

Cyanidotris(1,3,5-triaza-7-phosphaadamantane)-silver(I) tetrahydrate

Sizwe J. Zamisa,^{a*} Adesola A. Adeleke,^a Orpah Zinyemba^b and Bernard Omondi^a

^aSchool of Agriculture and Science, Discipline of Chemistry, University of KwaZulu-Natal, Private Bag X54001, Durban, 4000, South Africa, and ^bDepartment of Chemical Sciences, University of Johannesburg, PO Box 524 Auckland, Park, Johannesburg, 2006, South Africa. *Correspondence e-mail: Zamisas@ukzn.ac.za

Received 17 October 2025

Accepted 21 October 2025

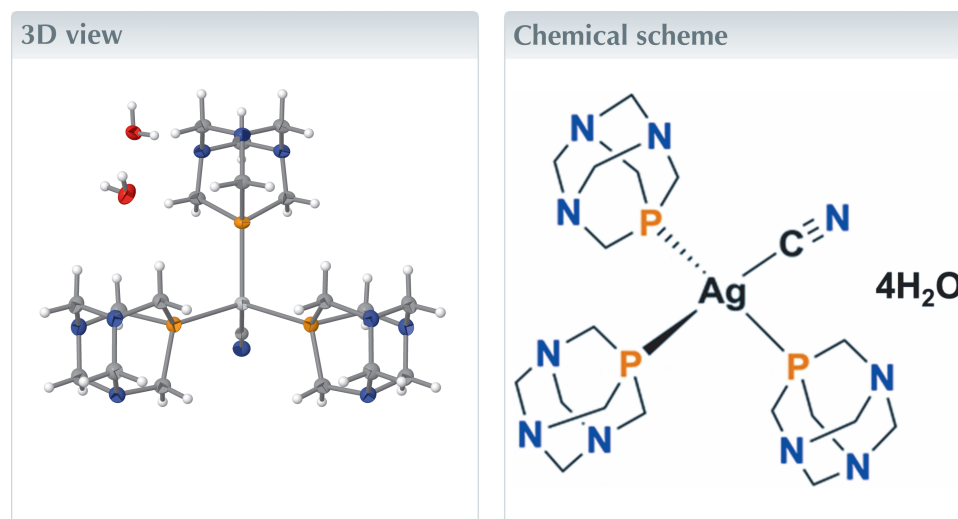
Edited by I. Brito, University of Antofagasta, Chile

Keywords: crystal structure; 1,3,5-triaza-7-phosphaadamantane (PTA); silver-PTA complex; cyanide ion.

CCDC reference: 2496890

Structural data: full structural data are available from iucrdata.iucr.org

The title compound, $[\text{Ag}(\text{CN})(\text{PTA})_3] \cdot 4\text{H}_2\text{O}$, is a water-soluble discrete silver(I) complex where the silver center is coordinated by three phosphorus atoms from distinct 1,3,5-triaza-7-phosphaadamantane (PTA, $\text{C}_6\text{H}_{12}\text{N}_3\text{P}$) ligands and one carbon atom from a cyanide ion, forming a distorted tetrahedral geometry. The asymmetric unit consisting of a $[\text{AgCN}(\text{PTA})_{3/2}]$ unit and two water molecules. The Ag–P bond distances range from 2.4696 (4) to 2.4728 (6) Å, and the Ag–C bond distance is 2.168 (2) Å, while the bond angles around the silver center vary between 107.402 (13) and 111.07 (3)°, confirming its distorted tetrahedral coordination environment. Intermolecular O–H···N and O–H···O hydrogen bonds in the crystal packing of the title compound generate a two-dimensional supramolecular architecture with a corrugated sheet-like topology that extends along the crystallographic *bc* plane.



