Retrieving radial inhomogeneities in particle composition of single, levitated aerosol particles using Mie resonance spectroscopy

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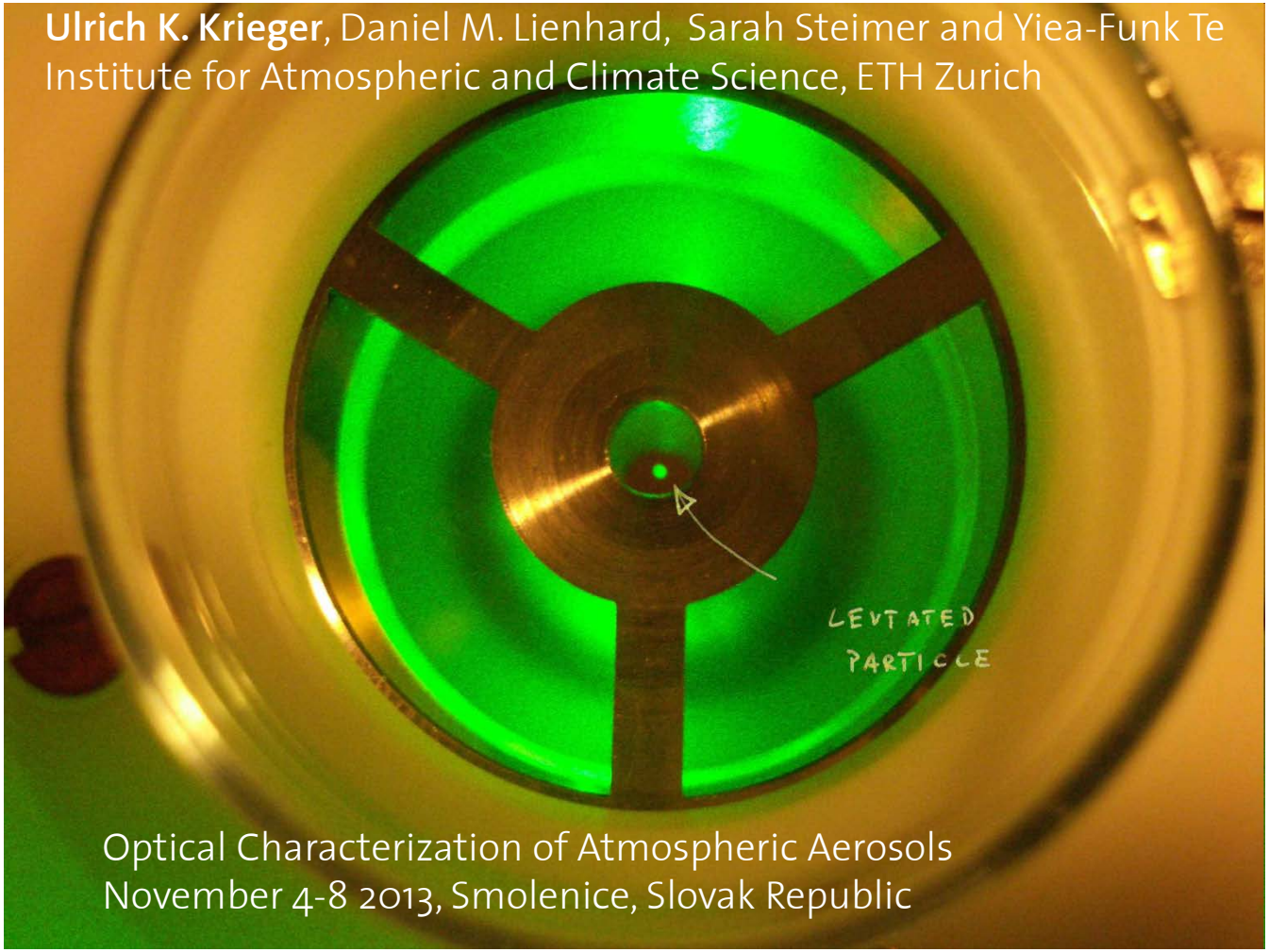

Optical Characterization of Atmospheric Aerosols
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ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Outline

Motivation

Why are we interested in “glassy” aerosol?

