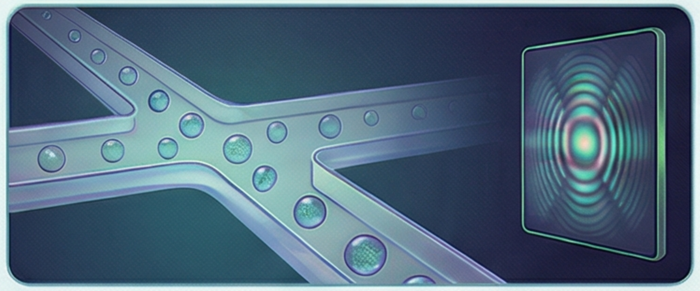
Decoding Protein Droplets: How Holography Reveals the Secret Lives of Condensates

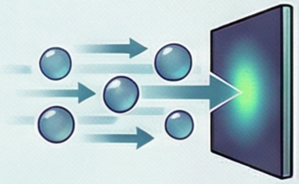
The Holographic Advantage

Label-Free & Contact-Free Precision



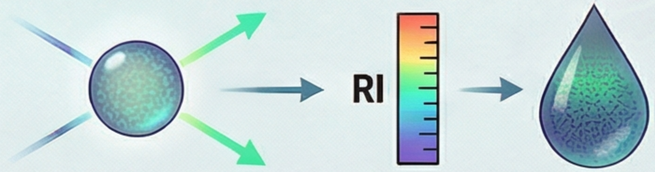
Measures condensates in flow, avoiding distortions caused by fluorescent dyes or surface attachment.

5,000
Particles Per Minute



Provides rapid, high-throughput statistical data on individual droplet diameter and refractive index.

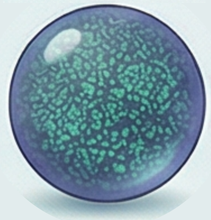
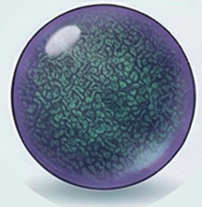
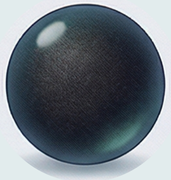
Refractive Index as a Density Proxy



Uses light-scattering patterns to determine the exact protein concentration within each droplet.

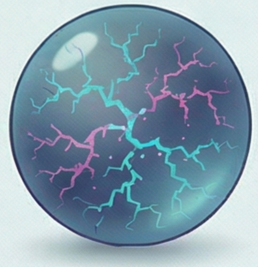
Cation Multivalency & Growth Rules

Higher Valence = Denser Droplets

Magnesium (Mg^{2+})	Spermidine (Spd^{3+})	Spermine (Sp^{4+})	PAMAM (Pmm)
+2 Effective Valence	+3	+4	~+16 Effective Valence
			
~350 µM Dense-Phase PopZ Concentration	**~450 µM**	**~600 µM**	**~1100 µM**

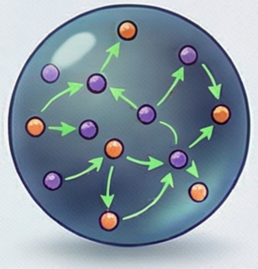
Increasing cation charge triggers 4-fold increase in protein concentration.

Growth via Self-Regulated Gelation



PopZ droplets grow through fractal-like polymer gelation rather than simple merging or ripening.

Enhanced Internal Dynamics



High-valence ions promote distributed interactions, allowing for faster molecular movement and structural heterogeneity.

von Hofe, *et al*, **2025**, *JACS*.