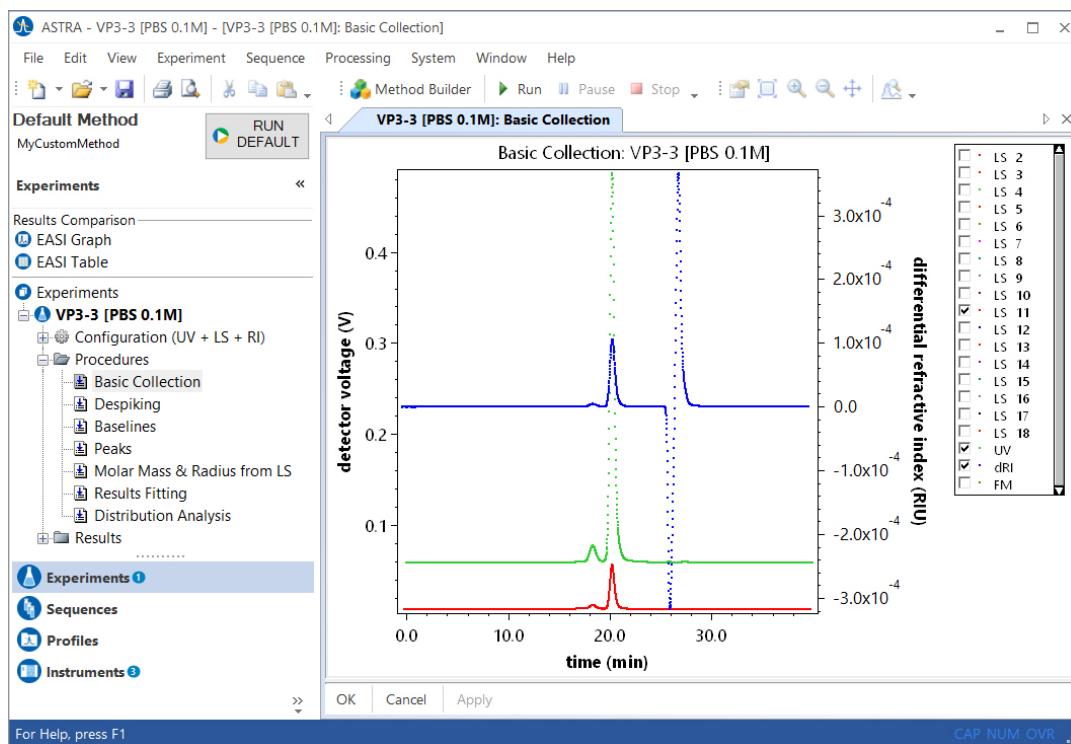


ASTRA 8

Luminary software for macromolecular
and nanoparticle characterization



WYATT
TECHNOLOGY

ASTRA[®] 8

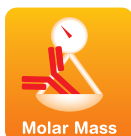
A complete solution for SEC-MALS and beyond

Essential analytics

ASTRA has been recognized for decades as the premier software for analyzing macromolecules and nanoparticles by multi-angle light scattering (MALS).

ASTRA 8 controls, acquires and analyzes data from Wyatt's industry-leading instruments, along with select HPLC modules, to provide absolute determination of:

- *Molar mass and size*
- *Protein conjugate or copolymer content*
- *Gene vector or drug nanocarrier payload*
- *Conformation and shape*
- *Particle concentration*
- *Intrinsic and specific viscosity*
- *Extinction coefficient and dn/dc*
- *Additional advanced properties*



ASTRA integrates MALS, UV, differential refractive index (dRI), dynamic light scattering (DLS) and intrinsic viscosity (IV) data for comprehensive, solution-based characterization.

Evolving to meet more needs

Since first introduced in 1989, ASTRA has combined fundamental physical principles with current software practices to deliver results with confidence.

Automation Do more with less effort. ASTRA automates sequential runs and maintenance.

Intelligence Band-broadening correction, automated peak and baseline selection are just the beginning.

Accuracy ASTRA offers a comprehensive solvent database with extensive temperature correction.

Wizardry The Method Builder wizard helps set up the system configuration and application-specific method with a guided process.

Integration With HPLC CONNECT™, ASTRA becomes a complete solution for running SEC-MALS methods.