Experimental setup,

Techniques used for analysis

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Example

Mie resonance spectra of shikimic acid particle humidifying diffusion model

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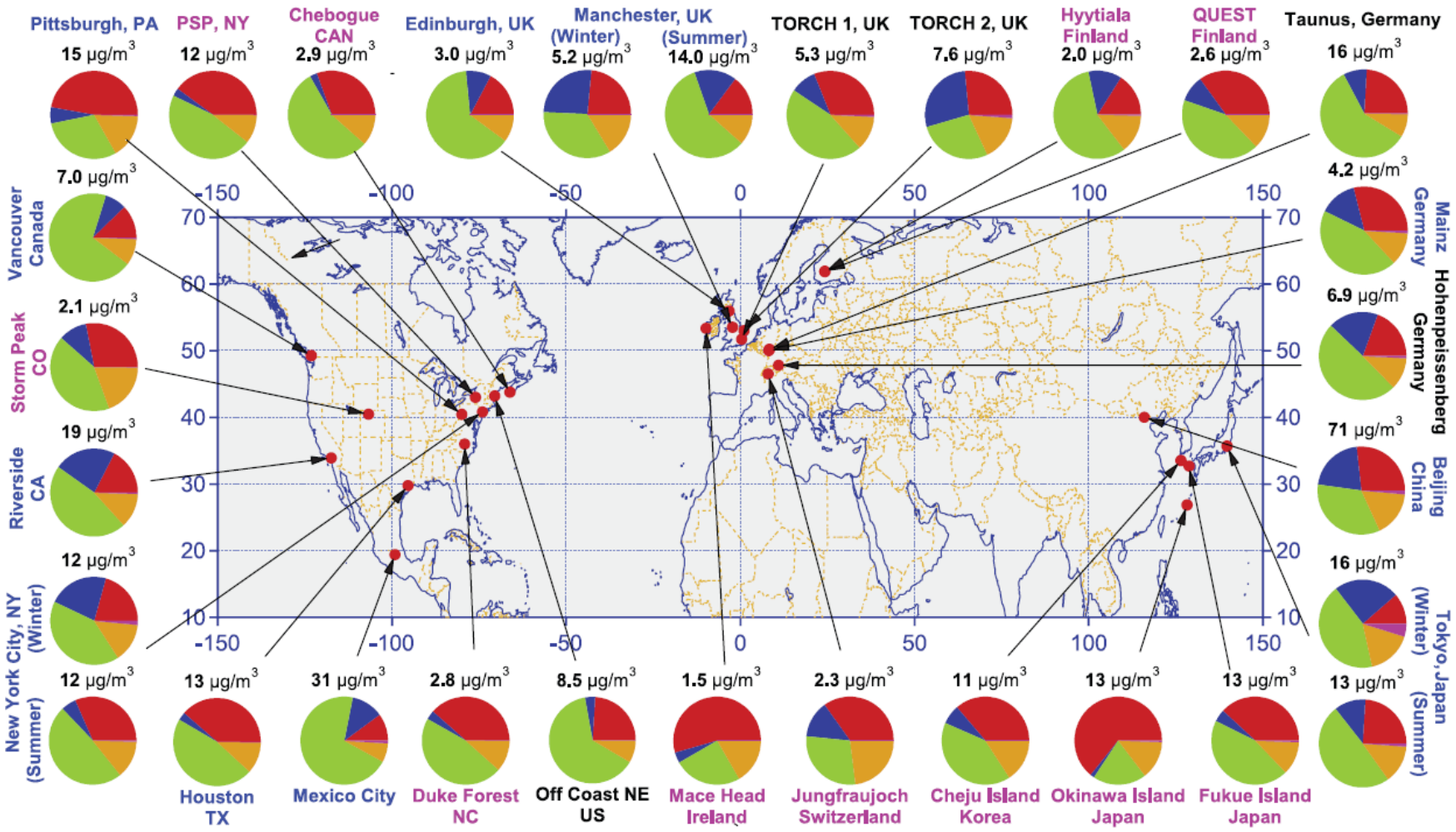
Non-refractory submicron particle mass composition measured with the AMS (Aerosol Mass Spectrometer)

