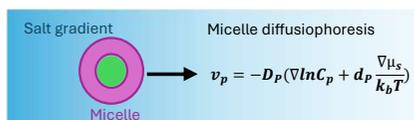


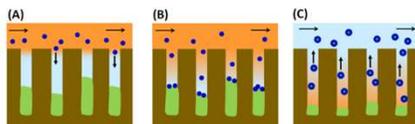
## ABSTRACT

Salt-induced diffusiophoresis is the migration of a charged nanoparticle in water, induced by an imposed directional gradient of salt concentration (Figure 1).<sup>1</sup>



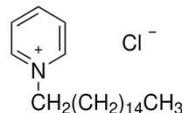
**Figure 1.** Salt-induced diffusiophoresis of micelle nanoparticles. The diffusiophoresis coefficient ( $d_p$ ) of micelles is defined by a linear law relating particle net migration rate ( $v_p$ ) to the gradient of salt chemical potential (thermodynamic driving force) ( $\mu_s$ ). In the embedded equation,  $D_p$ ,  $C_p$ ,  $k_b$  and  $T$  are particle Brownian mobility, particle concentration, Boltzmann constant and absolute temperature, respectively. Brownian mobility of micelles,  $D_p$ , is determined using dynamic light scattering (DLS), which is the focus of this poster. Determination of particle diffusiophoresis,  $d_p$ , requires the use of  $D_p$  and other transport parameters measured by Rayleigh interferometry (see Josie Nguyen's poster).

Micelles exemplify nanoparticles with the crucial ability of hosting small guest molecules. Thus, micelle diffusiophoresis is also important in the manipulation of small molecules. As shown in Fig. 2, salt-induced diffusiophoresis of micelles may be exploited for micelle insertion inside porous materials. This transport phenomenon can be also exploited inside microfluidics.<sup>2</sup>



**Figure 2.** Application of diffusiophoresis in hydrocarbon extraction: (A) An aqueous solution with salt (orange) and micelles (blue circles, ●) flows into dead-end pores filled with water (light blue) and hydrocarbon (green). A salt gradient at the pore entrances drives micelles into the pores. (B) Micelles reach the hydrocarbon deposit and extract hydrocarbons. (C) Water flows perpendicularly, creating an opposite salt gradient that drives micelles out of the pores.

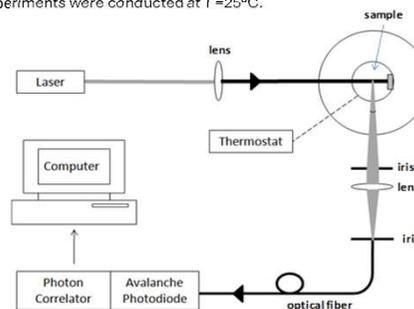
Micelle diffusiophoresis depends on micelle Brownian mobility,  $D_p$ . This transport parameter describes the intrinsic ability of a micelle to randomly move (diffuse) in water. The poster reports diffusion-coefficient measurements carried out on aqueous solutions of the cationic surfactant, **hexadecylpyridinium chloride (CPC)** (Fig. 3), in the presence of aqueous NaCl. The effect of surfactant and salt concentrations on the diffusion coefficient of CPC cationic micelles is examined. These data are used to extract values of  $D_p$ .



**Figure 3.** Chemical structure of hexadecylpyridinium chloride (CPC)

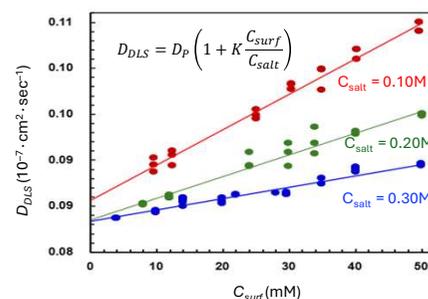
## METHOD

We employed DLS with a He-Ne laser to determine the experimental diffusion coefficient ( $D_{DLS}$ ) of CPC micelles.<sup>3</sup> Experiments were conducted at  $T=25^\circ\text{C}$ .



**Figure 3.** Scheme of DLS apparatus

## RESULTS



**Figure 4.** DLS diffusion coefficients ( $D_{DLS}$ ) as a function of surfactant concentration ( $C_{surf}$ ) at three different NaCl concentrations ( $C_{salt}$ ). The embedded equation shows theoretical dependence of DLS on  $C_{surf}$  and  $C_{salt}$ , where  $K$  is a micelle-micelle interaction parameter.

The Stokes-Einstein equation:

$$D_p = \frac{k_b T}{6\pi\eta R_p}$$

was applied to determine micelle hydrodynamic radius,  $R_p$ , where  $T$  is temperature,  $\eta$  is the viscosity of salt-water solution, and  $k_b$  is the Boltzmann constant.

If we assume that micelle-micelle interactions are electrostatic in nature, we can apply the following equation<sup>4</sup>:

$$K = \frac{\sigma Z_p^2}{2m}$$

where  $Z_p$  is the micelle net charge,  $\sigma$  is an electrophoretic coefficient and  $m = 97$  is the number of surfactants per micelle. Our results are reported in Table 1.

**Table 1:** Brownian mobility ( $D_p$ ), viscosity ( $\eta$ ), micelle radius ( $R_p$ ), interaction parameter ( $K$ ), electrophoretic coefficient ( $\sigma$ ), and micelle charge ( $Z_p$ ) extracted from experimental values of  $K$ . Errors are standard deviations.

$C_{salt} / M$	$D_p / 10^{-7} \cdot \text{cm}^2 \cdot \text{sec}^{-1}$	$\eta / 10^{-3} \cdot \text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-1}$	$R_p / \text{nm}$	$K$	$\sigma$	$Z_p$
0.10	$8.574 \pm 0.04$	0.901	$2.829 \pm 0.013$	$0.448 \pm 0.017$	0.272	18
0.20	$8.360 \pm 0.04$	0.908	$2.878 \pm 0.013$	$0.562 \pm 0.032$	0.215	23
0.30	$8.340 \pm 0.02$	0.916	$2.861 \pm 0.006$	$0.447 \pm 0.024$	0.286	22

## CONCLUSION

- DLS was effective in determining the Brownian mobility (DP) of micelles.
- The radius of CPC micelles was approximately 2.8 nm, and it remained constant across different NaCl concentrations.
- The slope values from the DLS diffusion data indicate that the micelle charge is about 20% of the structural charge, consistent with 80% counterion adsorption.
- These studies need to be extended to other common salts that are relevant to micelle diffusiophoresis such as KCl.

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