Structure description

The cage-like, monodentate phosphine ligand 1,3,5-triaza-7-phosphaadamantane (PTA) and its derivatives have attracted significant attention due to their exceptional solubility in aqueous media, attributed to their unique structure featuring a soft phosphorus donor and three hard nitrogen atoms (Krogstad *et al.*, 2007). PTA typically coordinates metals *via* the phosphorus atom in a monodentate fashion (PTA- κ P), while its nitrogen atoms offer additional coordination possibilities that influence the structure and function of metal complexes (Darensbourg *et al.*, 1997). Silver(I) ions form stable and soluble complexes with PTA, enhancing their suitability for applications in catalysis (Phillips *et al.*, 2004), medicinal chemistry (Guerrero & Gonsalvi, 2021), and photoluminescence (Sierra-Martin *et al.*, 2018). Herein, the synthesis and crystal structure of the discrete monomeric complex $[\text{Ag}(\text{CN})(\text{PTA})_3] \cdot 4\text{H}_2\text{O}$, containing silver(I) coordinated by PTA and cyanide, are reported.

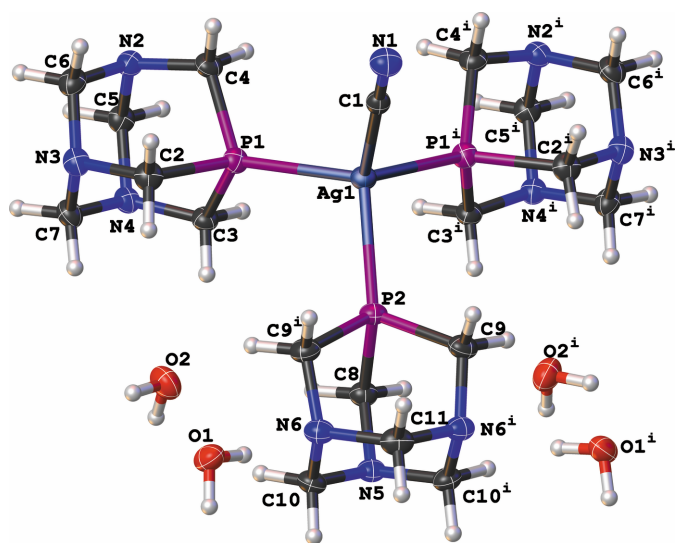


Figure 1
Molecular structure of the title compound with ellipsoids drawn at the 50% probability level.

The asymmetric unit of title compound (Fig. 1) comprises a discrete $[\text{Ag}(\text{CN})(\text{PTA})_{3/2}]$ unit and two water molecules, with the full molecule generated by the symmetry operation $x, \frac{3}{2} - y, z$. It is a neutral discrete complex where the silver(I) center is coordinated by three phosphorus atoms from three distinct PTA ligands and one carbon atom from the nitrile ion, resulting in a distorted tetrahedral geometry around the Ag centre. The bond angles around Ag1 range from $107.402(13)$ to $111.07(3)^\circ$, with Ag—P bond distances between 2.4696 (4) and 2.4728 (6) Å and an Ag—C bond distance of 2.168 (2) Å. The crystal structure exhibits an intricate hydrogen-bonding

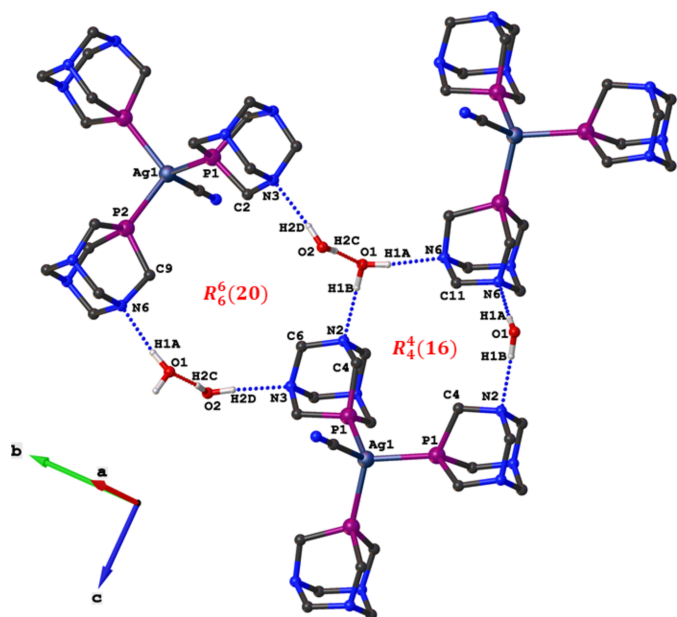


Figure 2
Representation of the intermolecular O—H...O (red dotted lines) and O—H...N (blue dotted lines) hydrogen bond in the crystal packing of the title compound.

