Panel 3: Categorical Distance Independence from Spatial Distance
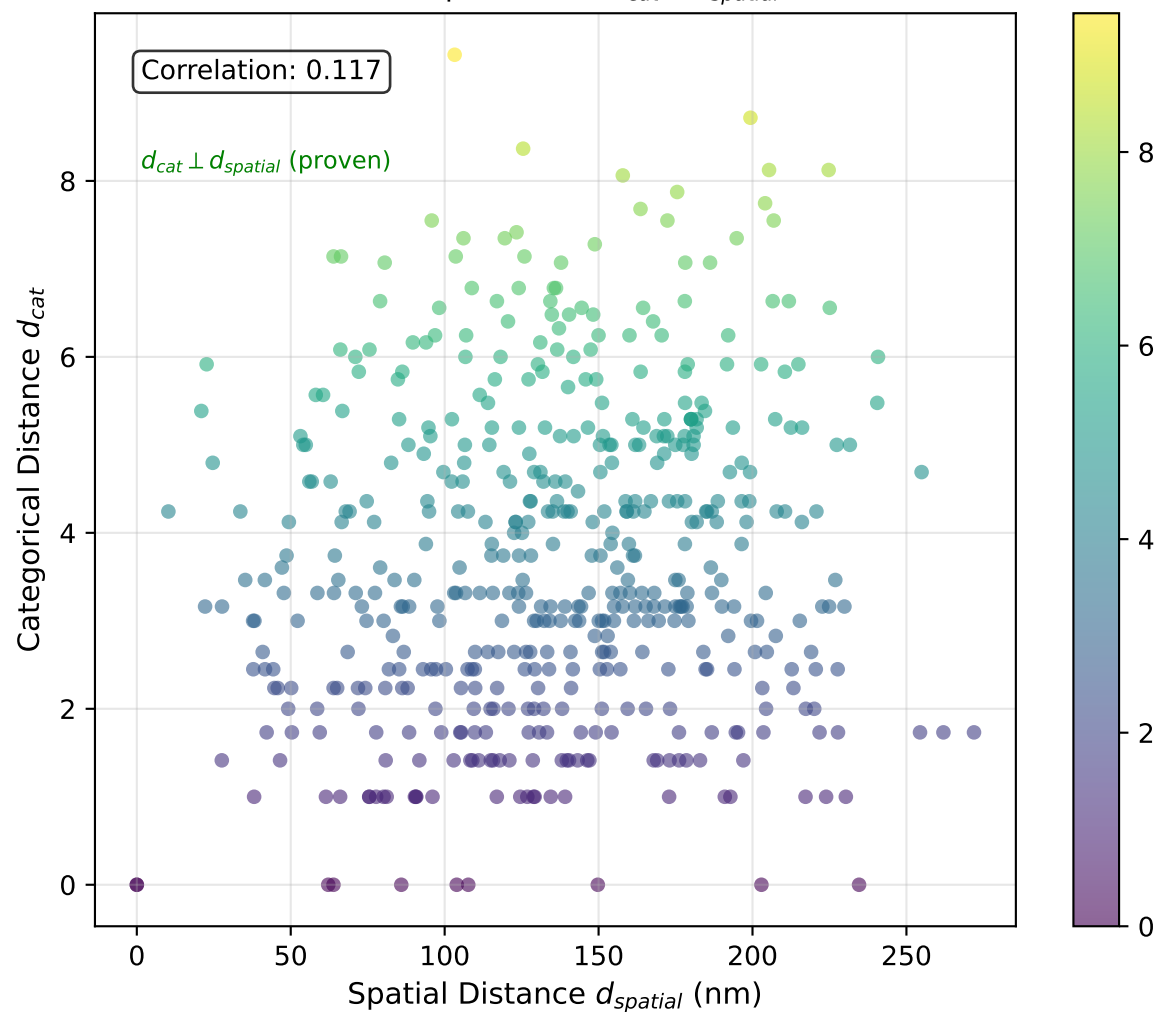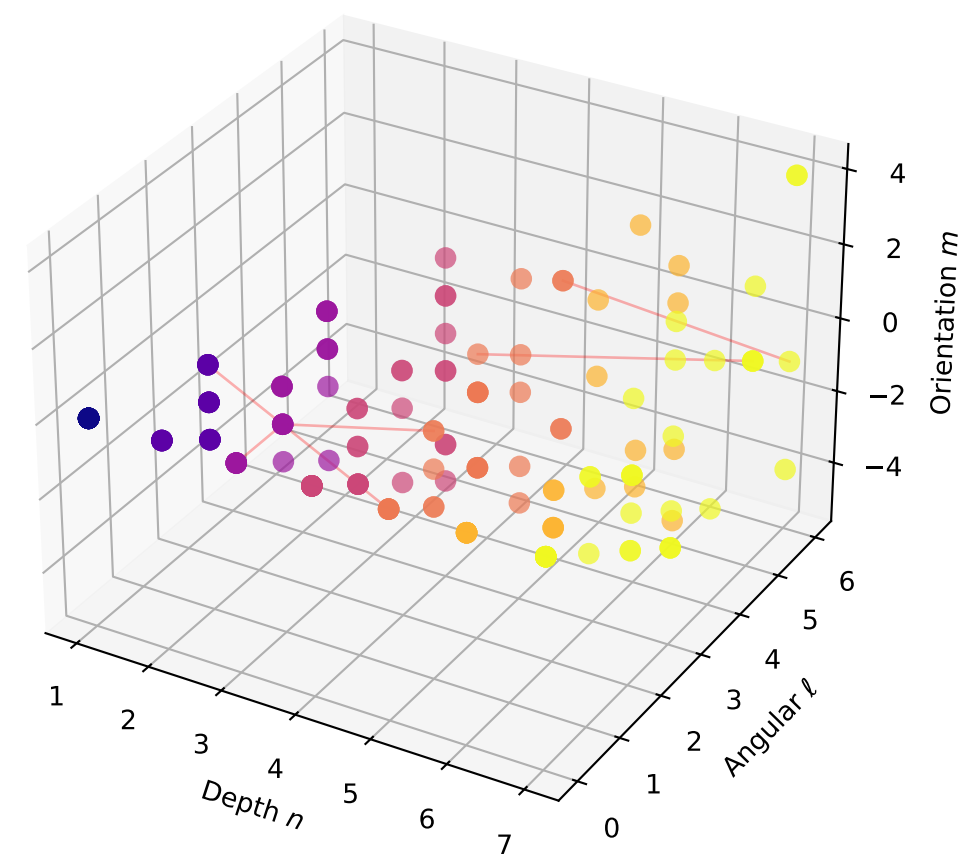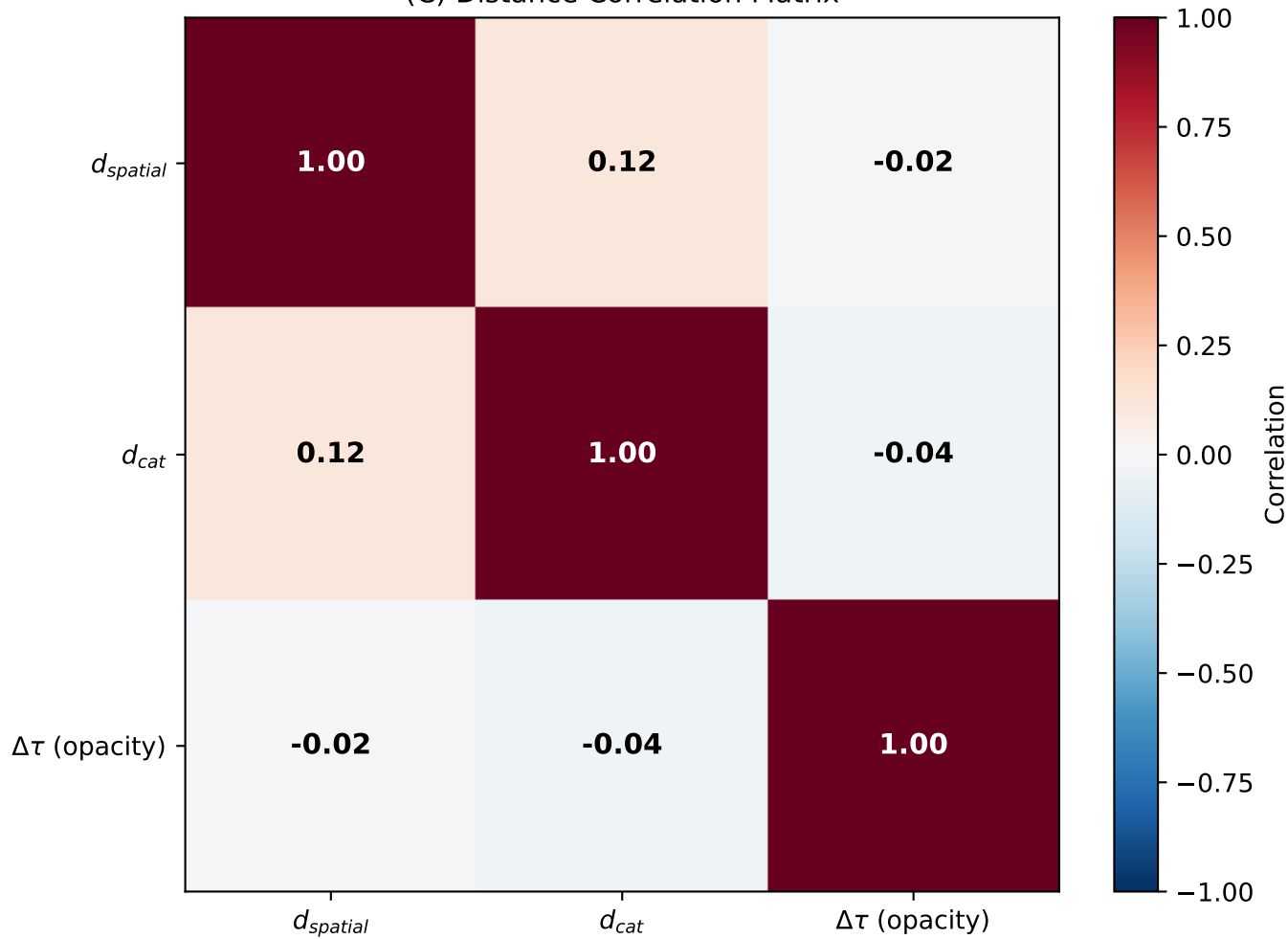
(A) Independence: $d_{cat} \perp d_{spatial}$

Correlation: 0.117

$d_{cat} \perp d_{spatial}$ (proven)

Categorical Distance d_{cat}

Spatial Distance $d_{spatial}$ (nm)

d_{cat}

(B) Partition Coordinate Space (n, ℓ, m)

Depth n

Angular ℓ

Orientation m

(C) Distance Correlation Matrix

	$d_{spatial}$	d_{cat}	$\Delta\tau$ (opacity)
$d_{spatial}$	1.00	0.12	-0.02
d_{cat}	0.12	1.00	-0.04
$\Delta\tau$ (opacity)	-0.02	-0.04	1.00

Correlation

(D) d_{cat} Distribution by System Complexity

Atoms: $\langle d_{cat} \rangle = 1.24$
Molecules: $\langle d_{cat} \rangle = 2.17$
Proteins: $\langle d_{cat} \rangle = 3.48$

Categorical Distance d_{cat}

Atomic ($n \leq 2$)

Molecular ($2 < n \leq 4$)

Protein ($n > 4$)