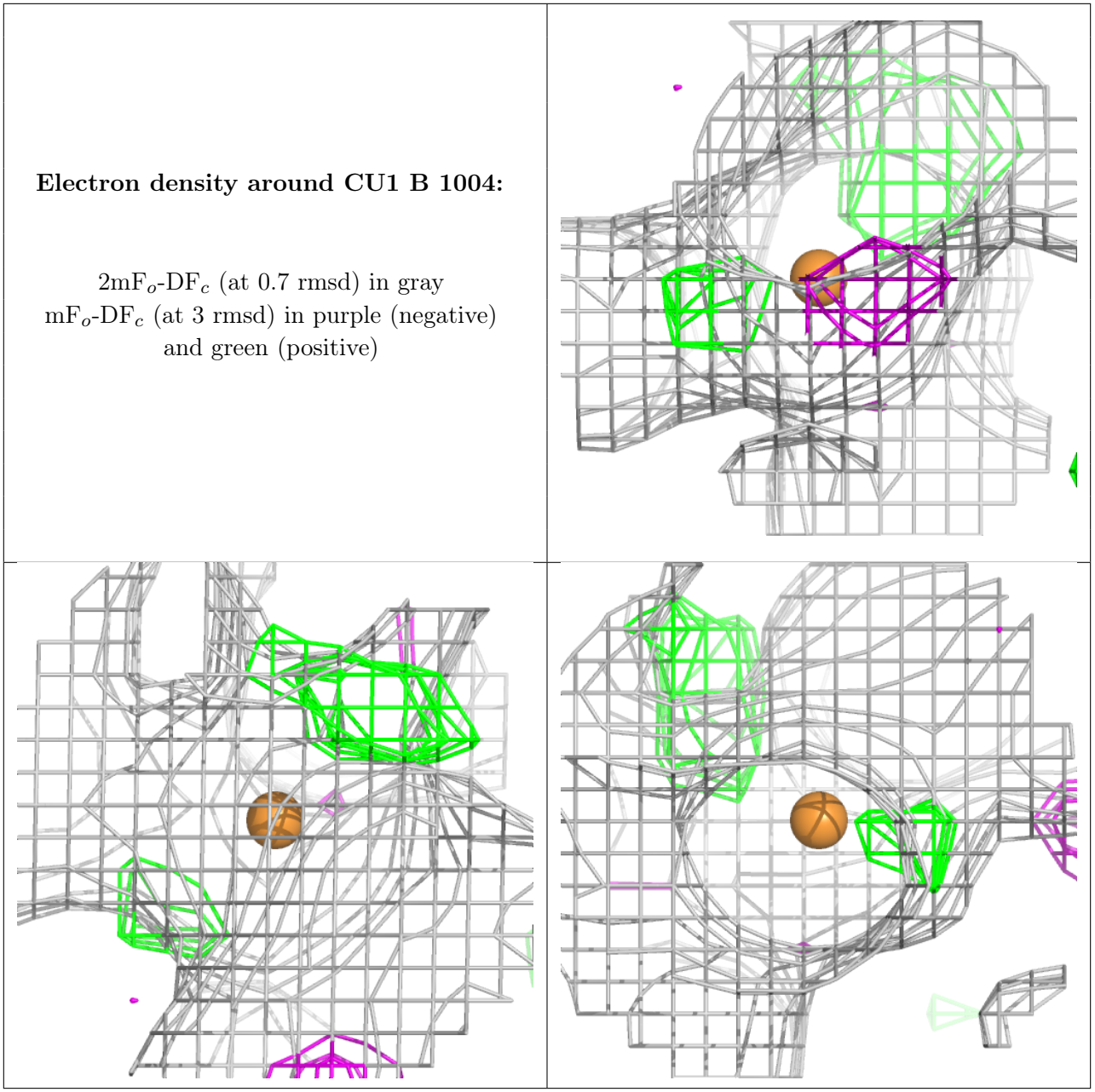
Electron density around CU1 B 1003:

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



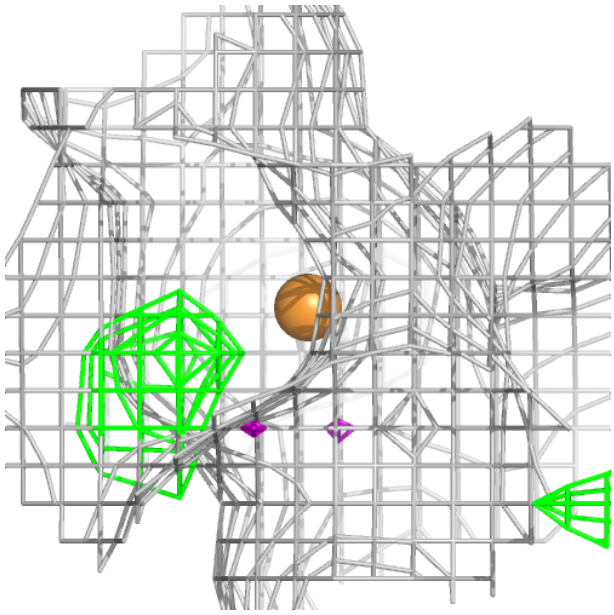
Electron density around CU1 B 1004:

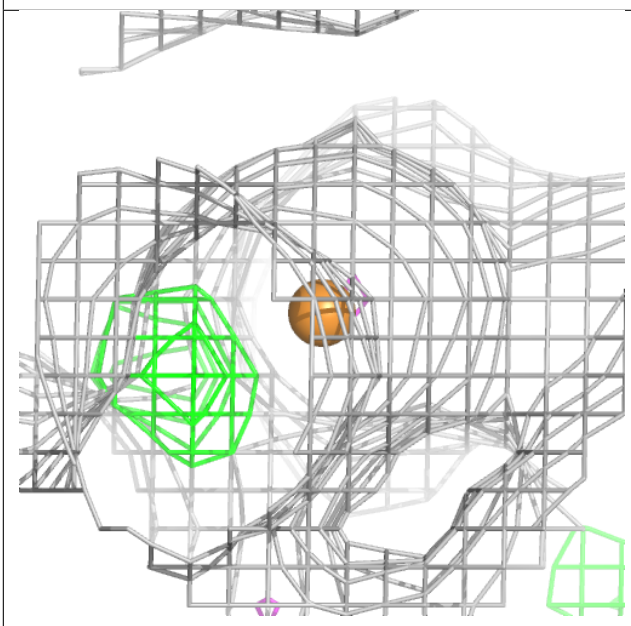
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



Electron density around CU1 A 1003:

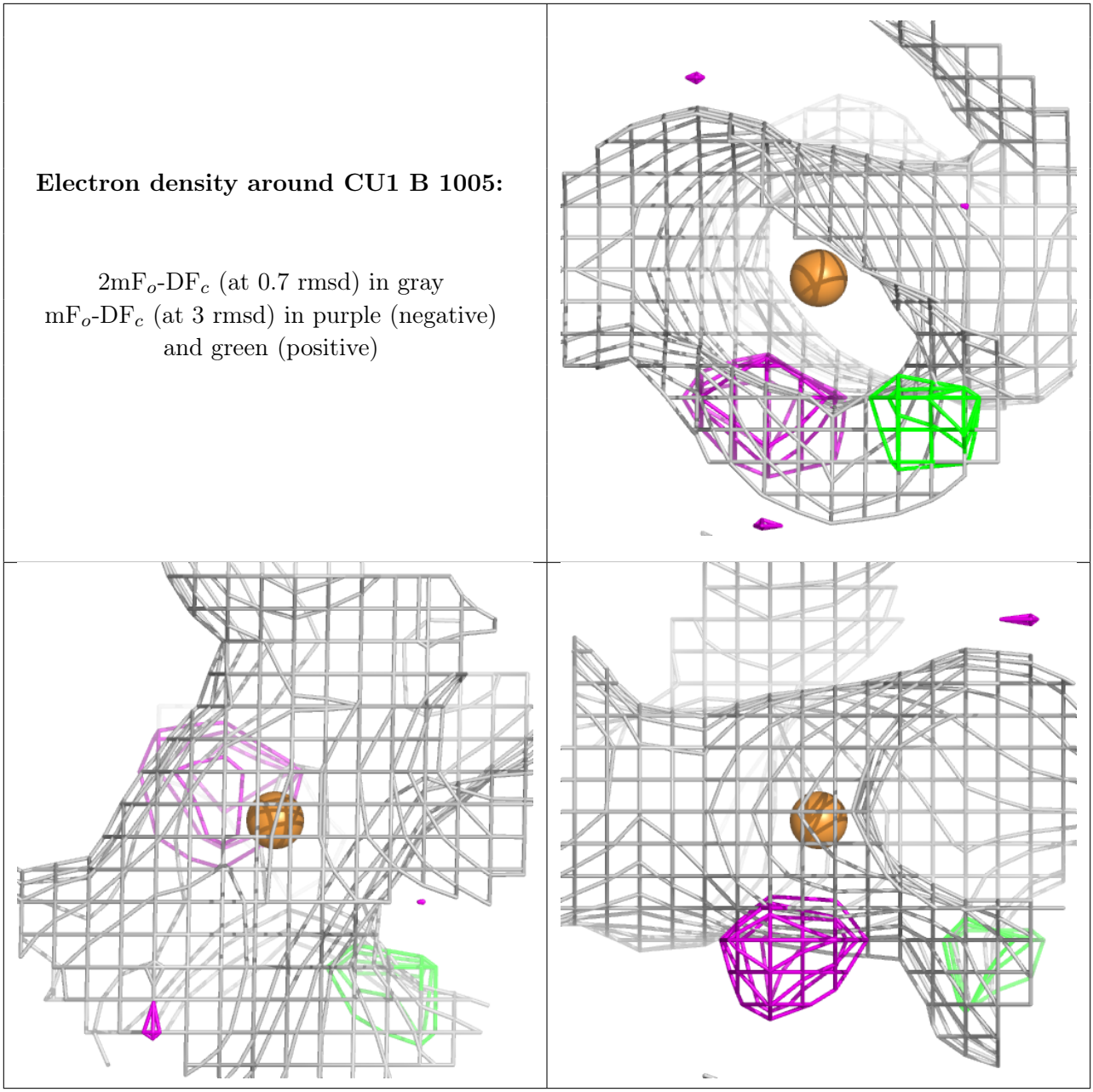
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)