Table 1
Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O1—H1A...N6	0.87	1.97	2.8379 (19)	172
O1—H1B...N2 ⁱ	0.87	1.98	2.8518 (18)	178
O2—H2C...O1 ⁱⁱ	0.87	1.93	2.7931 (19)	174
O2—H2D...N3 ⁱⁱⁱ	0.87	2.01	2.8796 (19)	176

Symmetry codes: (i) $x, y, z + 1$; (ii) $x - \frac{1}{2}, y, -z + \frac{3}{2}$; (iii) $-x + 1, -y + 2, -z + 1$.

Table 2
Experimental details.

Crystal data	
Chemical formula	$[\text{Ag}(\text{CN})(\text{C}_6\text{H}_{12}\text{N}_3\text{P})_3]\cdot 4\text{H}_2\text{O}$
M_r	677.42
Crystal system, space group	Orthorhombic, $Pnma$
Temperature (K)	173
a, b, c (Å)	11.9813 (4), 20.8423 (7), 12.2359 (4)
V (Å ³)	3055.52 (18)
Z	4
Radiation type	Mo $K\alpha$
μ (mm ⁻¹)	0.86
Crystal size (mm)	0.35 × 0.26 × 0.2
Data collection	
Diffractometer	Bruker APEXII CCD
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	62216, 3898, 3438
R_{int}	0.036
$(\sin \theta/\lambda)_{\text{max}}$ (Å ⁻¹)	0.667
Refinement	
$R[F^2 > 2\sigma(F^2)], wR(F^2), S$	0.024, 0.058, 1.11
No. of reflections	3898
No. of parameters	184
H-atom treatment	H-atom parameters constrained
$\Delta\rho_{\text{max}}, \Delta\rho_{\text{min}}$ (e Å ⁻³)	0.43, -0.39

Computer programs: *COSMO* and *SAINT* (Bruker, 2009), *SHELXS* (Sheldrick, 2008), *SHELXL2018/3* (Sheldrick, 2015) and *OLEX2* (Dolomanov *et al.*, 2009).

network involving both water molecules and the discrete $[\text{Ag}(\text{CN})(\text{PTA})_3]$ units. One water molecule, O1, participates in two distinct hydrogen bonds, in one of which it links adjacent silver complexes through O—H...N hydrogen bonds involving nitrogen atoms N2 and N6, forming hydrogen-bonded motifs described by the graph-set notation $R_4^4(16)$

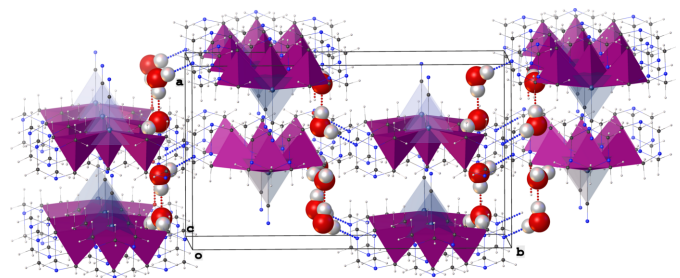


Figure 3
Representation of the 2-D supramolecular structure of the title compound. The silver and phosphorus atoms are drawn as blue- and purple-colored polyhedra, respectively, while the water molecules are drawn using a space-filling model. The intermolecular O—H...O and O—H...N hydrogen bonds are shown as red and blue dotted lines, respectively.

(Table 1, Fig. 2). In the second, O1 acts as a hydrogen-bond acceptor while O2 functions as a donor, connecting through O—H...N hydrogen bonds to N3 of an adjacent [Ag(CN)(PTA)₃] complex. This interaction leads to the formation of a larger hydrogen-bonded ring which can be described by graph-set notation $R_6^6(20)$ (Fig. 2). Overall, these O—H...N and O—H...O hydrogen bonds generate a two-dimensional supramolecular architecture with a corrugated sheet-like topology that extends along the crystallographic *bc* plane as shown in Fig. 3.