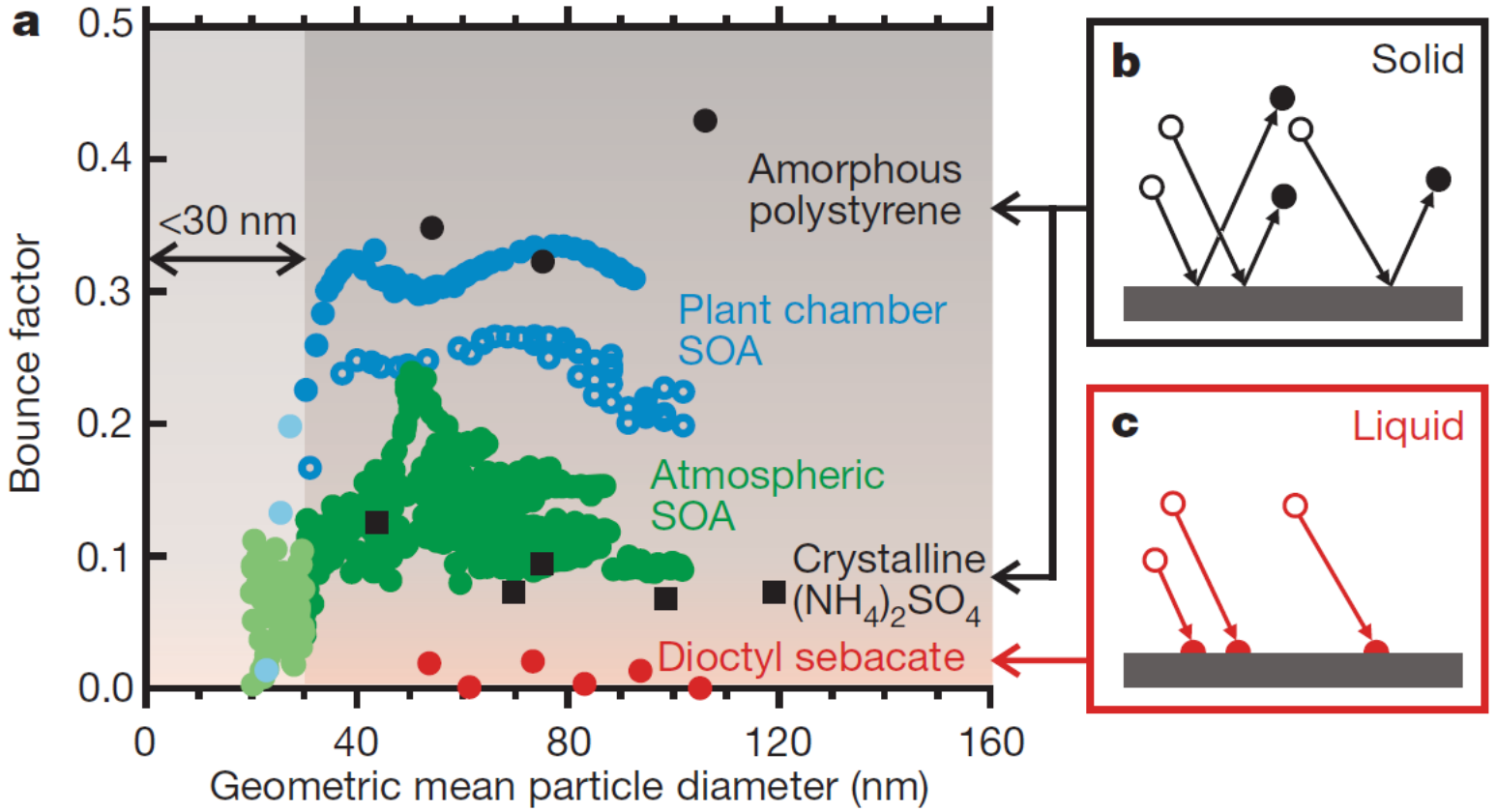


Colors for the study labels indicate the type of sampling location: urban areas (blue), <100 miles downwind of major cites (black), and rural/remote areas >100 miles downwind (pink).

Sulfate Ammonium Nitrate Organics Chloride

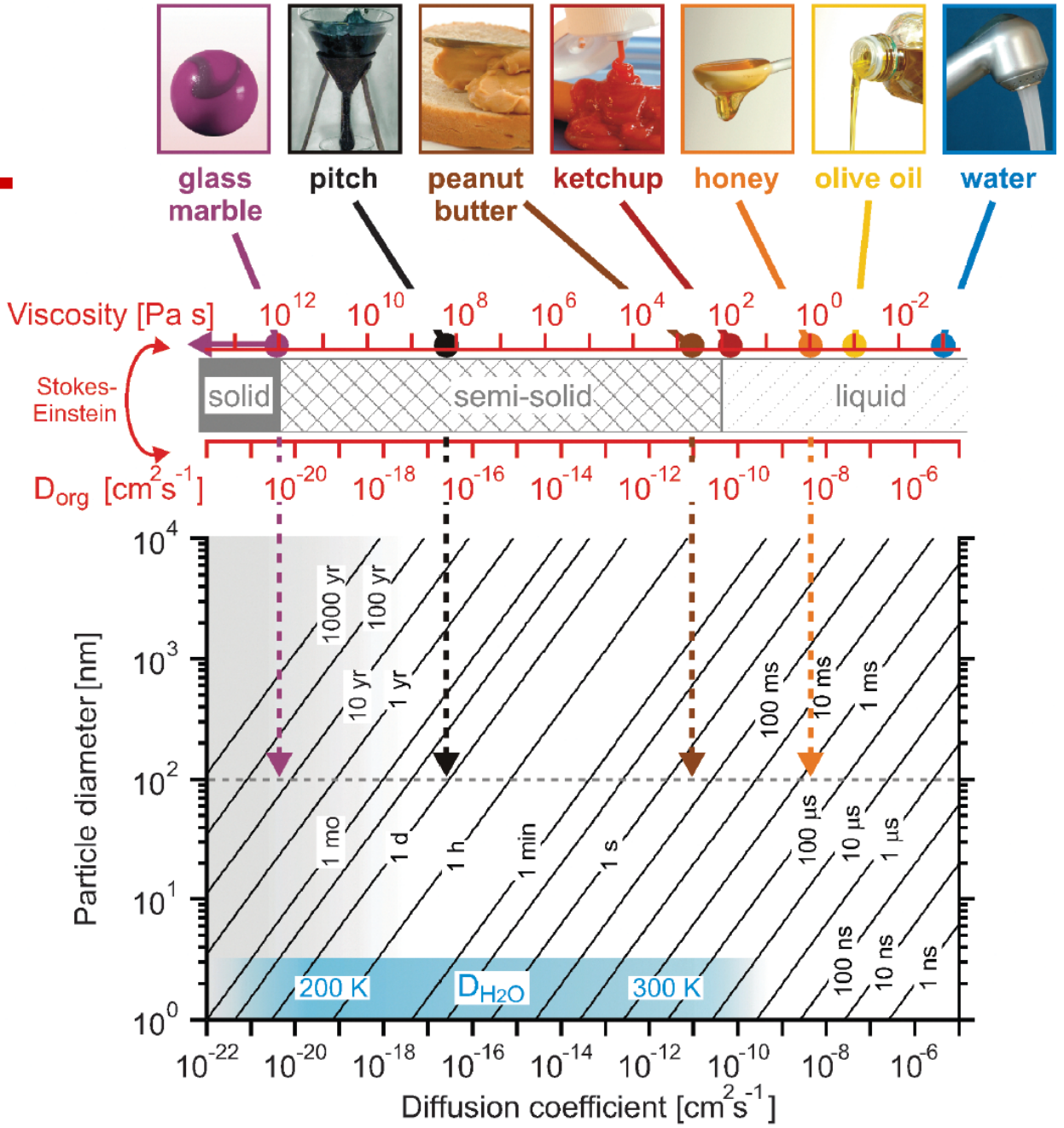
Zhang et al., GRL, 2007

Amorphous solid state of biogenic SOA



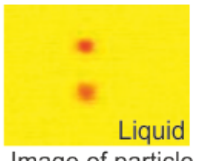
Virtanen et al., *Nature*, **467**, 824 (2010)