FFF-MALS Launch and control ASTRA, including the 21 CFR Part 11 compliance package, from VISION™ software for use with the Eclipse™ field-flow fractionation system. VISION transfers digital UV/VIS signals directly to ASTRA.

Regulatory compliance

Following industry standards, ASTRA offers an optional 21 CFR Part 11 compliance package, including IQ/OQ documentation and procedures.

- Administrator, researcher, technician and guest access levels
- Full audit trails
- Electronic signatures
- Sign-in/sign-out during a run

- Secure SQL Server database
- Local or remote database connectivity
- Data integrity validation
- Full IQ/OQ procedures and documentation validation

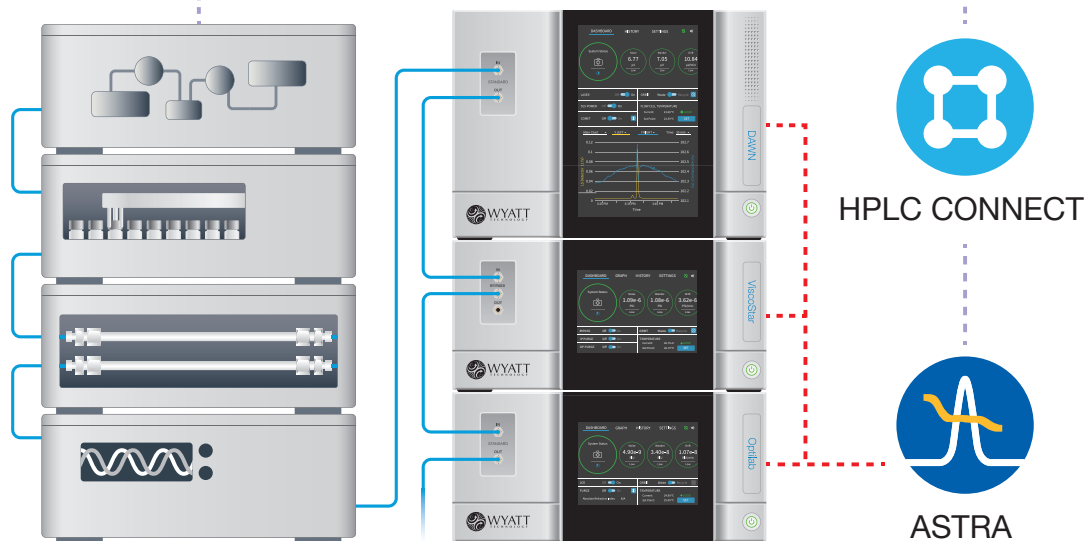


ASTRA Advantages

Absolute characterization means no column calibration or reference molecules required

Explore the power of Triple, Quadruple and even Quintuple Detection for characterization by GPC/SEC and FFF