Synthesis and crystallization

A methanol solution of PTA (3.84 g, 8.14 mmol) was mixed with aqueous KAg(CN)₂ (3.00 g, 8.14 mmol). The solution volume was reduced by rotary evaporation, then acetonitrile (40 ml) was added to form a cloudy solution. The solvent was reduced using a rotary evaporator to give a white solid, which was isolated by vacuum filtration, washed with 2 × 5 ml of cold ethanol, and dried *in vacuo*. X-ray quality crystals were obtained by taking an aliquot of cloudy solution after the addition of acetonitrile and leaving it to stand overnight at room temperature.

Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2.

Acknowledgements

We thank the University of KwaZulu-Natal for their support of this research.

References

- Bruker (2009). *COSMO* and *SAINT*. Bruker AXS Inc., Madison, Wisconsin, USA.
- Darensbourg, D. J., Decuir, T. J., Stafford, N. W., Robertson, J. B., Draper, J. D., Reibenspies, J. H., Kathó, A. & Joó, F. (1997). *Inorg. Chem.* **36**, 4218–4226.
- Dolomanov, O. V., Bourhis, L. J., Gildea, R. J., Howard, J. A. K. & Puschmann, H. (2009). *J. Appl. Cryst.* **42**, 339–341.
- Guerriero, A. & Gonsalvi, L. (2021). *Inorg. Chim. Acta* **518**, 120251.
- Krogstad, D. A., Ellis, G. S., Gunderson, A. K., Hammrich, A. J., Rudolf, J. W. & Halfen, J. A. (2007). *Polyhedron* **26**, 4093–4100.
- Phillips, A. D., Gonsalvi, L., Romerosa, A., Vizza, F. & Peruzzini, M. (2004). *Coord. Chem. Rev.* **248**, 955–993.
- Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.
- Sheldrick, G. M. (2015). *Acta Cryst.* **C71**, 3–8.
- Sierra-Martin, B., Maldonado-Valdivia, A., Serrano-Ruiz, M., Romerosa, A. & Fernandez-Barbero, A. (2018). *Colloids Surf. A Physicochem. Eng. Asp.* **557**, 14–19.

full crystallographic data

IUCrData (2025). **10**, x250925 [<https://doi.org/10.1107/S2414314625009253>]

Cyanidotris(1,3,5-triaza-7-phosphaadamantane)silver(I) tetrahydrate

Sizwe J. Zamisa, Adesola A. Adeleke, Orpah Zinyemba and Bernard Omondi

Cyanidotris(1,3,5-triaza-7-phosphaadamantane)silver(I) tetrahydrate

Crystal data

[Ag(CN)(C₆H₁₂N₃P)₃]₄·4H₂O

M_r = 677.42

Orthorhombic, *Pnma*

a = 11.9813 (4) Å

b = 20.8423 (7) Å

c = 12.2359 (4) Å

V = 3055.52 (18) Å³

Z = 4

F(000) = 1408

D_x = 1.473 Mg m⁻³

Mo *Kα* radiation, *λ* = 0.71073 Å

Cell parameters from 9406 reflections

θ = 2.4–28.1°

μ = 0.86 mm⁻¹

T = 173 K

Plate, colourless

0.35 × 0.26 × 0.2 mm

Data collection

Bruker APEXII CCD

diffractometer

Graphite monochromator

φ and *ω* scans

62216 measured reflections

3898 independent reflections

3438 reflections with *I* > 2σ(*I*)