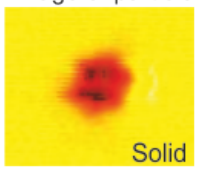
Equilibration times

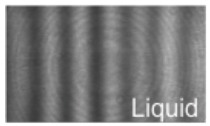


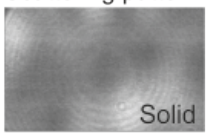
Koop et al., *Phys. Chem. Chem. Phys.*, **13**, 19238 (2011)

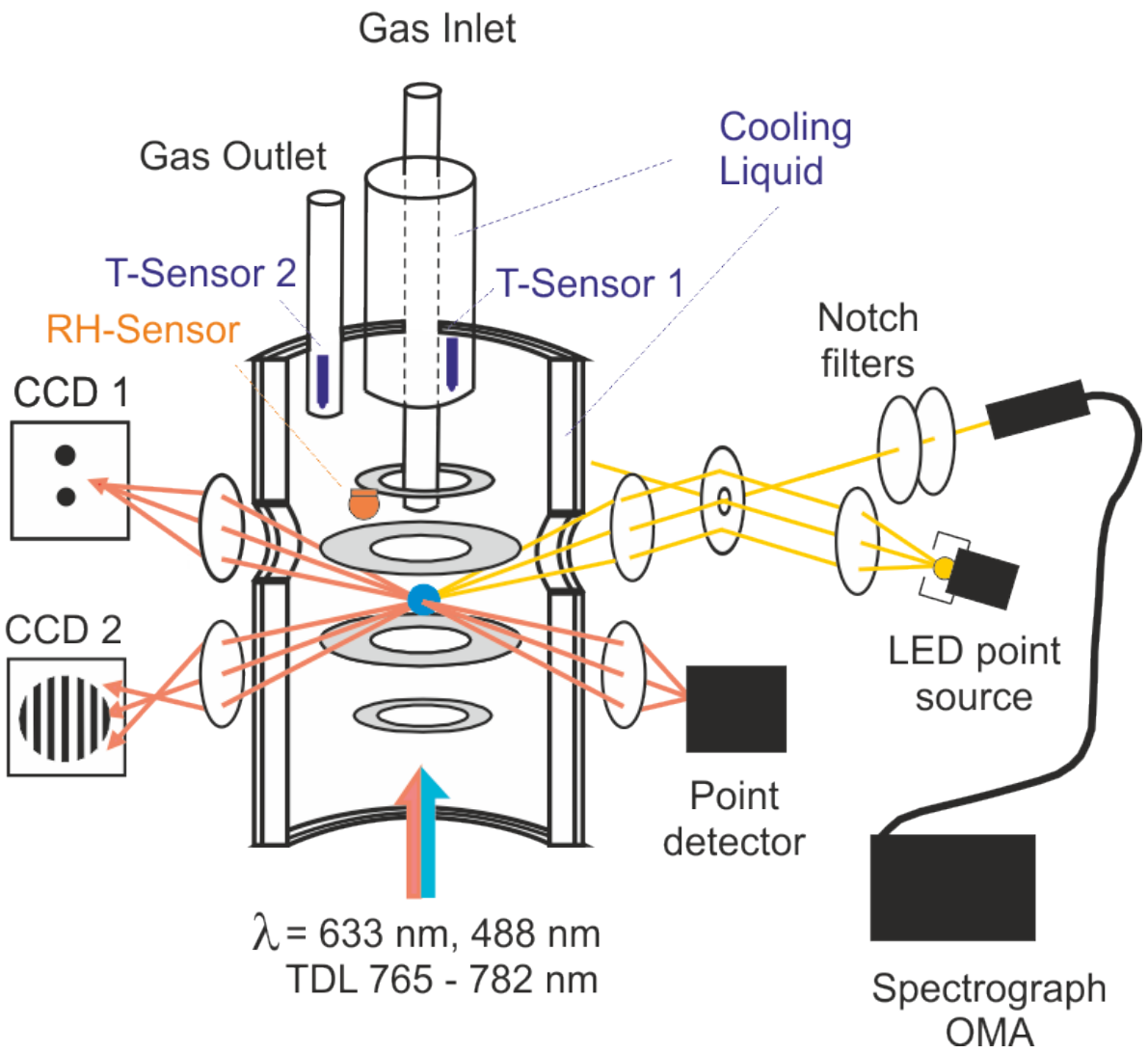
Electrodynamic balance



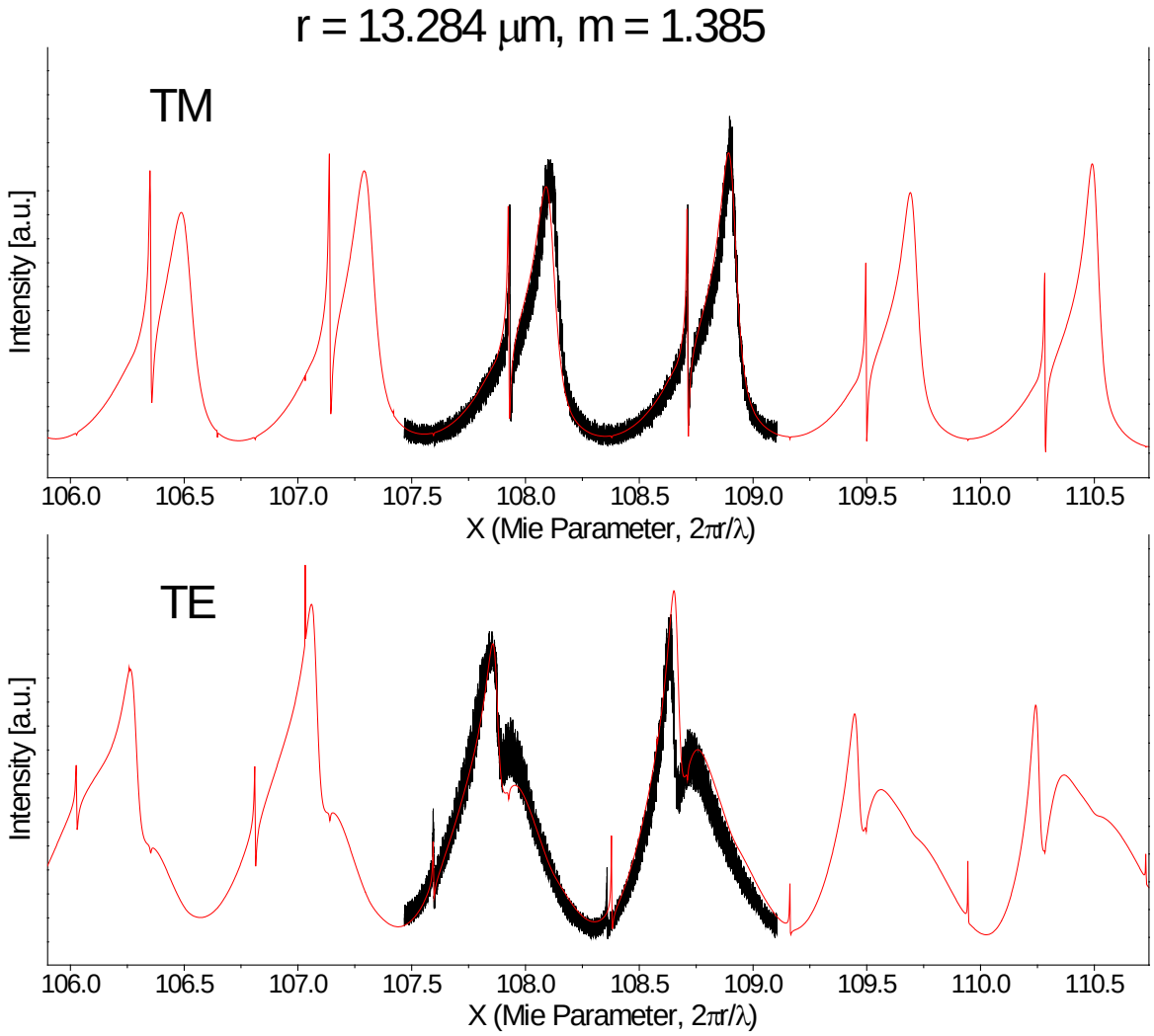




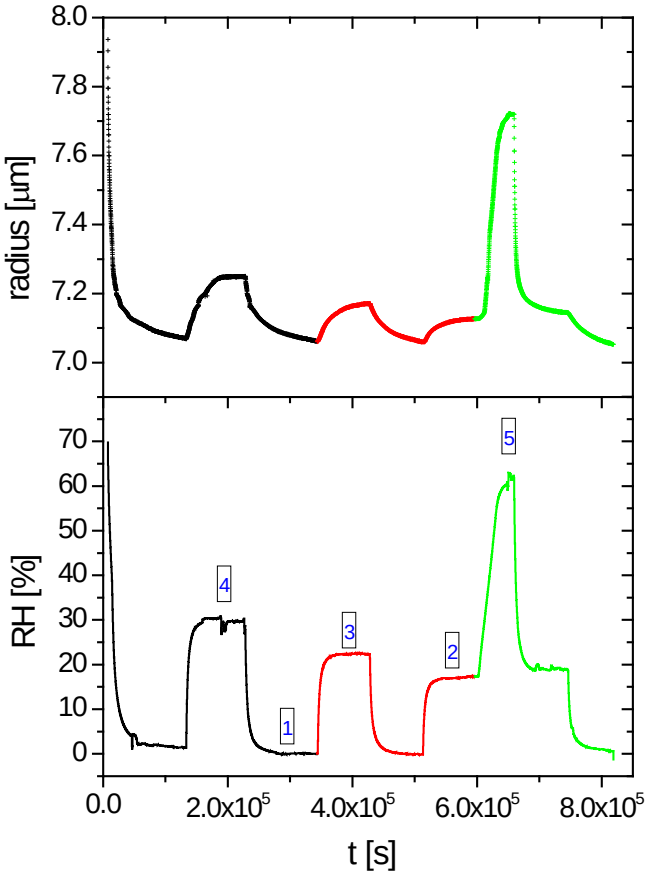


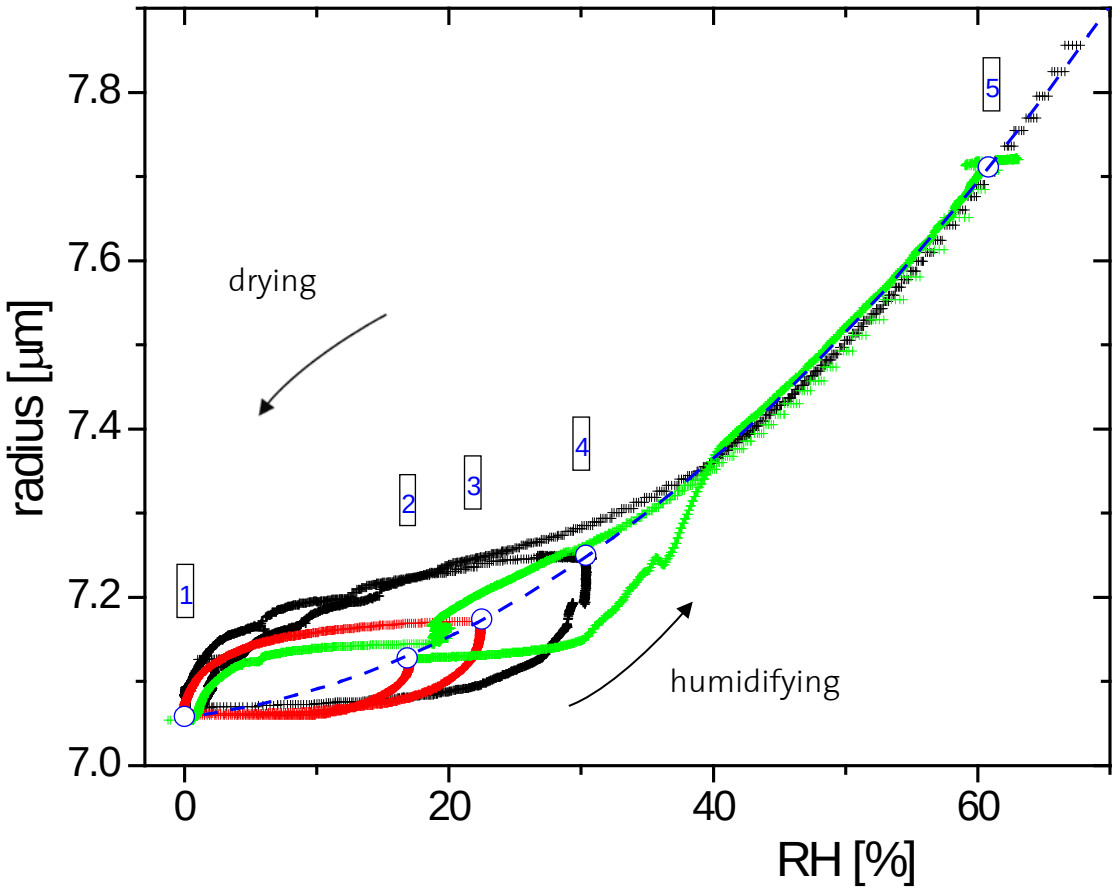


Mie Resonance Spectrum or "Whispering gallery modes" (TDL)



Water uptake impedance on sucrose particle





Zobrist et al., *Phys. Chem. Chem. Phys.*, **13**, 3514 (2011)

Nonlinear diffusion of H_2O in a droplet

$$\frac{\partial n}{\partial t} = \nabla \bullet (D_{liq} \nabla n) = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 D_{liq} \frac{\partial n}{\partial r} \right)$$