One program to control them all: ASTRA with HPLC CONNECT is SEC-MALS central



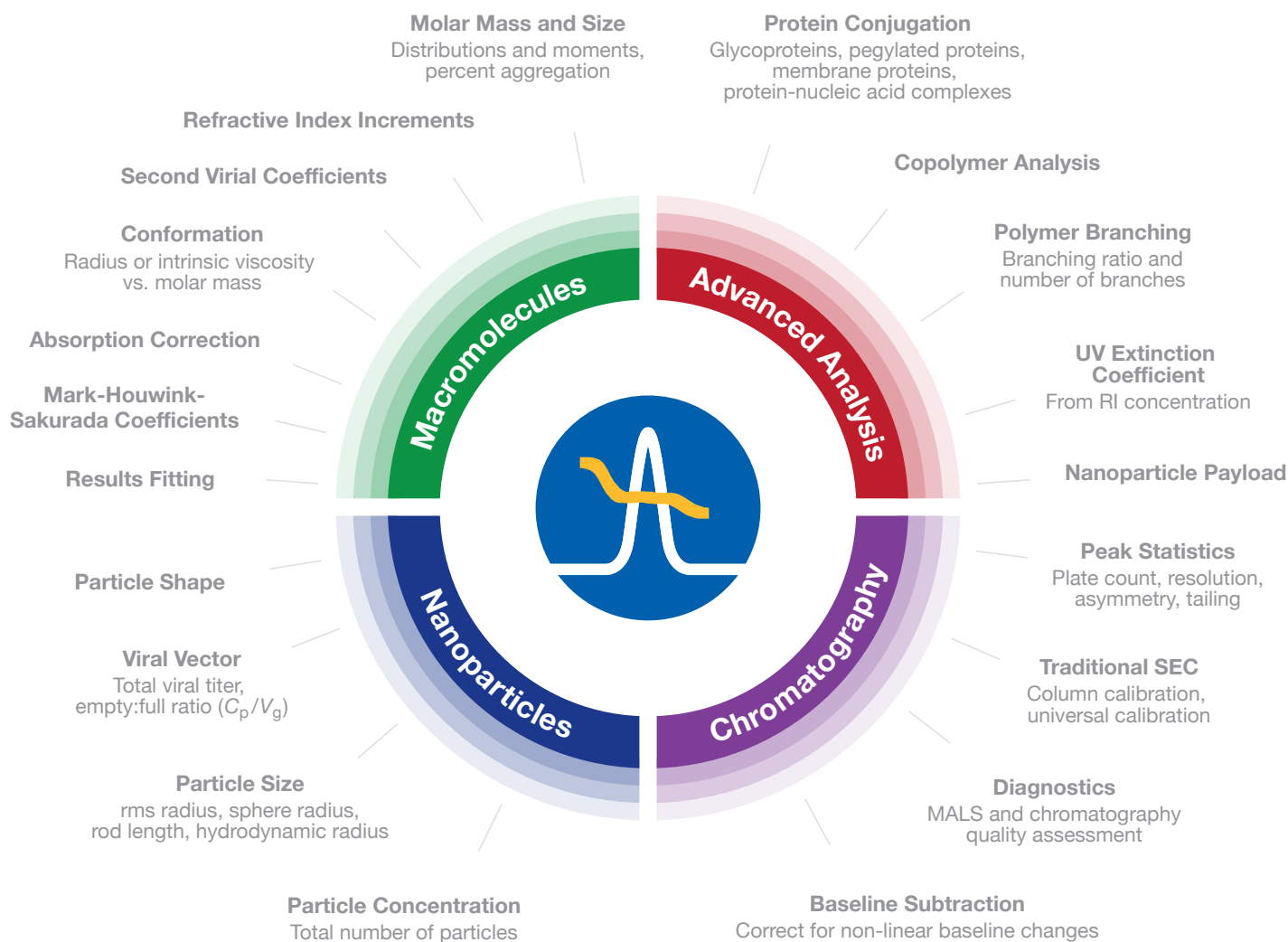
Application-specific modules meet critical needs in research, product development, process development and quality control

One-click MW™ with auto-baseline and auto-peak find makes SEC-MALS as easy as conventional analytical SEC

Light Scattering University® is the premier training ground for ASTRA and SEC-MALS, hands-on and ground-up

Comprehensive Characterization

Analyses and methods for diverse applications



Building on over 40 years of light scattering research and development, ASTRA includes an unrivaled range of analysis features. ASTRA takes full advantage of modern multicore computers, processing data at high speed and with superior accuracy. ASTRA is available in 64-bit and 32-bit versions.

Learn more about ASTRA's capabilities at <https://www.wyatt.com/benefits>

Molar mass in a single click? Absolutely!



Quick setup:

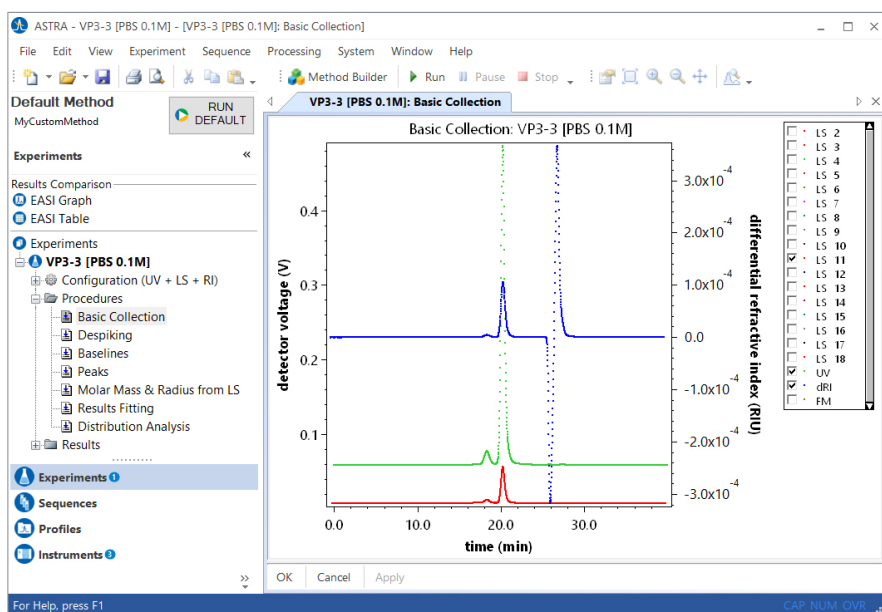
ASTRA's Method Builder lets you set up a default method optimized for your sample type in three easy steps:

1. Select experiment type
2. Input parameters
3. Click 'Run'

ASTRA will:

- Synchronize data collection with your HPLC
- Autoset parameters to determine MW and R_g
- Generate custom reports and graphs
- Prepare for the next run

Analyze your way, whenever you want



The ASTRA workspace is organized to present a clear outline of your instruments, methods, experiments and results:

- Customize instrument configurations and experiments
- Set up and review methods, sequences and instrument/sample/solvent profiles
- Optimize analysis procedures and save as methods
- Open multiple experiments for comparison of results
- Prepare custom reports or export the results to your favorite graphing package

HPLC CONNECT

MALS & HPLC/UHPLC integration

ASTRA offers multiple paths to integrating MALS analysis with HPLC/UHPLC instrumentation:

Classic ASTRA analysis, third party control—use native HPLC control software to send UV signals and triggers to ASTRA.

Import Similar to 'Classic' operation, but ASTRA reads in Empower™ and ChemStation™ sequences created in the native HPLC software. Sequence import saves operator time and eliminates human error when transferring the information.

HPLC CONNECT Eliminate HPLC software entirely and ensure perfect synchronization by letting ASTRA take control of pumps, autosamplers, UV and other common HPLC detectors. Available for select HPLC systems.

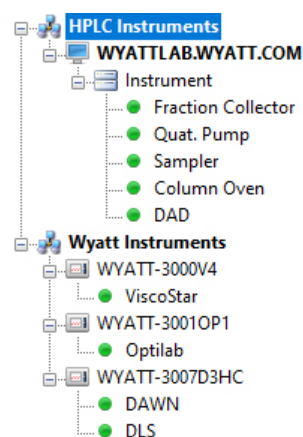


ASTRA's HPLC DASHBOARD™ provides the convenience of a handheld controller with real-time indication and setup of your HPLC system.

Integrated HPLC control

ASTRA's optional HPLC CONNECT module ensures full digital synchronization of your HPLC pump, autosampler, UV, light scattering and other detectors.

- Convenience and savings – a single software solution for control, acquisition and analysis
- Minimize user error
- Uniform look and feel

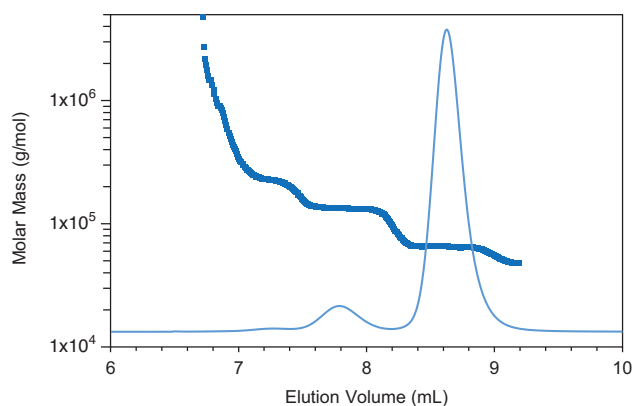


Digital signal acquisition

HPLC CONNECT imports signals from HPLC UV/Vis detectors directly into ASTRA.