*R*_{int} = 0.036

*θ*_{max} = 28.3°, *θ*_{min} = 1.9°

h = -15→15

k = -23→27

l = -16→16

Refinement

Refinement on *F*²

Least-squares matrix: full

R[*F*² > 2σ(*F*²)] = 0.024

wR(*F*²) = 0.058

S = 1.11

3898 reflections

184 parameters

0 restraints

Hydrogen site location: mixed

H-atom parameters constrained

w = 1/[σ²(*F*_o²) + (0.0231*P*)² + 1.851*P*]

where *P* = (*F*_o² + 2*F*_c²)/3

(Δ/σ)_{max} = 0.001

Δρ_{max} = 0.43 e Å⁻³

Δρ_{min} = -0.39 e Å⁻³

Special details

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Refinement. Refinement of *F*² against ALL reflections. The weighted *R*-factor *wR* and goodness of fit *S* are based on *F*², conventional *R*-factors *R* are based on *F*, with *F* set to zero for negative *F*². The threshold expression of *F*² > 2σ(*F*²) is used only for calculating *R*-factors(gt) etc. and is not relevant to the choice of reflections for refinement. *R*-factors based on *F*² are statistically about twice as large as those based on *F*, and *R*-factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$	Occ. (<1)
Ag1	0.62465 (2)	0.750000	0.41337 (2)	0.02013 (6)	
P1	0.55217 (3)	0.84680 (2)	0.32110 (3)	0.02075 (9)	
P2	0.55002 (5)	0.750000	0.60179 (5)	0.02143 (13)	
N1	0.90084 (18)	0.750000	0.41775 (17)	0.0290 (5)	
N2	0.54207 (11)	0.92245 (7)	0.13404 (11)	0.0223 (3)	
N3	0.54339 (11)	0.98006 (7)	0.31065 (11)	0.0237 (3)	
N4	0.37430 (11)	0.92177 (6)	0.25146 (11)	0.0214 (3)	
N5	0.37219 (16)	0.750000	0.74784 (15)	0.0217 (4)	
N6	0.54111 (12)	0.80939 (7)	0.80538 (11)	0.0241 (3)	
C1	0.80555 (19)	0.750000	0.41643 (17)	0.0189 (4)	
C2	0.59015 (14)	0.92665 (8)	0.37527 (14)	0.0246 (4)	
H2A	0.563175	0.930191	0.451508	0.030*	
H2B	0.672493	0.930543	0.376499	0.030*	
C3	0.40053 (13)	0.86158 (8)	0.30910 (13)	0.0214 (3)	
H3A	0.365732	0.825328	0.269456	0.026*	
H3B	0.367502	0.863133	0.383219	0.026*	
C4	0.58916 (14)	0.86184 (8)	0.17668 (13)	0.0234 (3)	
H4A	0.671453	0.863213	0.169771	0.028*	
H4B	0.561692	0.825747	0.131485	0.028*	
C5	0.41875 (14)	0.92161 (8)	0.13962 (13)	0.0224 (3)	
H5A	0.389489	0.959593	0.100374	0.027*	
H5B	0.391112	0.882910	0.101303	0.027*	
C6	0.58279 (14)	0.97793 (8)	0.19676 (14)	0.0258 (4)	
H6A	0.558832	1.017712	0.159278	0.031*	
H6B	0.665409	0.977234	0.196821	0.031*	
C7	0.42017 (14)	0.97741 (8)	0.30966 (14)	0.0242 (3)	
H7A	0.393020	0.976580	0.386059	0.029*	
H7B	0.391326	1.017034	0.275111	0.029*	
C8	0.39835 (19)	0.750000	0.62980 (18)	0.0220 (5)	
H8A	0.364394	0.788376	0.595632	0.026*	0.5
H8B	0.364394	0.711624	0.595632	0.026*	0.5
C9	0.58800 (15)	0.68332 (9)	0.69428 (13)	0.0252 (4)	
H9A	0.560961	0.642493	0.662501	0.030*	
H9B	0.670341	0.680760	0.699484	0.030*	
C10	0.41789 (14)	0.80712 (8)	0.80178 (13)	0.0238 (3)	
H10A	0.389011	0.808843	0.877528	0.029*	
H10B	0.390437	0.845722	0.763055	0.029*	
C11	0.5815 (2)	0.750000	0.8573 (2)	0.0272 (5)	
H11A	0.557928	0.750000	0.934895	0.033*	
H11B	0.664079	0.750001	0.855846	0.033*	
O1	0.63144 (11)	0.91639 (6)	0.91827 (10)	0.0299 (3)	
H1A	0.599261	0.883175	0.888933	0.045*	
H1B	0.602530	0.918979	0.983341	0.045*	
O2	0.36431 (11)	0.91126 (6)	0.57555 (11)	0.0344 (3)	
H2C	0.292257	0.914947	0.581713	0.052*	