$$D_{liq} = f(T, n)$$

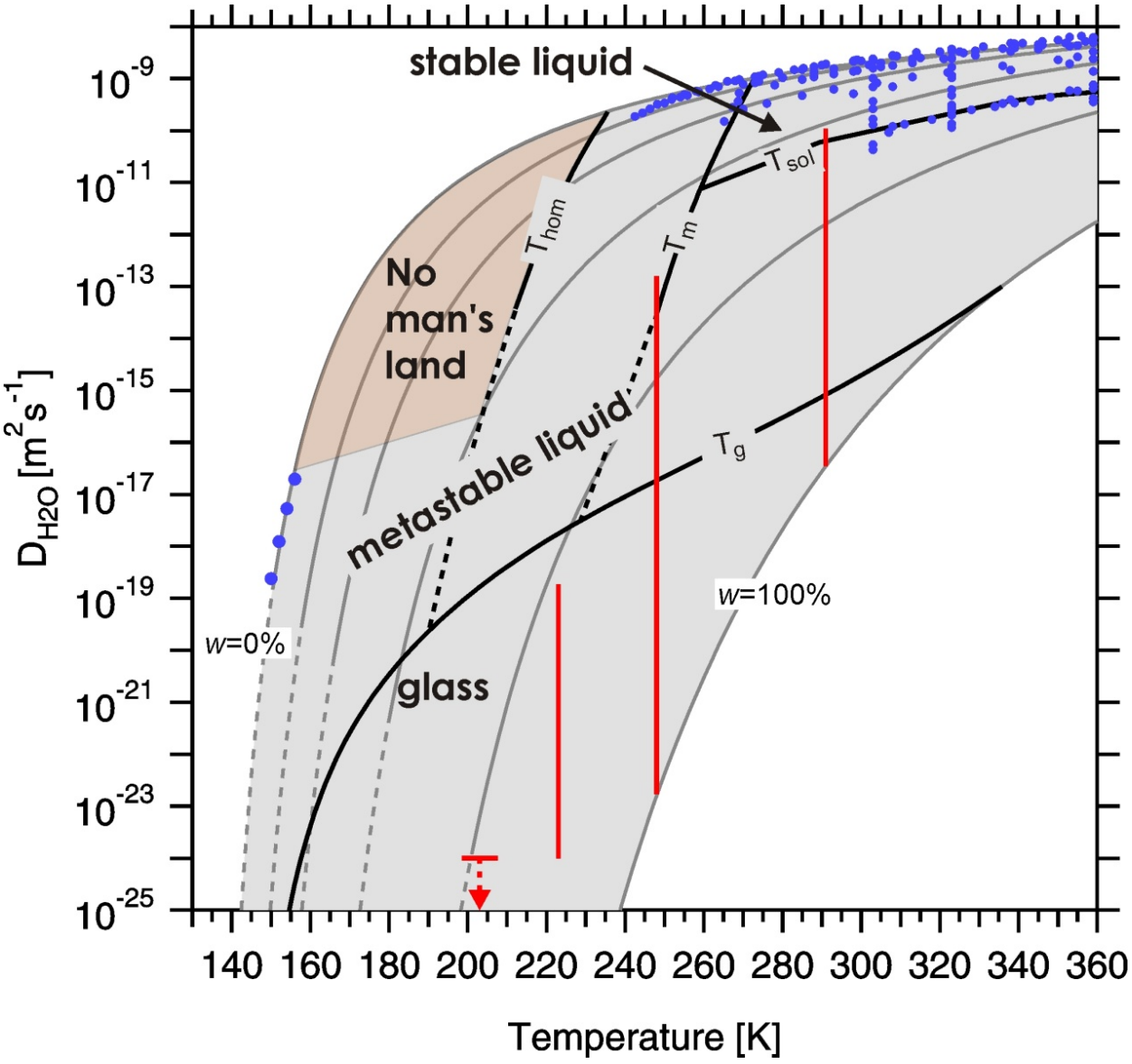
Fick's second law

$$D_{liq} = f(T)$$

$$\frac{\partial n}{\partial t} = D_{liq} \nabla^2 n$$

Zobrist et al., *Phys. Chem. Chem. Phys.*, **13**, 3514 (2011)

Derive diffusivity