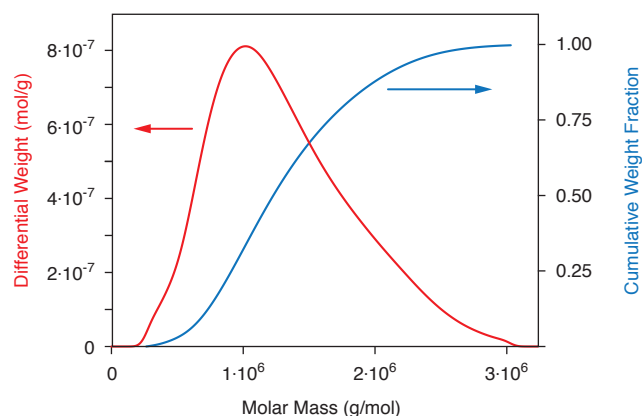
- Eliminates cabling and parasitic noise
- No need to track and match analog settings
- Signals from all UV/Vis wavelengths, acquired with a multi-wavelength detector, may be recorded in ASTRA for use with the *Viral Vector Analysis* method and other analyses.

Absolute molar mass analysis



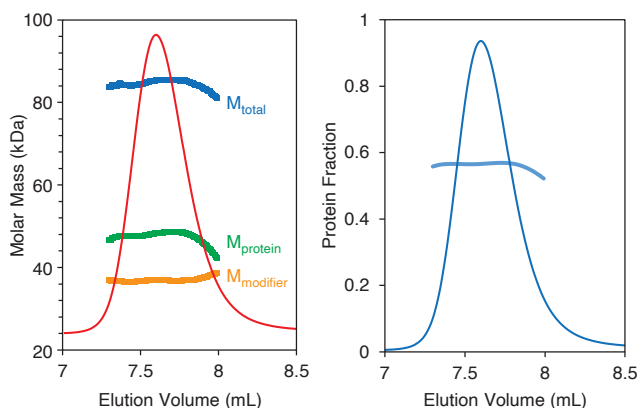
ASTRA's Band Broadening Correction accounts for interdetector dispersion, mathematically adjusting peaks so that each data slice provides matched signals from each detector in the chromatographic elution series. This algorithm is responsible for the uniform molar mass across the BSA monomer, dimer and trimer peaks plus additional oligomers eluting from the SEC column.

Molar mass and size distributions



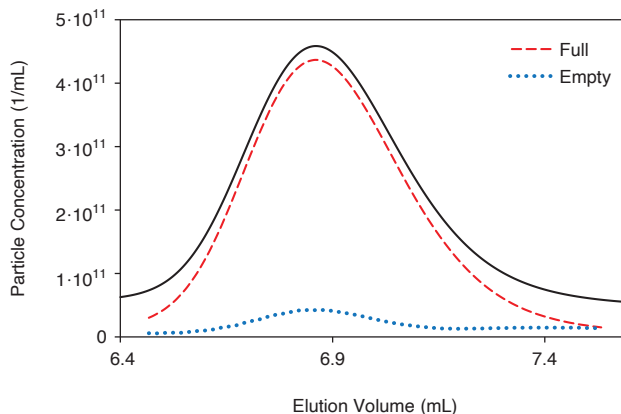
In addition to plotting the molar mass and size determined by MALS over a chromatogram or fractogram, ASTRA can convert the data into distributions. This graph shows differential and cumulative distributions of molar mass as measured for hyaluronic acid.

Protein conjugate and copolymer analysis



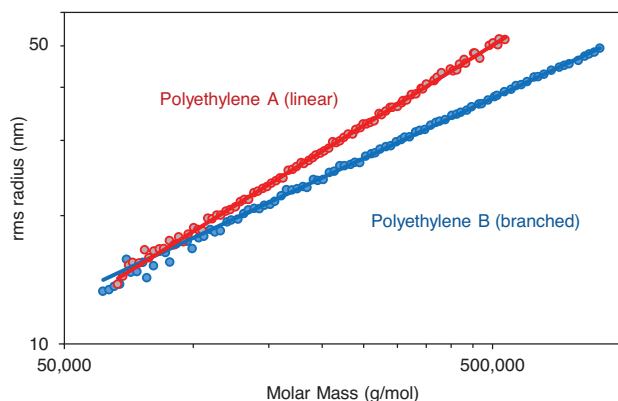
The ASTRA workspace has rich features for characterizing proteins using the Protein Conjugate Analysis algorithms with simultaneous signals from UV, RI and MALS. The characterization includes molecular weight, extinction coefficient, stoichiometry and composition analysis. The same analysis works for copolymers as well.