H2D 0.390923 0.943306 0.612940 0.052*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Ag1	0.01658 (9)	0.02286 (10)	0.02095 (9)	0.000	0.00045 (7)	0.000
P1	0.0166 (2)	0.0217 (2)	0.0239 (2)	0.00258 (17)	-0.00155 (16)	0.00100 (16)
P2	0.0180 (3)	0.0264 (3)	0.0200 (3)	0.000	0.0037 (2)	0.000
N1	0.0214 (11)	0.0348 (12)	0.0308 (11)	0.000	-0.0006 (9)	0.000
N2	0.0181 (7)	0.0238 (7)	0.0251 (7)	0.0004 (6)	0.0003 (6)	0.0019 (6)
N3	0.0189 (7)	0.0230 (7)	0.0290 (7)	-0.0010 (6)	-0.0025 (6)	-0.0016 (6)
N4	0.0157 (7)	0.0222 (7)	0.0263 (7)	0.0014 (6)	-0.0013 (5)	-0.0010 (5)
N5	0.0169 (10)	0.0270 (10)	0.0213 (9)	0.000	0.0019 (7)	0.000
N6	0.0198 (7)	0.0299 (8)	0.0226 (6)	-0.0020 (6)	0.0016 (5)	-0.0026 (6)
C1	0.0202 (12)	0.0193 (11)	0.0171 (9)	0.000	-0.0007 (8)	0.000
C2	0.0194 (8)	0.0275 (9)	0.0270 (8)	-0.0016 (7)	-0.0054 (7)	-0.0006 (7)
C3	0.0160 (8)	0.0236 (8)	0.0246 (8)	-0.0006 (6)	0.0012 (6)	-0.0008 (6)
C4	0.0168 (8)	0.0266 (9)	0.0268 (8)	0.0035 (7)	0.0019 (6)	0.0000 (7)
C5	0.0183 (8)	0.0249 (8)	0.0239 (8)	0.0010 (7)	-0.0040 (6)	0.0011 (6)
C6	0.0202 (8)	0.0256 (9)	0.0315 (9)	-0.0034 (7)	0.0003 (7)	0.0024 (7)
C7	0.0201 (8)	0.0222 (8)	0.0301 (8)	0.0026 (7)	-0.0010 (7)	-0.0034 (7)
C8	0.0177 (11)	0.0266 (12)	0.0215 (10)	0.000	-0.0004 (9)	0.000
C9	0.0206 (8)	0.0303 (9)	0.0247 (8)	0.0050 (7)	0.0037 (7)	0.0010 (7)
C10	0.0199 (8)	0.0279 (9)	0.0235 (8)	0.0022 (7)	0.0031 (7)	-0.0027 (7)
C11	0.0204 (12)	0.0380 (14)	0.0231 (11)	0.000	-0.0034 (10)	0.000
O1	0.0335 (7)	0.0293 (7)	0.0268 (6)	-0.0078 (6)	0.0049 (5)	0.0000 (5)
O2	0.0333 (7)	0.0291 (7)	0.0407 (8)	0.0006 (6)	0.0008 (6)	-0.0107 (6)

Geometric parameters (Å, °)