Zobrist et al., *Phys. Chem. Chem. Phys.*, **13**, 3514 (2011)

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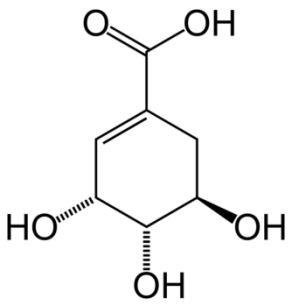
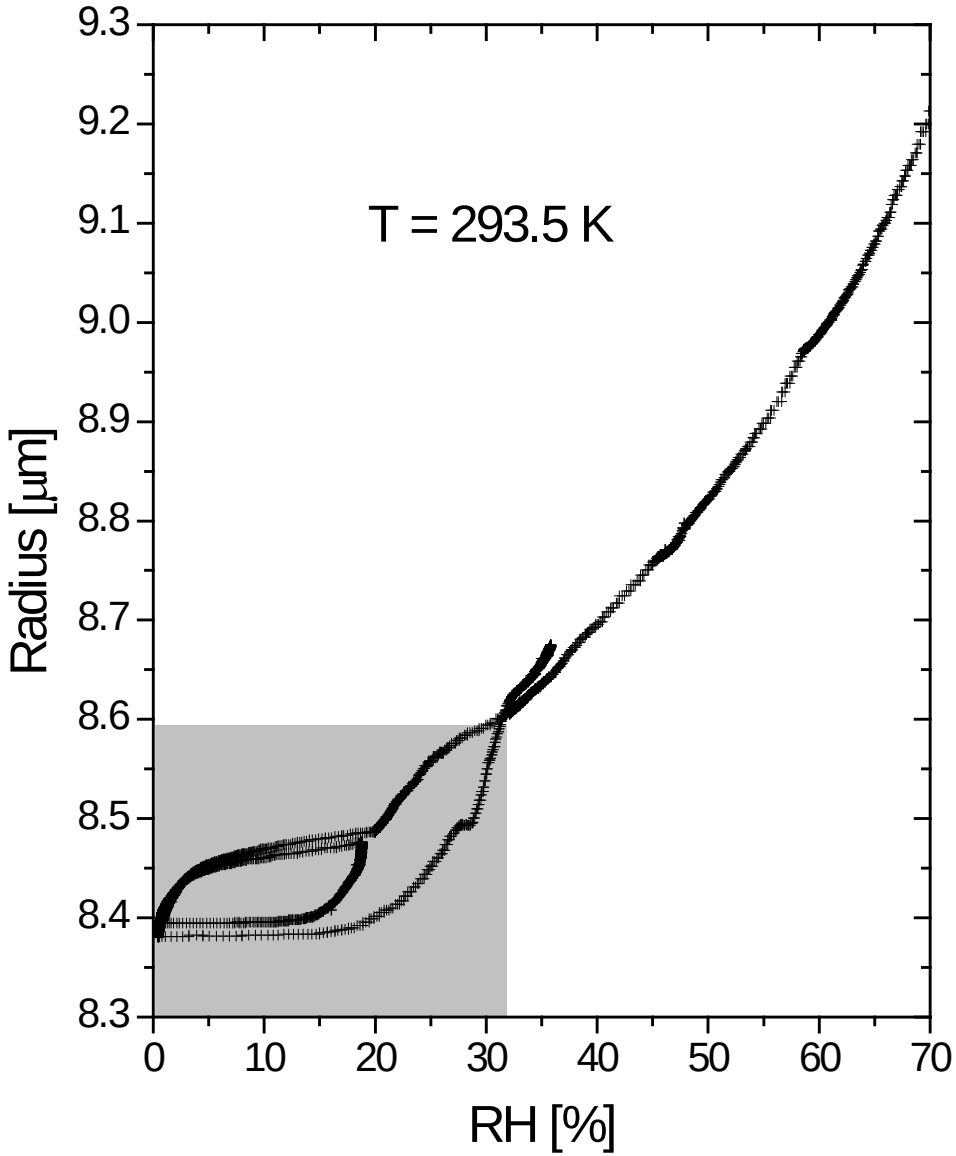
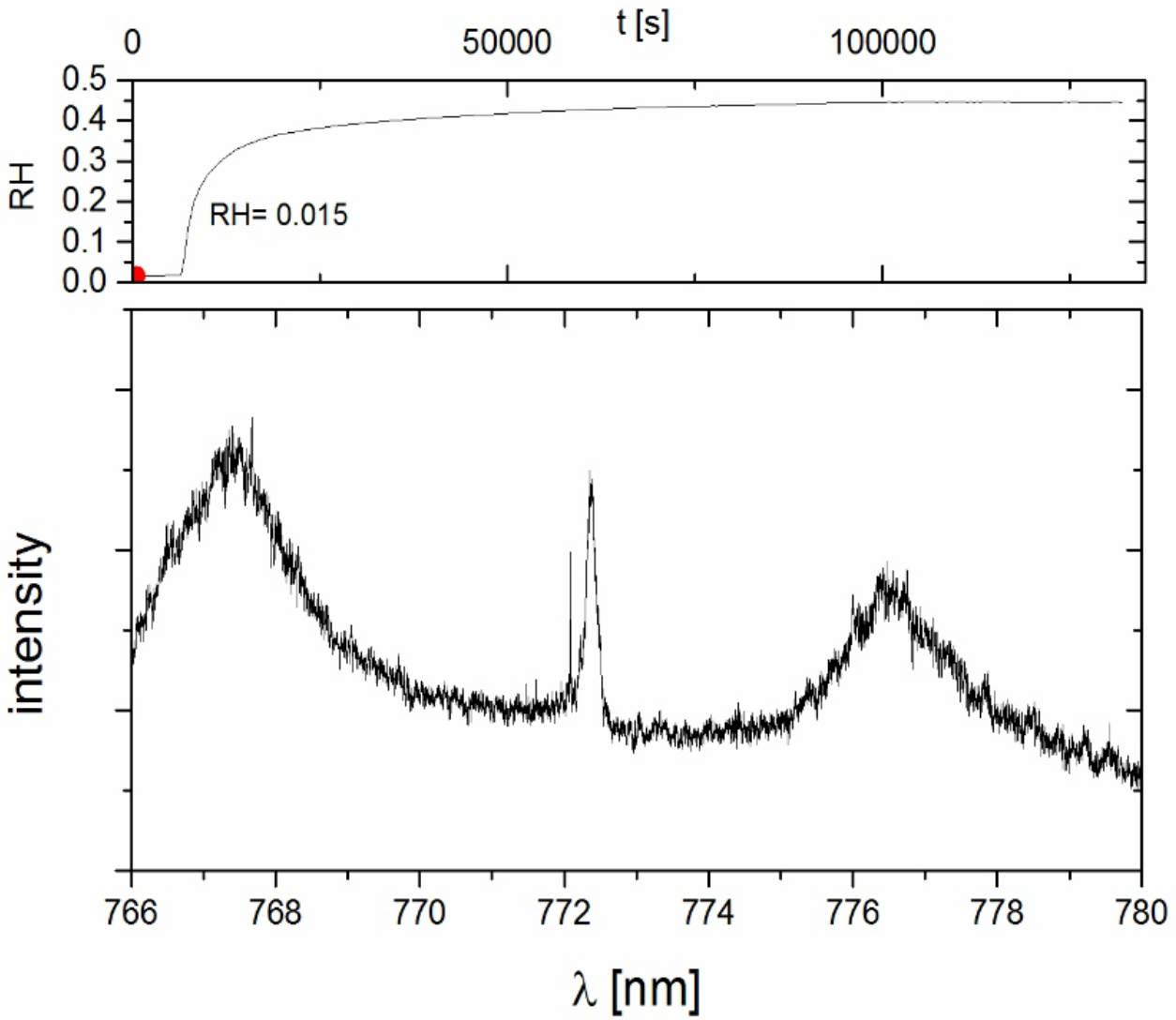
Shikimic acid