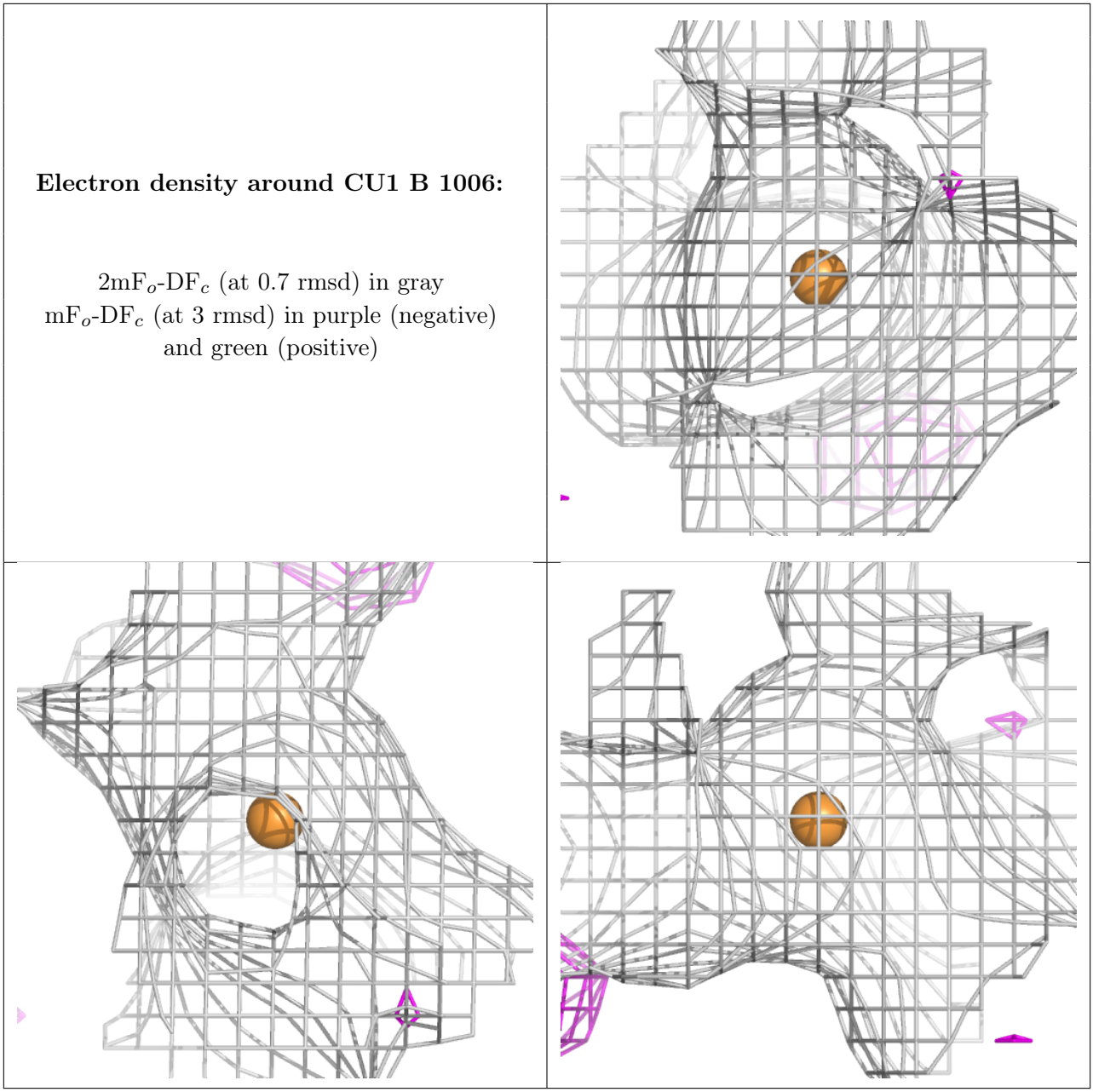
Electron density around CU1 B 1005:

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



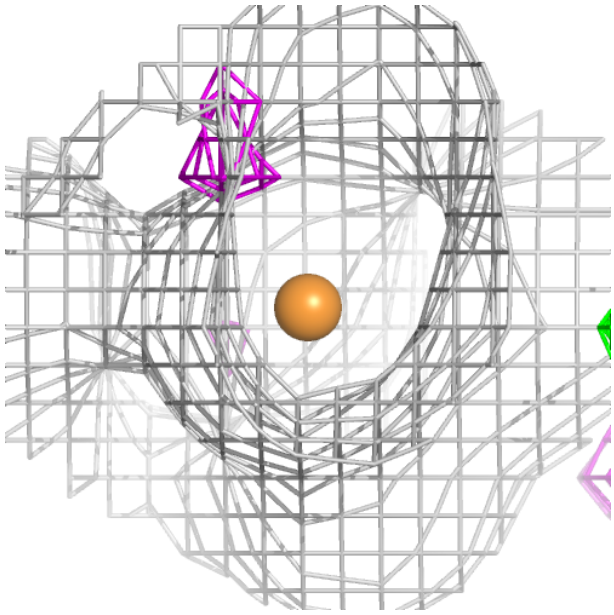
Electron density around CU1 B 1006:

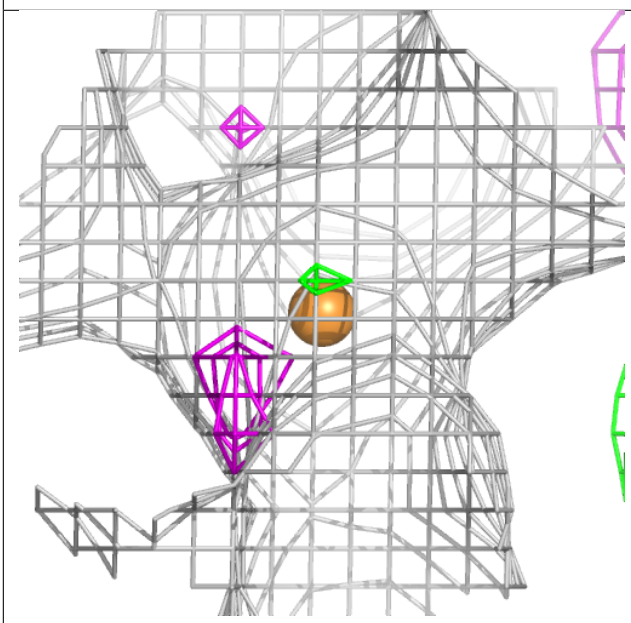
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

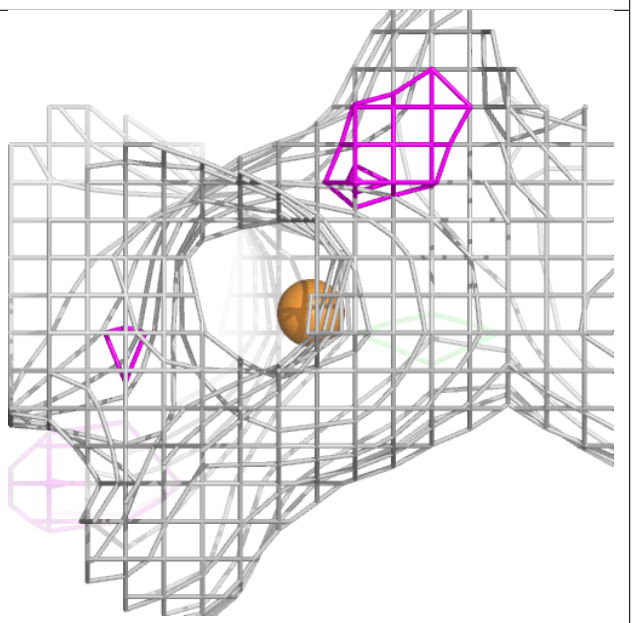


Electron density around CU1 B 1008:

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

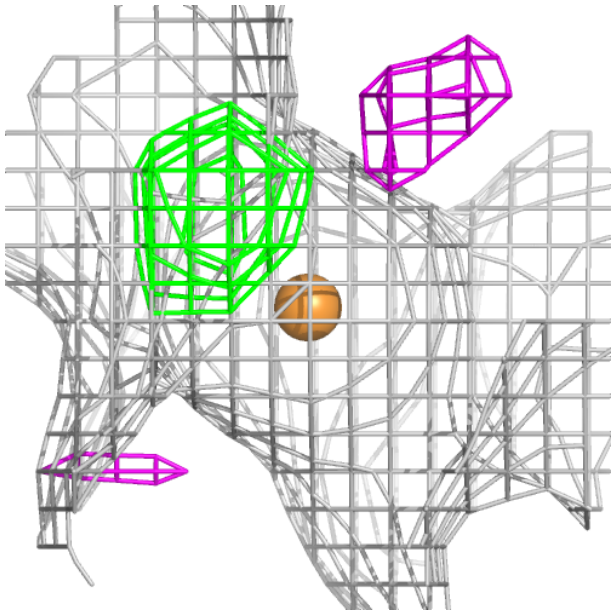


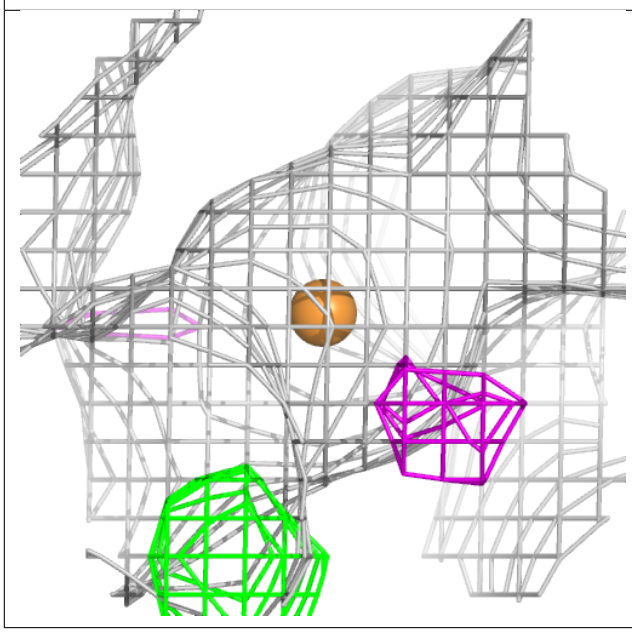


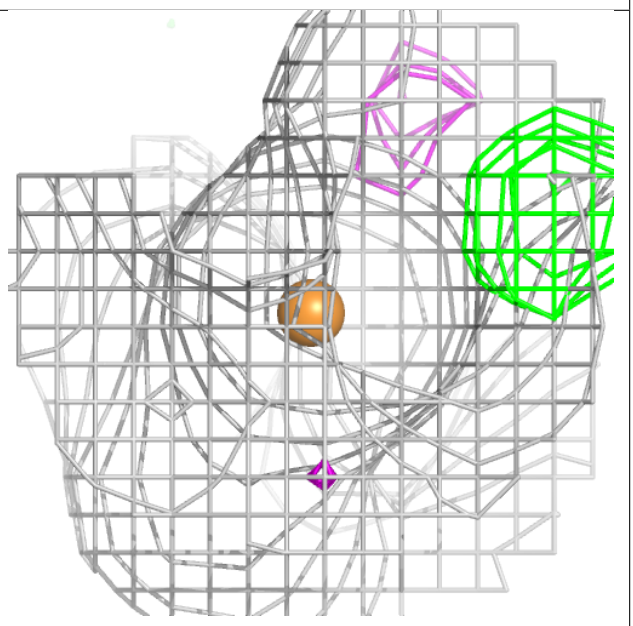


Electron density around CU1 A 1009:

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

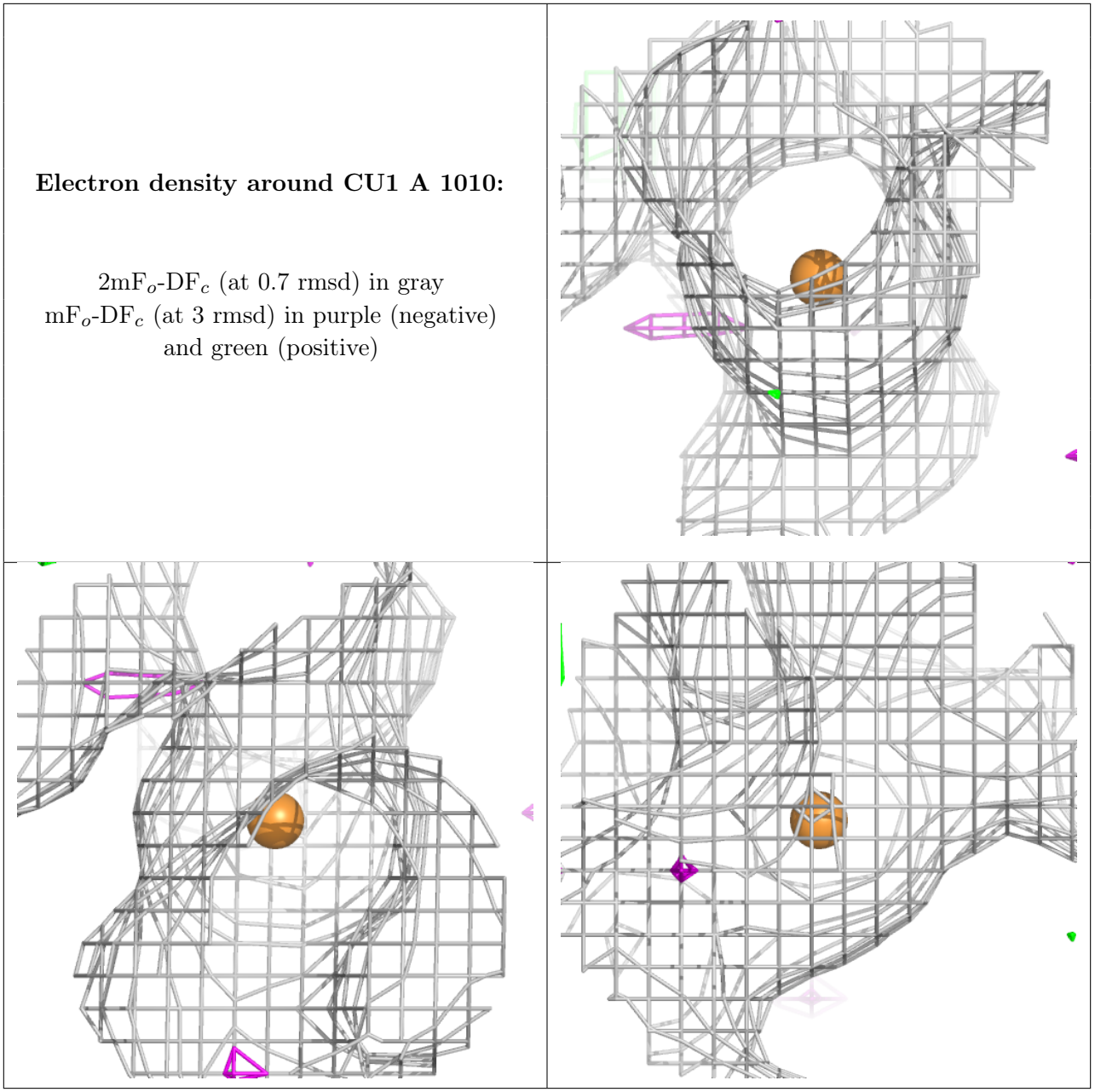






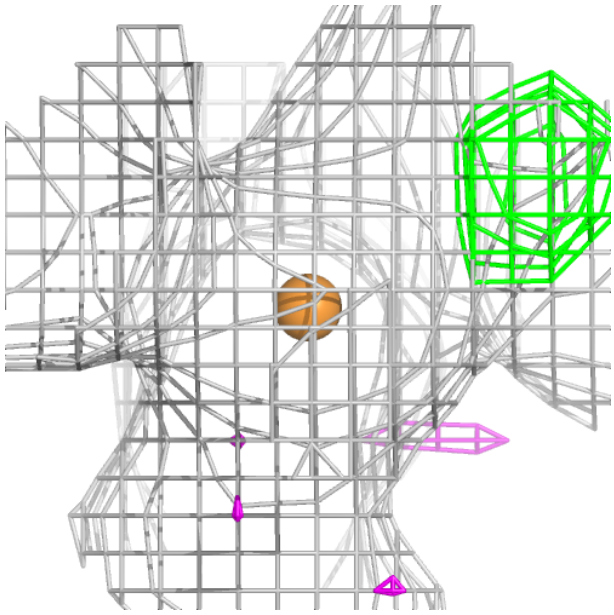
Electron density around CU1 A 1010:

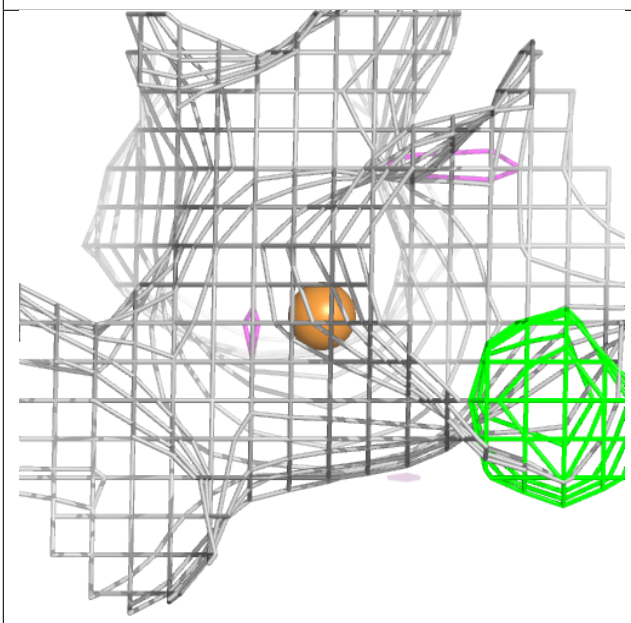
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

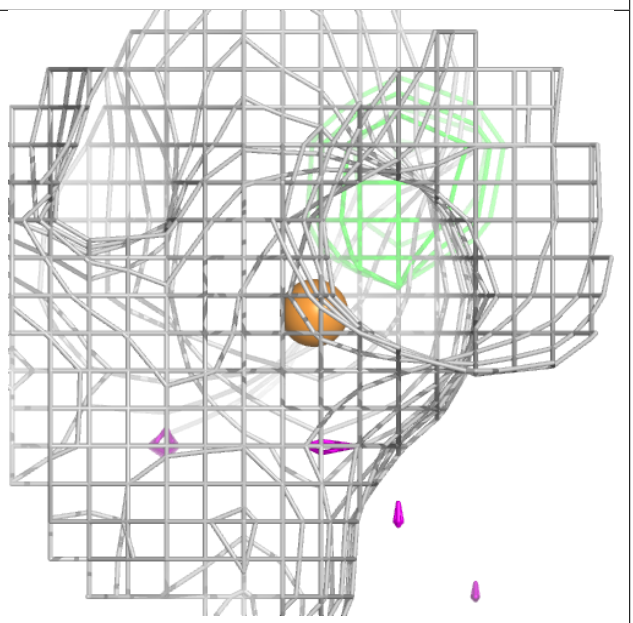


Electron density around CU1 A 1011:

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

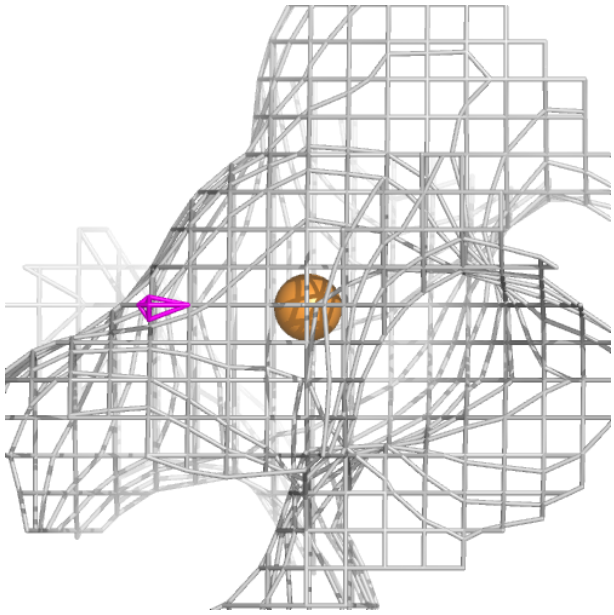


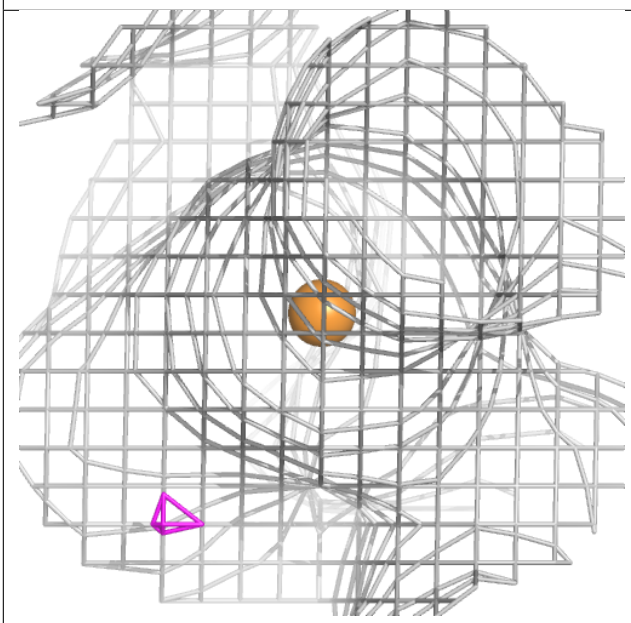


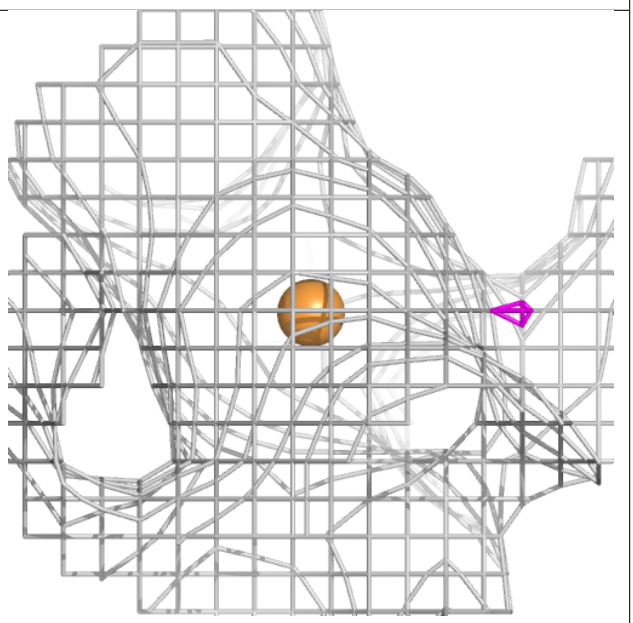


Electron density around CU1 A 1012:

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

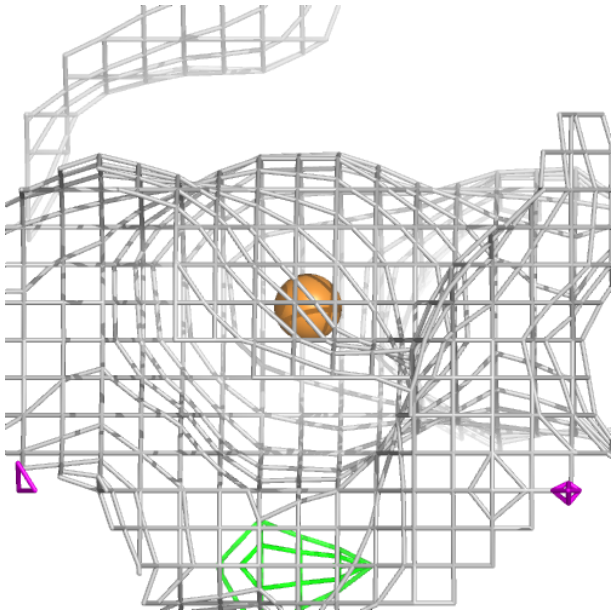


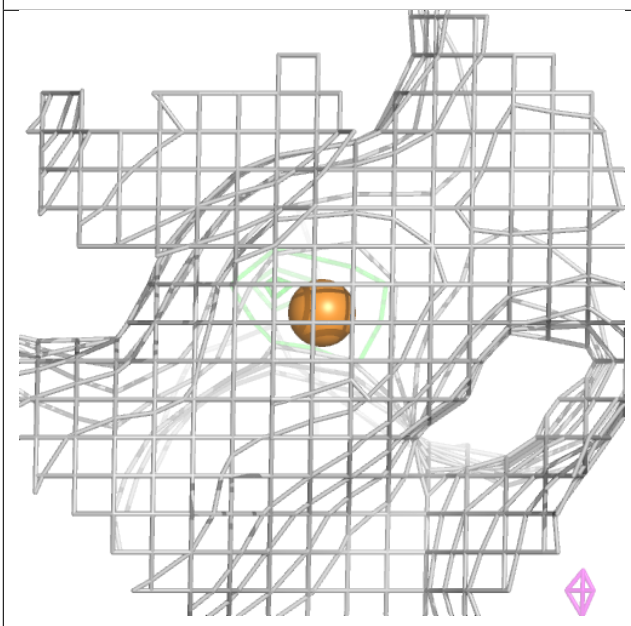


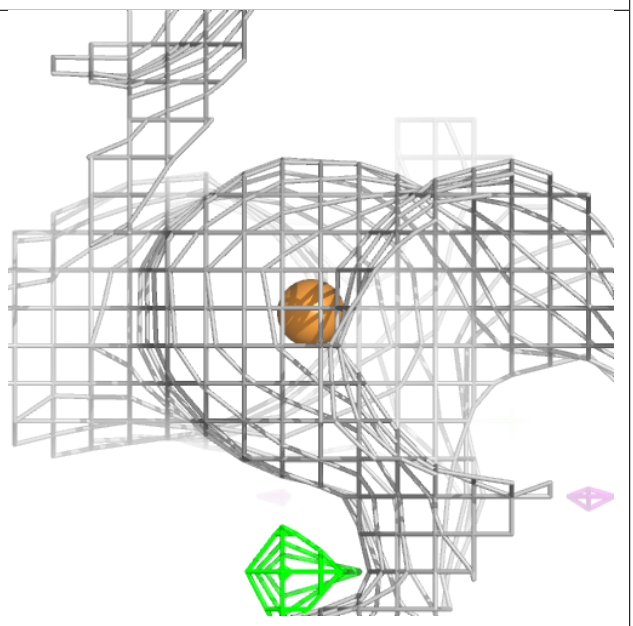


Electron density around CU1 A 1002:

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

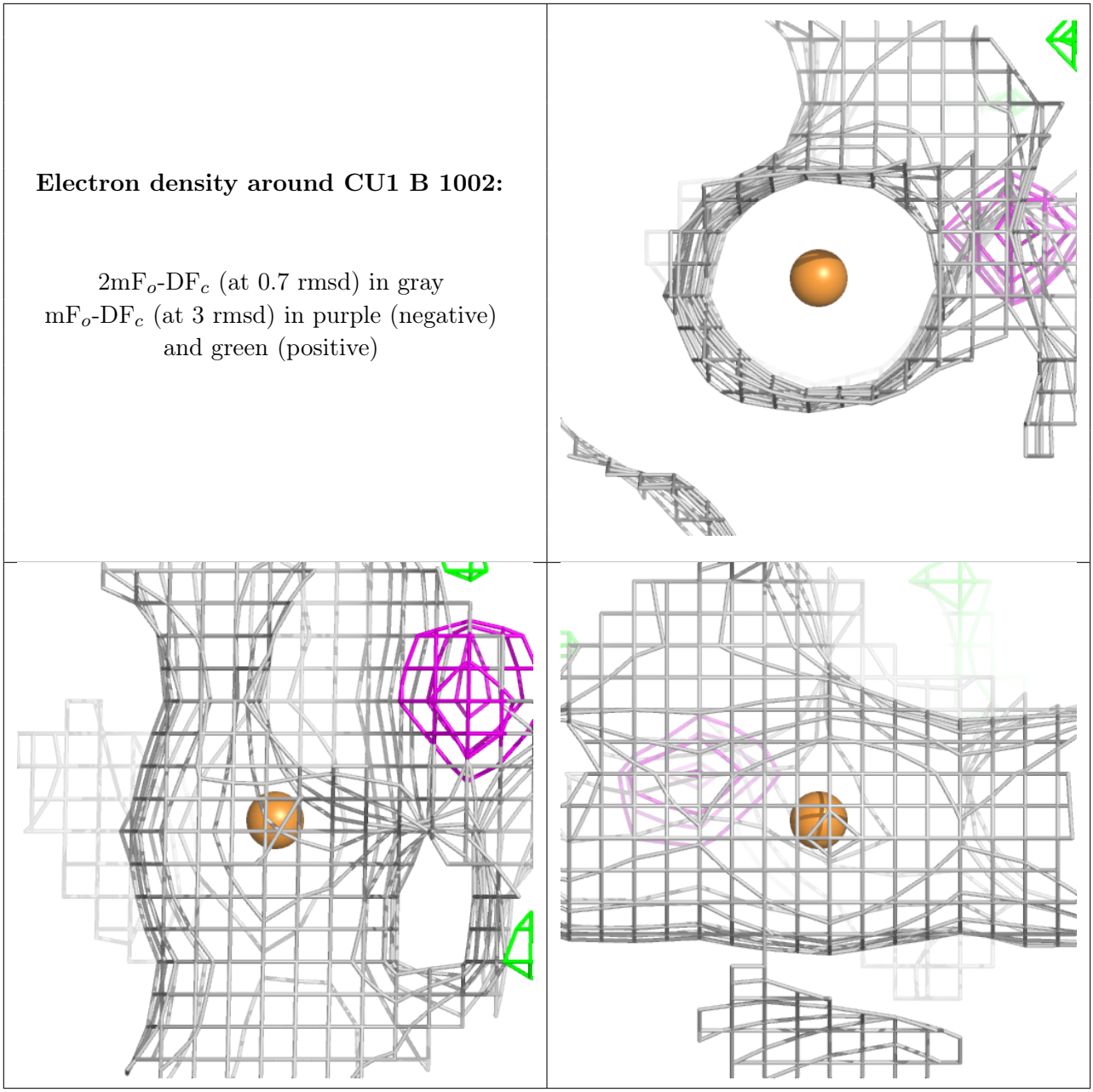






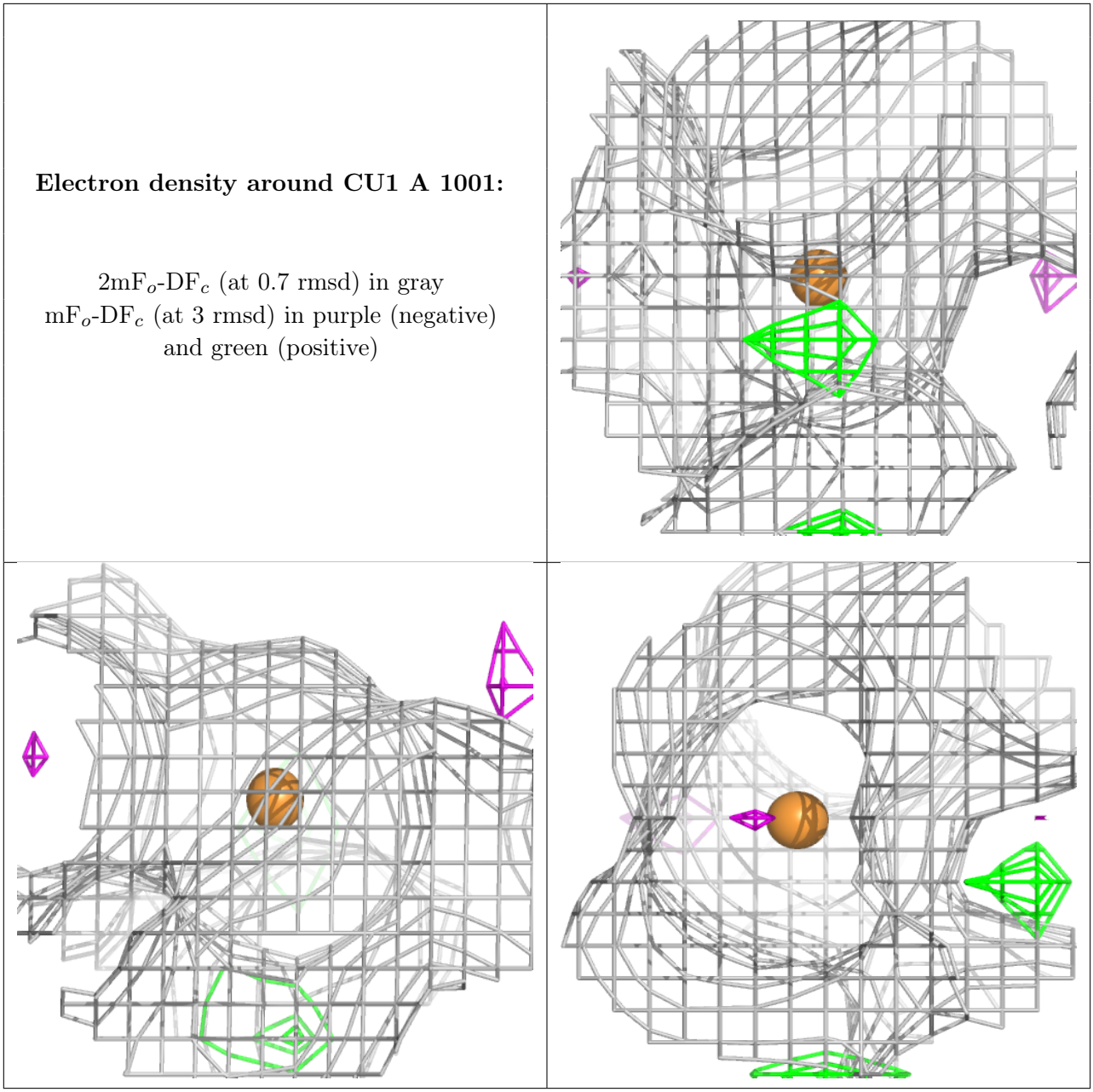
Electron density around CU1 B 1002:

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



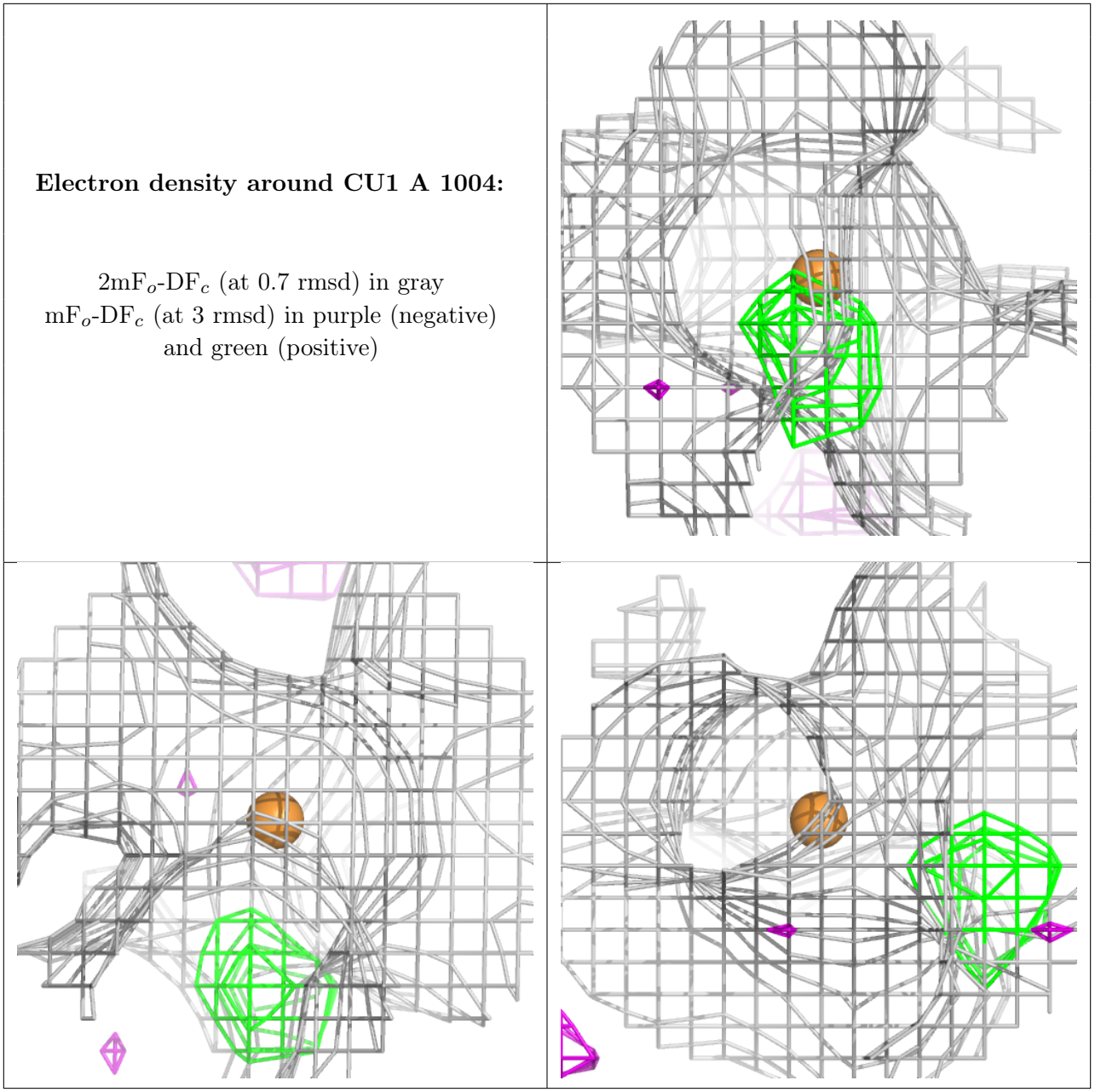
Electron density around CU1 A 1001:

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



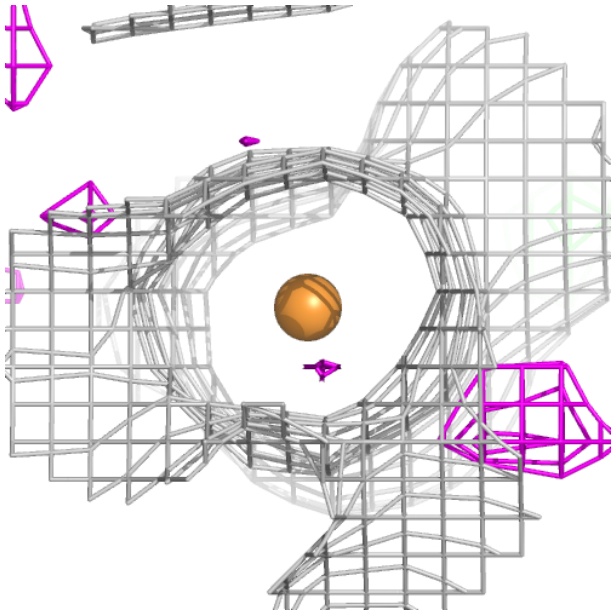
Electron density around CU1 A 1004:

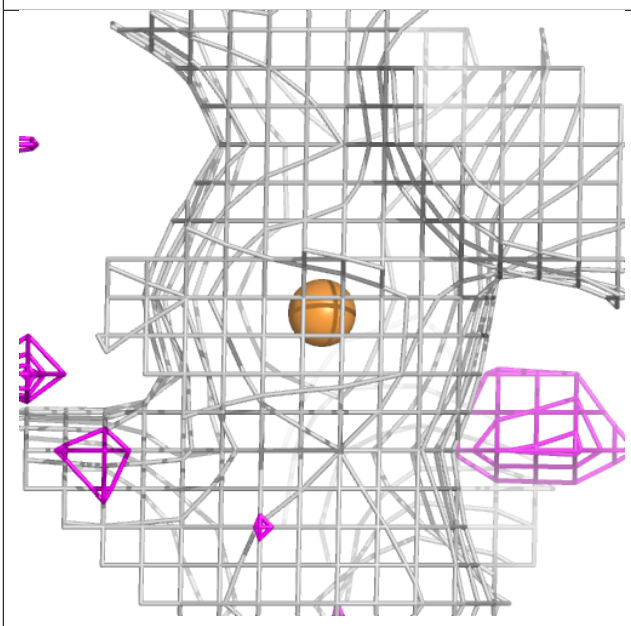
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

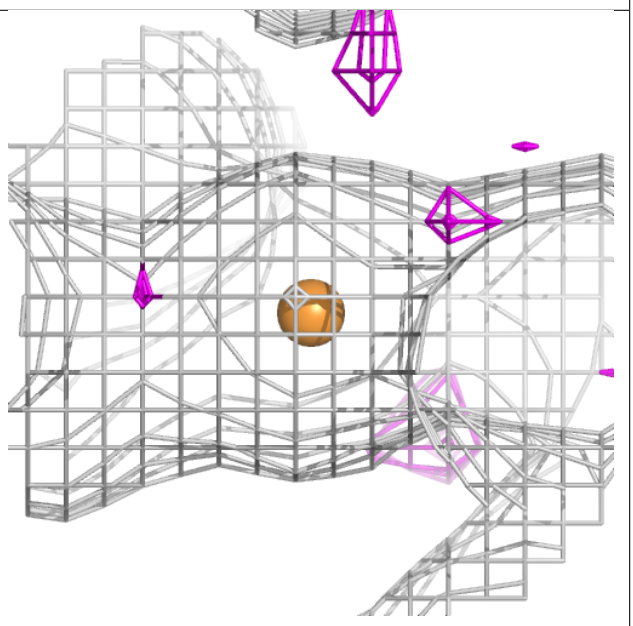


Electron density around CU1 A 1005:

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

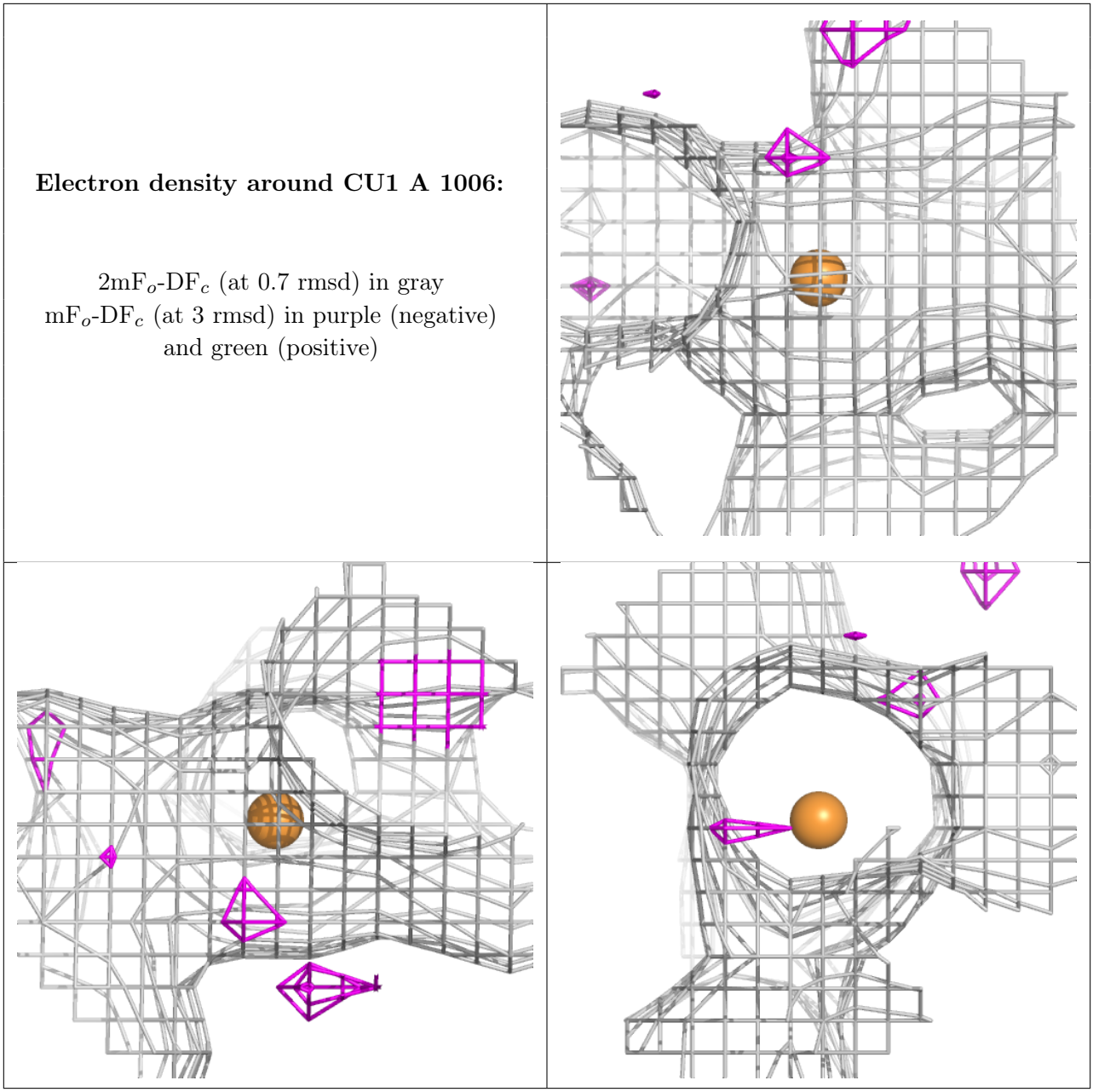






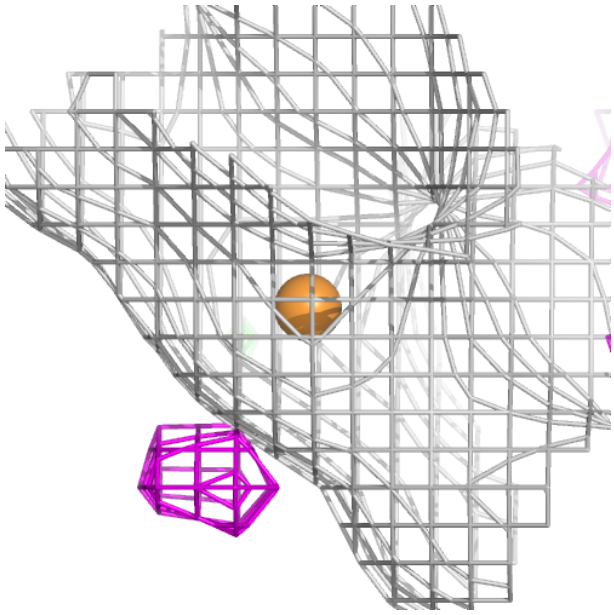
Electron density around CU1 A 1006:

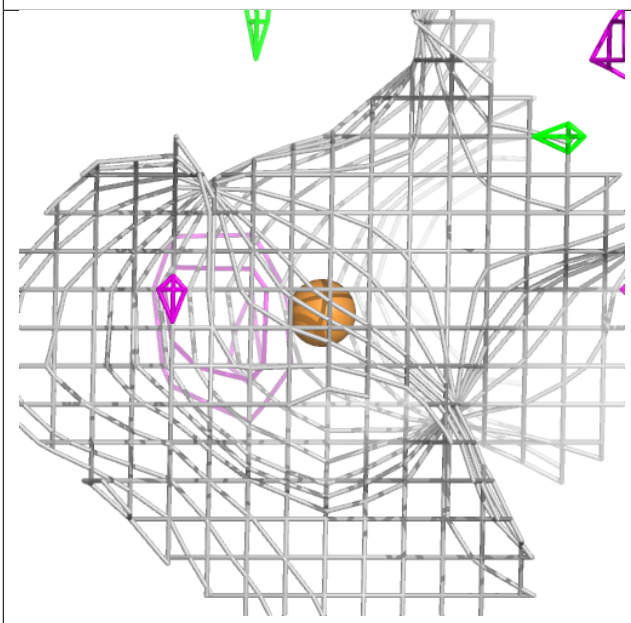
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

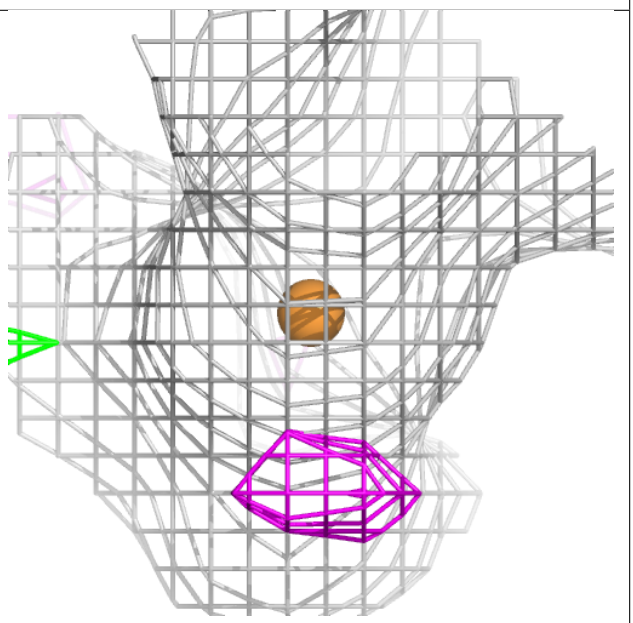


Electron density around CU1 B 1007:

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

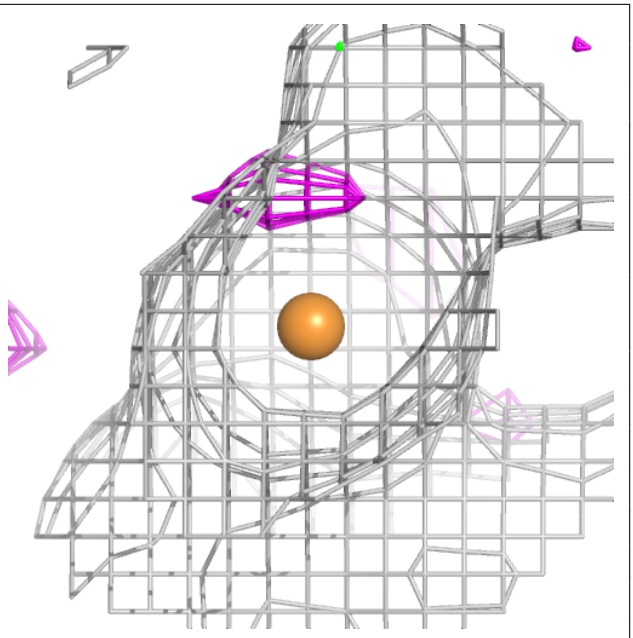


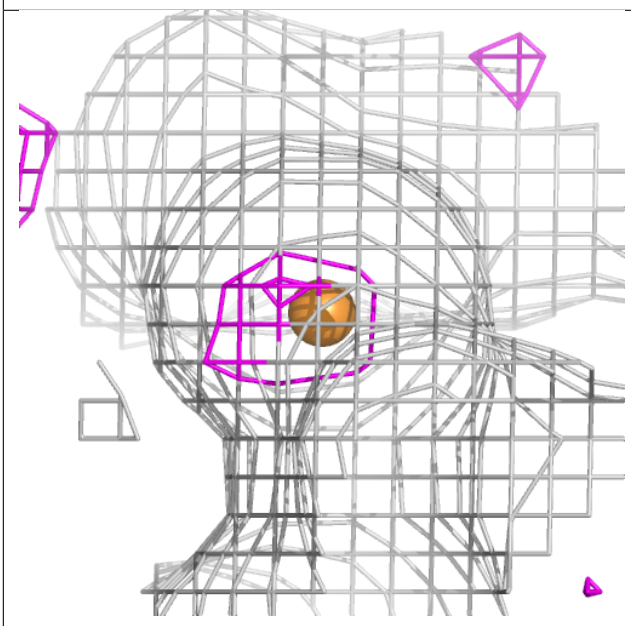


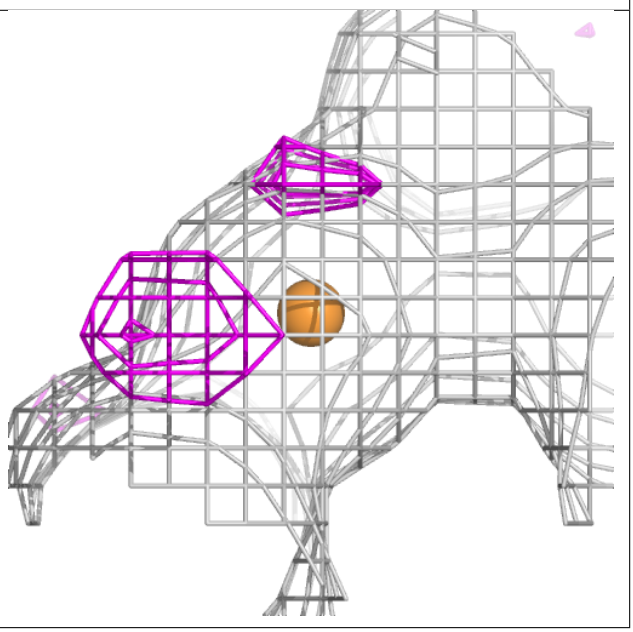


Electron density around CU1 A 1007:

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

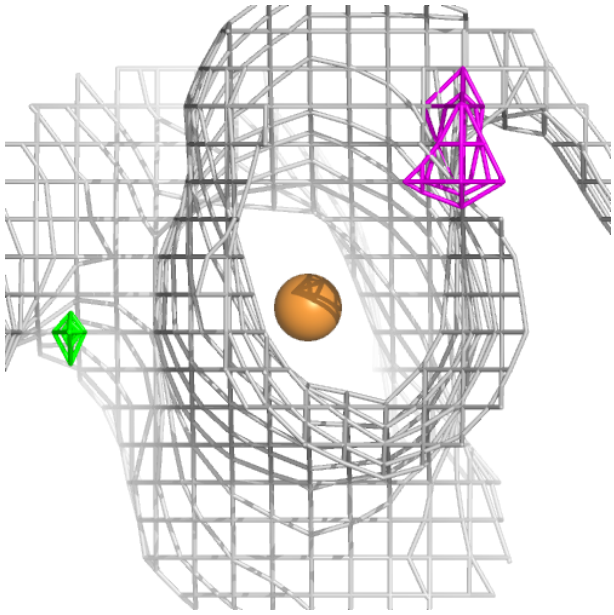


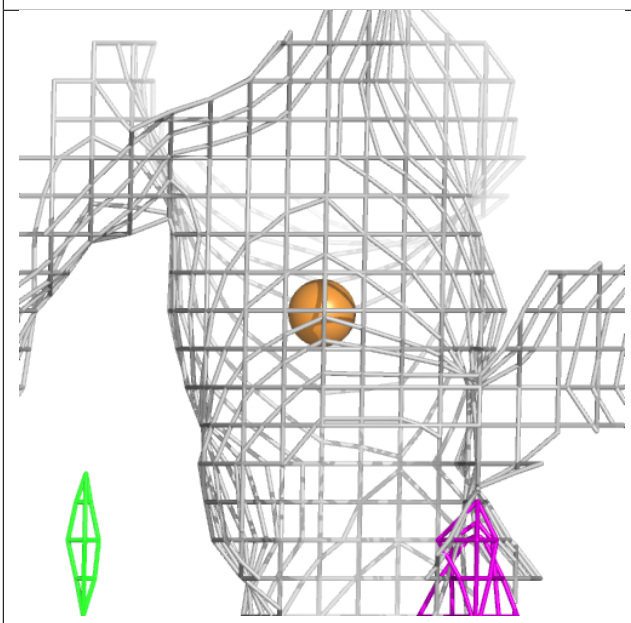


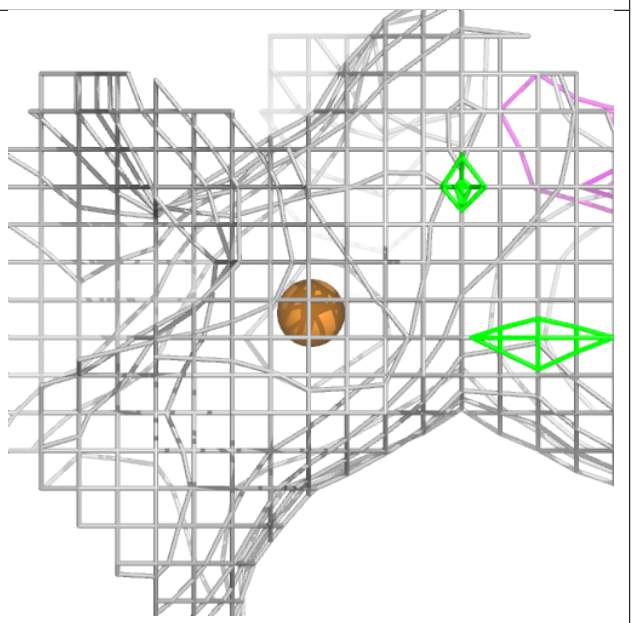


Electron density around CU1 B 1009:

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

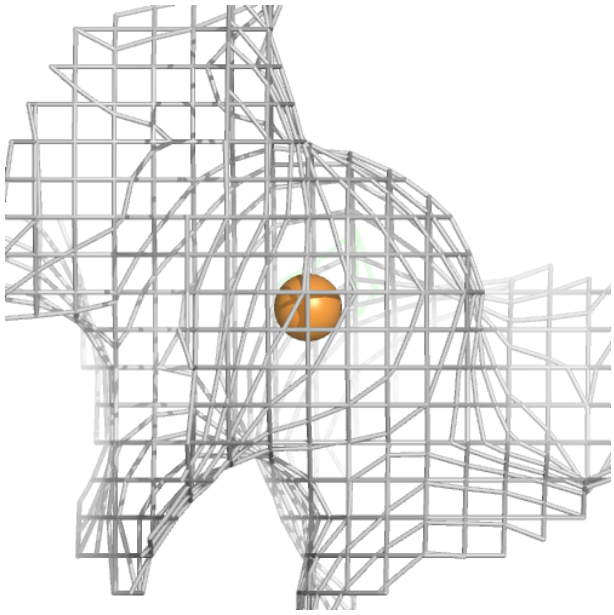


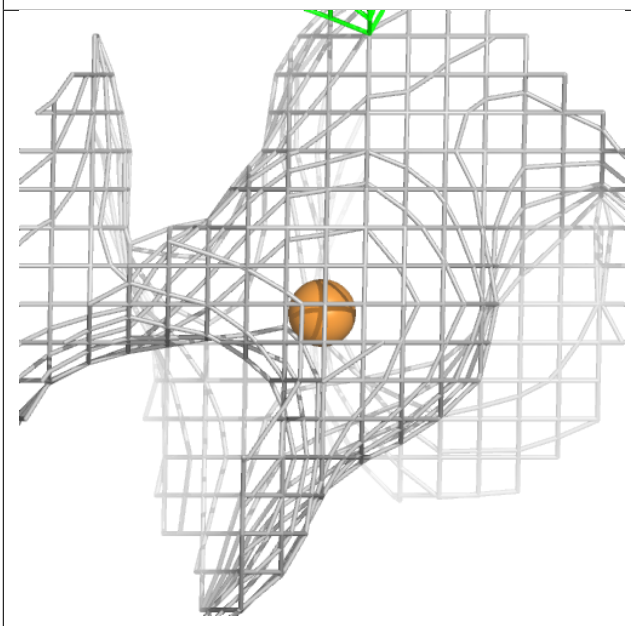


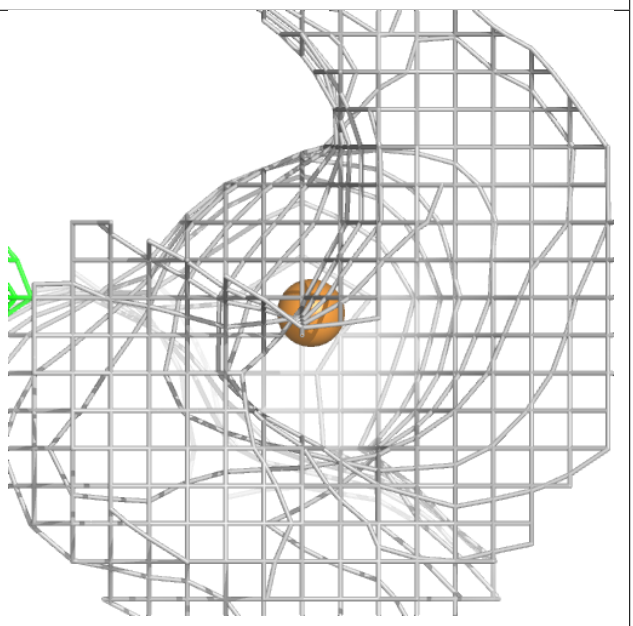


Electron density around CU1 B 1010:

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

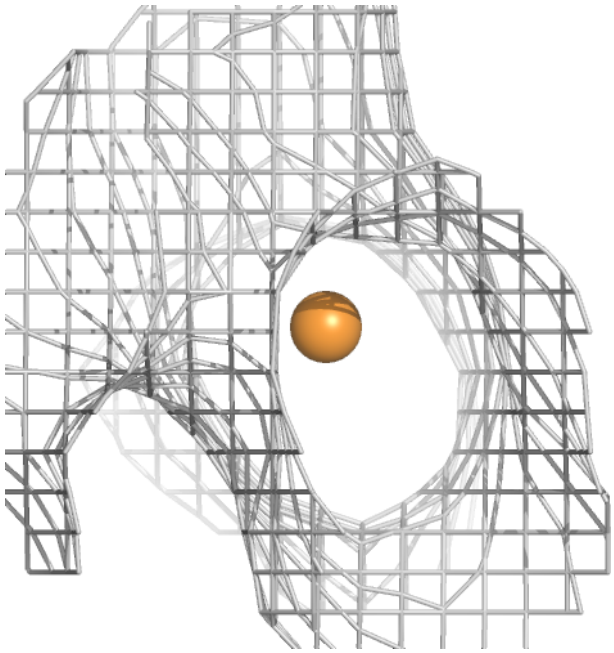


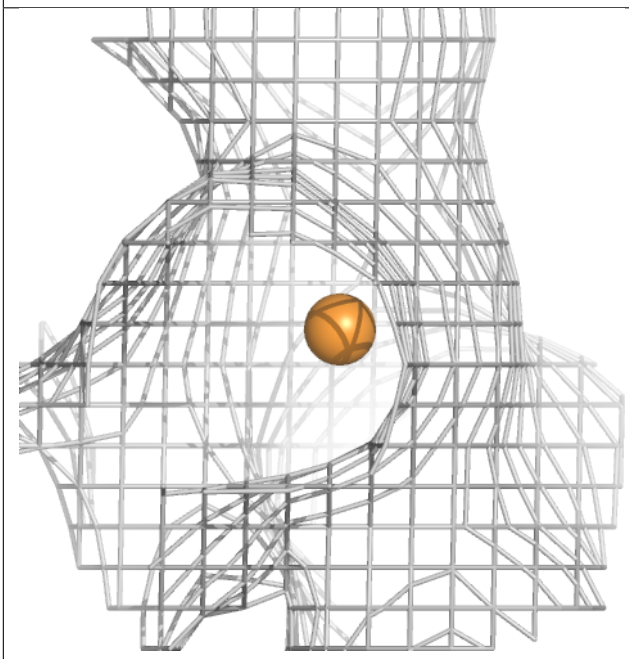


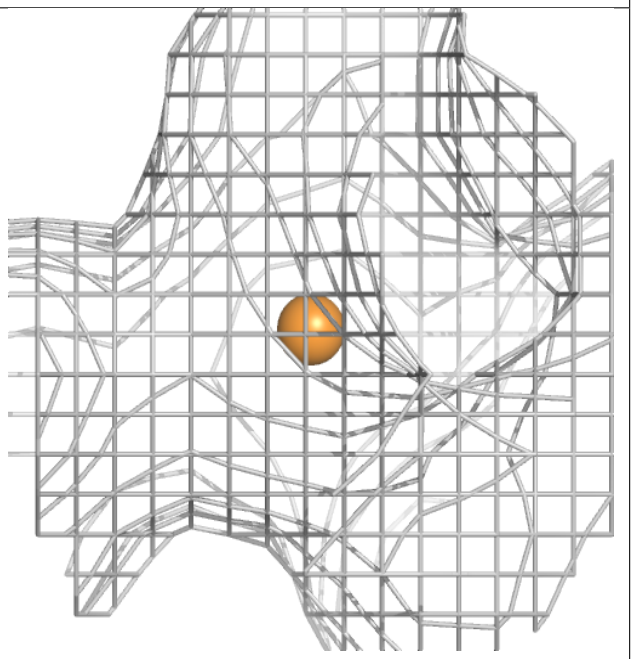


Electron density around CU1 B 1011:

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

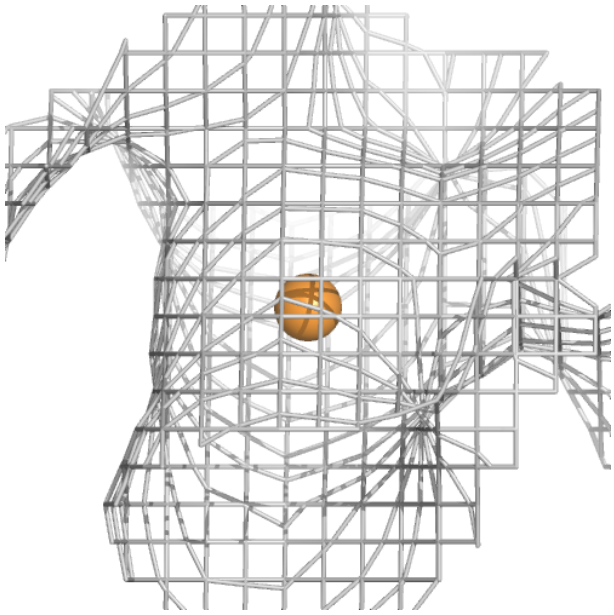


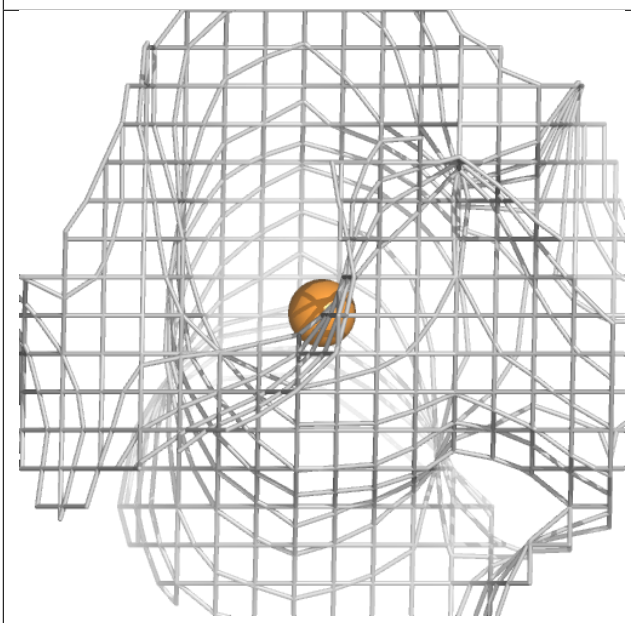


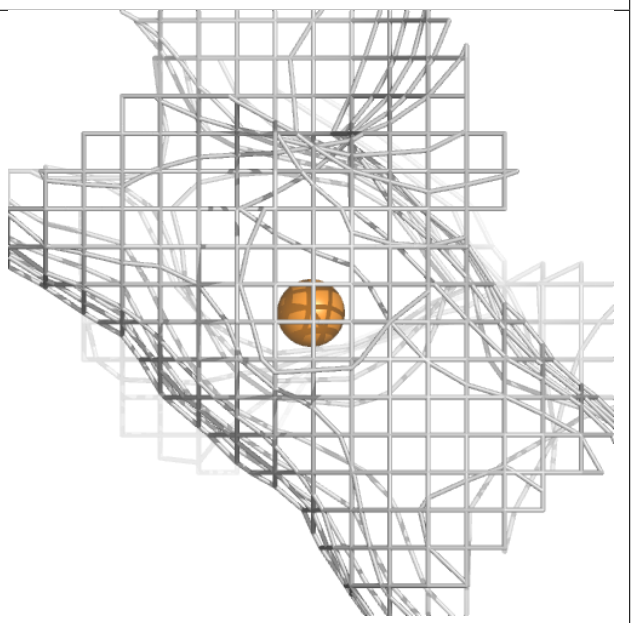


Electron density around CU1 B 1012:

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

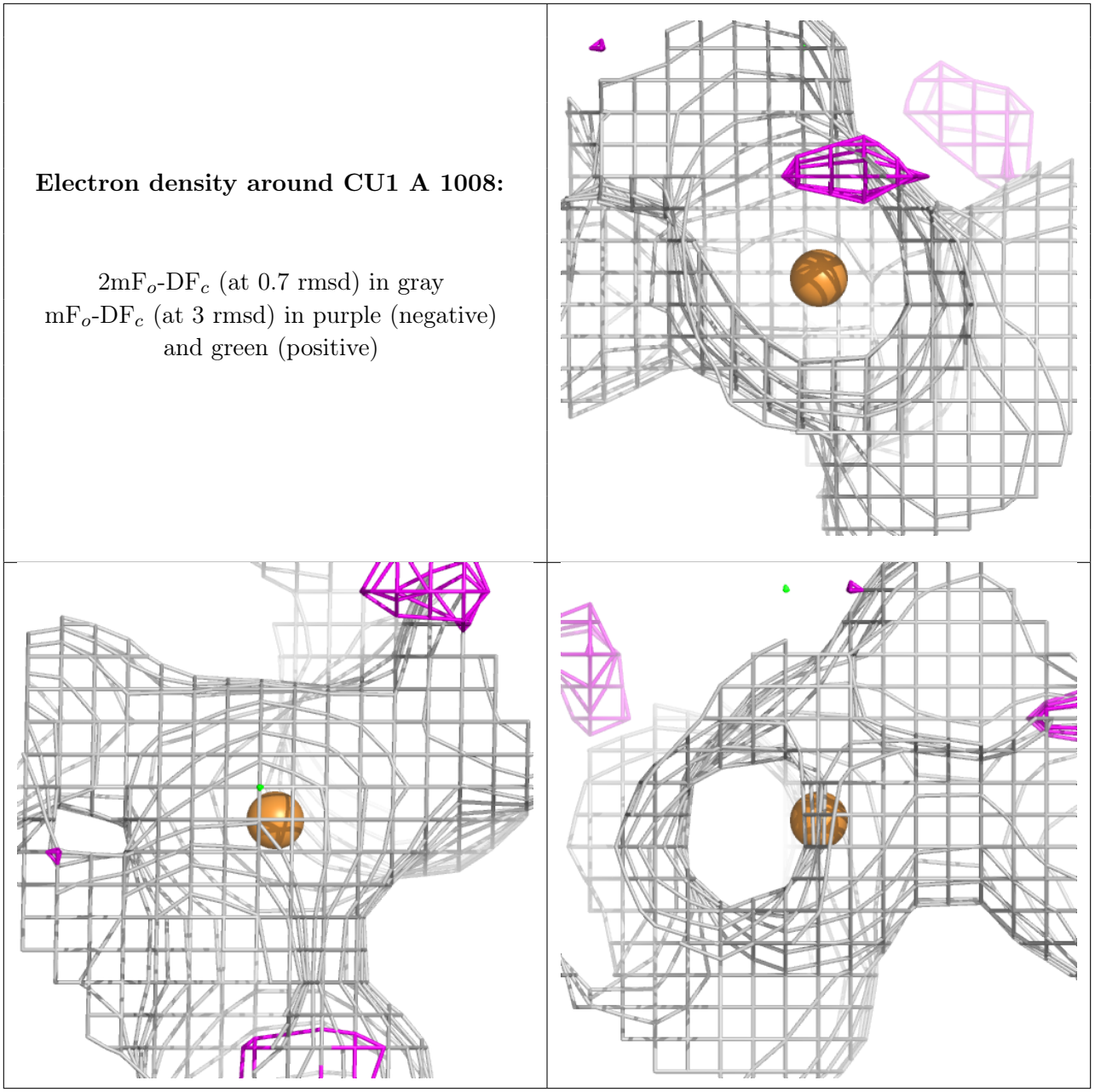






Electron density around CU1 A 1008:

$2mF_o$-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.