Ag1—P1 ⁱ	2.4696 (4)	N6—C11	1.4732 (19)
Ag1—P1	2.4696 (4)	C2—H2A	0.9900
Ag1—P2	2.4728 (6)	C2—H2B	0.9900
Ag1—C1	2.168 (2)	C3—H3A	0.9900
P1—C2	1.8484 (17)	C3—H3B	0.9900
P1—C3	1.8486 (16)	C4—H4A	0.9900
P1—C4	1.8486 (17)	C4—H4B	0.9900
P2—C8	1.849 (2)	C5—H5A	0.9900
P2—C9 ⁱ	1.8492 (17)	C5—H5B	0.9900
P2—C9	1.8492 (17)	C6—H6A	0.9900
N1—C1	1.142 (3)	C6—H6B	0.9900
N2—C4	1.479 (2)	C7—H7A	0.9900
N2—C5	1.479 (2)	C7—H7B	0.9900
N2—C6	1.471 (2)	C8—H8A	0.9900
N3—C2	1.476 (2)	C8—H8B	0.9900
N3—C6	1.472 (2)	C9—H9A	0.9900
N3—C7	1.477 (2)	C9—H9B	0.9900
N4—C3	1.473 (2)	C10—H10A	0.9900

N4—C5	1.468 (2)	C10—H10B	0.9900
N4—C7	1.468 (2)	C11—H11A	0.9900
N5—C8	1.478 (3)	C11—H11B	0.9900
N5—C10	1.467 (2)	O1—H1A	0.8700
N5—C10 ⁱ	1.467 (2)	O1—H1B	0.8700
N6—C9 ⁱ	1.479 (2)	O2—H2C	0.8700
N6—C10	1.478 (2)	O2—H2D	0.8700
P1 ⁱ —Ag1—P1	109.55 (2)	N2—C4—P1	113.00 (11)
P1 ⁱ —Ag1—P2	107.402 (13)	N2—C4—H4A	109.0
P1—Ag1—P2	107.402 (13)	N2—C4—H4B	109.0
C1—Ag1—P1	111.07 (3)	H4A—C4—H4B	107.8
C1—Ag1—P1 ⁱ	111.07 (3)	N2—C5—H5A	108.8
C1—Ag1—P2	110.21 (6)	N2—C5—H5B	108.8
C2—P1—Ag1	119.02 (6)	N4—C5—N2	113.91 (13)
C2—P1—C3	96.91 (8)	N4—C5—H5A	108.8
C2—P1—C4	97.53 (8)	N4—C5—H5B	108.8
C3—P1—Ag1	121.21 (5)	H5A—C5—H5B	107.7
C3—P1—C4	97.55 (7)	N2—C6—N3	114.28 (14)
C4—P1—Ag1	119.42 (6)	N2—C6—H6A	108.7
C8—P2—Ag1	121.88 (8)	N2—C6—H6B	108.7
C8—P2—C9	97.38 (7)	N3—C6—H6A	108.7
C9—P2—Ag1	118.79 (5)	N3—C6—H6B	108.7
C9 ⁱ —P2—Ag1	118.79 (5)	H6A—C6—H6B	107.6
C9 ⁱ —P2—C8	97.38 (7)	N3—C7—H7A	108.7
C9 ⁱ —P2—C9	97.46 (11)	N3—C7—H7B	108.7
C4—N2—C5	110.78 (13)	N4—C7—N3	114.06 (13)
C6—N2—C4	111.15 (13)	N4—C7—H7A	108.7
C6—N2—C5	108.45 (13)	N4—C7—H7B	108.7
C2—N3—C7	110.83 (13)	H7A—C7—H7B	107.6
C6—N3—C2	111.27 (14)	P2—C8—H8A	109.0
C6—N3—C7	108.15 (13)	P2—C8—H8B	109.0
C5—N4—C3	111.53 (12)	N5—C8—P2	112.93 (15)
C7—N4—C3	111.14 (13)	N5—C8—H8A	109.0
C7—N4—C5	108.55 (13)	N5—C8—H8B	109.0
C10 ⁱ —N5—C8	111.13 (11)	H8A—C8—H8B	107.8
C10—N5—C8	111.13 (12)	P2—C9—H9A	109.0
C10—N5—C10 ⁱ	108.47 (18)	P2—C9—H9B	109.0
C10—N6—C9 ⁱ	110.82 (13)	N6 ⁱ —C9—P2	113.07 (12)
C11—N6—C9 ⁱ	111.00 (15)	N6 ⁱ —C9—H9A	109.0
C11—N6—C10	108.29 (15)	N6 ⁱ —C9—H9B	109.0
N1—C1—Ag1	179.82 (19)	H9A—C9—H9B	107.8
P1—C2—H2A	108.9	N5—C10—N6	114.35 (14)
P1—C2—H2B	108.9	N5—C10—H10A	108.7
N3—C2—P1	113.18 (11)	N5—C10—H10B	108.7
N3—C2—H2A	108.9	N6—C10—H10A	108.7
N3—C2—H2B	108.9	N6—C10—H10B	108.7
H2A—C2—H2B	107.8	H10A—C10—H10B	107.6