Viral vector particle concentrations



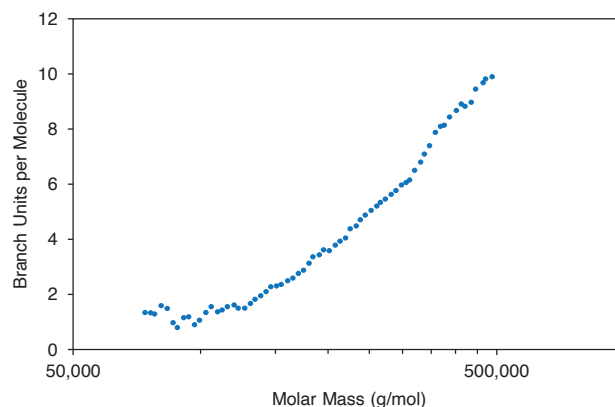
The *Viral Vector Analysis* method determines multiple critical quality attributes. This graph shows an overlay of the size-exclusion chromatogram of an adeno-associated virus (black solid line) with particle concentrations determined at each data slice for sub-populations of full capsids (red, long dash) and empty capsids (blue, dotted).

Polymer branching



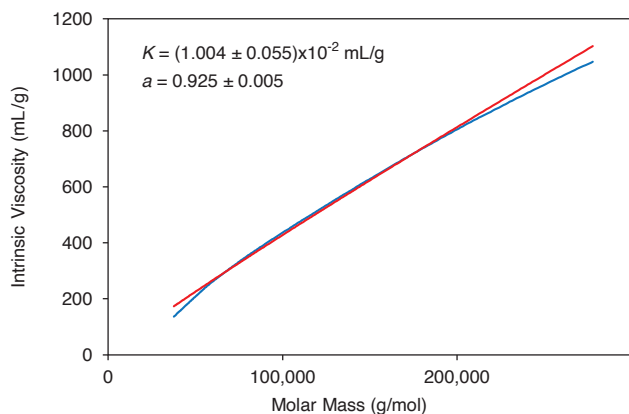
ASTRA's Conformation Plot reveals branching by comparing rms radius with molar mass for linear and branched polymers. Here, the value of the slope of $\log(R_g)$ vs. $\log(M_w)$ for Polyethylene A indicates that it is a linear polymer. The branching of Polyethylene B is apparent by its significantly smaller slope in contrast with Polyethylene A.

Branching calculations



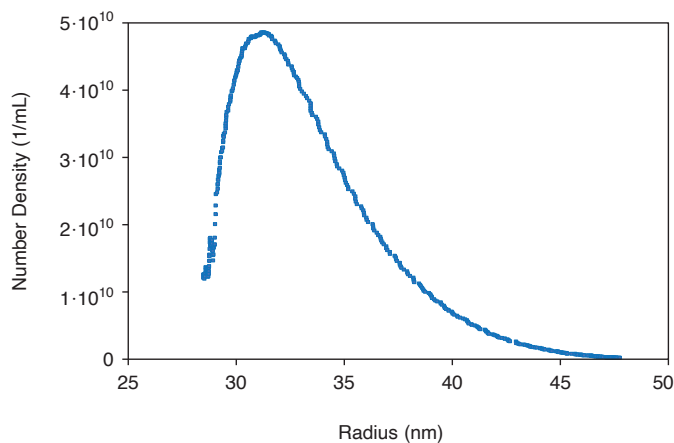
The data to the left were analyzed to yield the average number of branching units per molecule and its dependence on molar mass. Above, ASTRA compares linear and branched polymers in order to determine branching ratio. Branching begins above a molar mass of $\sim 100,000$ g/mol.

Mark-Houwink parameters



Mark-Houwink parameters relate the molar mass of a polymer to its intrinsic viscosity. The determination of molar mass by the viscometric technique of Universal Calibration depends on accurate determination of these parameters. Here, the Mark-Houwink parameters K and a of alginate are determined directly by triple detection, combining MALS (for absolute molar mass), differential viscosity and refractive index measurements.