P1—C3—H3A	109.0	N6—C11—N6 ⁱ	114.33 (19)
P1—C3—H3B	109.0	N6 ⁱ —C11—H11A	108.7
N4—C3—P1	112.93 (11)	N6—C11—H11A	108.7
N4—C3—H3A	109.0	N6—C11—H11B	108.7
N4—C3—H3B	109.0	N6 ⁱ —C11—H11B	108.7
H3A—C3—H3B	107.8	H11A—C11—H11B	107.6
P1—C4—H4A	109.0	H1A—O1—H1B	104.5
P1—C4—H4B	109.0	H2C—O2—H2D	104.5
Ag1—P1—C2—N3	178.57 (9)	C6—N2—C4—P1	60.19 (15)
Ag1—P1—C3—N4	179.99 (8)	C6—N2—C5—N4	-55.12 (17)
Ag1—P1—C4—N2	-178.41 (9)	C6—N3—C2—P1	-59.84 (16)
Ag1—P2—C8—N5	180.000 (1)	C6—N3—C7—N4	55.62 (18)
Ag1—P2—C9—N6 ⁱ	177.87 (9)	C7—N3—C2—P1	60.54 (16)
C2—P1—C3—N4	49.85 (12)	C7—N3—C6—N2	-55.30 (18)
C2—P1—C4—N2	-48.90 (13)	C7—N4—C3—P1	-61.08 (15)
C2—N3—C6—N2	66.65 (17)	C7—N4—C5—N2	55.58 (17)
C2—N3—C7—N4	-66.60 (18)	C8—P2—C9—N6 ⁱ	-49.37 (14)
C3—P1—C2—N3	-49.83 (13)	C8—N5—C10—N6	-67.05 (19)
C3—P1—C4—N2	49.15 (13)	C9 ⁱ —P2—C8—N5	-49.27 (6)
C3—N4—C5—N2	-67.19 (17)	C9—P2—C8—N5	49.28 (6)
C3—N4—C7—N3	67.02 (17)	C9 ⁱ —P2—C9—N6 ⁱ	49.11 (16)
C4—P1—C2—N3	48.78 (13)	C9 ⁱ —N6—C10—N5	66.84 (19)
C4—P1—C3—N4	-48.73 (12)	C9 ⁱ —N6—C11—N6 ⁱ	-66.9 (2)
C4—N2—C5—N4	67.12 (17)	C10—N5—C8—P2	60.44 (12)
C4—N2—C6—N3	-66.84 (17)	C10 ⁱ —N5—C8—P2	-60.44 (12)
C5—N2—C4—P1	-60.46 (15)	C10 ⁱ —N5—C10—N6	55.4 (2)
C5—N2—C6—N3	55.17 (18)	C10—N6—C11—N6 ⁱ	54.9 (2)
C5—N4—C3—P1	60.20 (15)	C11—N6—C10—N5	-55.13 (18)
C5—N4—C7—N3	-55.98 (17)		

Symmetry code: (i) $x, -y+3/2, z$.

Hydrogen-bond geometry ($\text{\AA}, ^\circ$)

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O1—H1A \cdots N6	0.87	1.97	2.8379 (19)	172
O1—H1B \cdots N2 ⁱⁱ	0.87	1.98	2.8518 (18)	178
O2—H2C \cdots O1 ⁱⁱⁱ	0.87	1.93	2.7931 (19)	174
O2—H2D \cdots N3 ^{iv}	0.87	2.01	2.8796 (19)	176

Symmetry codes: (ii) $x, y, z+1$; (iii) $x-1/2, y, -z+3/2$; (iv) $-x+1, -y+2, -z+1$.