Nanoparticle concentration



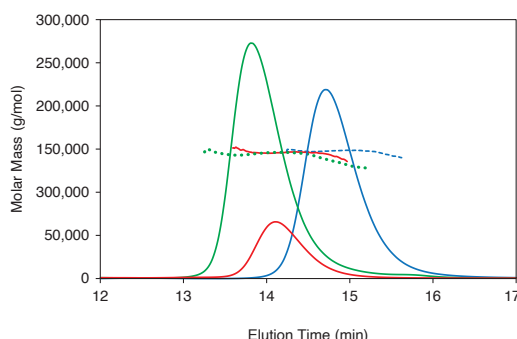
ASTRA utilizes MALS data alone to calculate the number of particles per mL throughout a fractogram or chromatogram. This capability provides truly quantitative, high-resolution size distributions with large particle ensembles, unlike other nanoparticle counting techniques that stumble on either size resolution or sampling efficiency. This graph shows the quantitative distribution of a liposome batch for drug delivery.

ASTRA 8

Productivity features

Complex analyses in a simple, intuitive presentation

ASTRA's EASI Graph lets you select from a large set of analyses such as Molar Mass/Chromatogram Overlay, Protein Conjugates, Conformation Plots and Polymer Branching, showing these key results for one or more samples.



Customized reports

ASTRA provides customized reporting options so you can export exactly the information you need. It even allows you to customize the report with your company's logo and descriptive text.

Compile key results from multiple peaks and samples

ASTRA's EASI Table gives you a quick and easy overview of the most important results of multiple samples in one compact table.

EASI Table			
Experiments:	All	Peaks:	All
		Abscissa:	min
Peak 1			
	Mn (kDa)	Mw (kDa)	Polydispersity (Mw/Mn)
sample01	66.8 (±0.2%)	66.8 (±0.2%)	1.00 (±0.23%)
sample02	65.9 (±0.0%)	65.9 (±0.0%)	1.00 (±0.05%)
sample03	65.7 (±0.4%)	65.7 (±0.4%)	1.00 (±0.54%)
sample04	66.6 (±0.0%)	66.6 (±0.0%)	1.00 (±0.07%)
sample05	66.8 (±0.2%)	66.8 (±0.2%)	1.00 (±0.26%)
sample06	65.8 (±0.2%)	65.8 (±0.2%)	1.00 (±0.29%)
Average	66.3	66.3	1.00
Standard deviation	0.5	0.5	0.00
% Standard deviation	0.8	0.8	0.00
Minimum	65.7	65.7	1.00
Maximum	66.8	66.8	1.00

Sequences and unattended runs

With ASTRA you can set up multiple, unattended runs synchronized with the HPLC system.

Sequence2: Samples													-	+	□	×
	Vial	Enable	Name	Description	Inj	Method	Duration (min)	Inj Vol (μL)	Delay	dn/dc (mL/g)	A2 (mol mL ⁻¹ g ⁻¹)	UV Ext (mL/(mg cm))	Conc (mg/mL)			
1	1	<input type="checkbox"/>	Sample A	after purification	3	/System/Methods/Light ...	30.000	50.00	0.000	0.1850	0.0000e+00	5.600e-01	1.000			
2	2	<input checked="" type="checkbox"/>	Sample B	after purification	3	/System/Methods/Light ...	30.000	50.00	0.000	0.1850	0.0000e+00	7.000e-01	2.000			
3	3	<input checked="" type="checkbox"/>	Sample C	after purification	3	/System/Methods/Light ...	30.000	50.00	0.000	0.1850	0.0000e+00	3.400e-01	0.900			
4	4	<input checked="" type="checkbox"/>	Sample D	after purification	1	/System/Methods/Light ...	30.000	50.00	0.000	0.1850	0.0000e+00	1.240e+00	1.000			
5	5	<input checked="" type="checkbox"/>	Sample E	after purification	1	/System/Methods/Light ...	30.000	50.00	0.000	0.1850	0.0000e+00	9.010e-01	1.200			



Left to Right

Geoffrey K. Wyatt, Chief Executive Officer
Dr. Philip J. Wyatt, Chairman of the Board
Clifford D. Wyatt, President

Wyatt Technology provides absolute macromolecular and nanoparticle characterization solutions by developing the finest instrumentation and services to chemical, petrochemical, pharmaceutical, biotechnological and academic laboratories worldwide. We delight our customers with unparalleled levels of service and support, facilitating their cutting-edge research and development efforts.

ASTRA is one of many tools in Wyatt's light scattering toolkit for essential macromolecular and nanoparticle characterization.

Learn more at www.wyatt.com

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