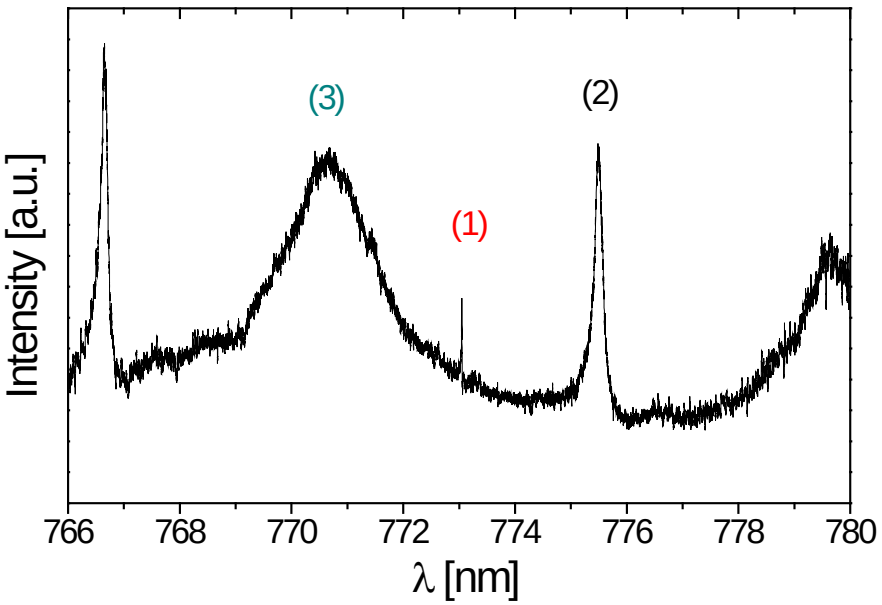
M=174 g/mol

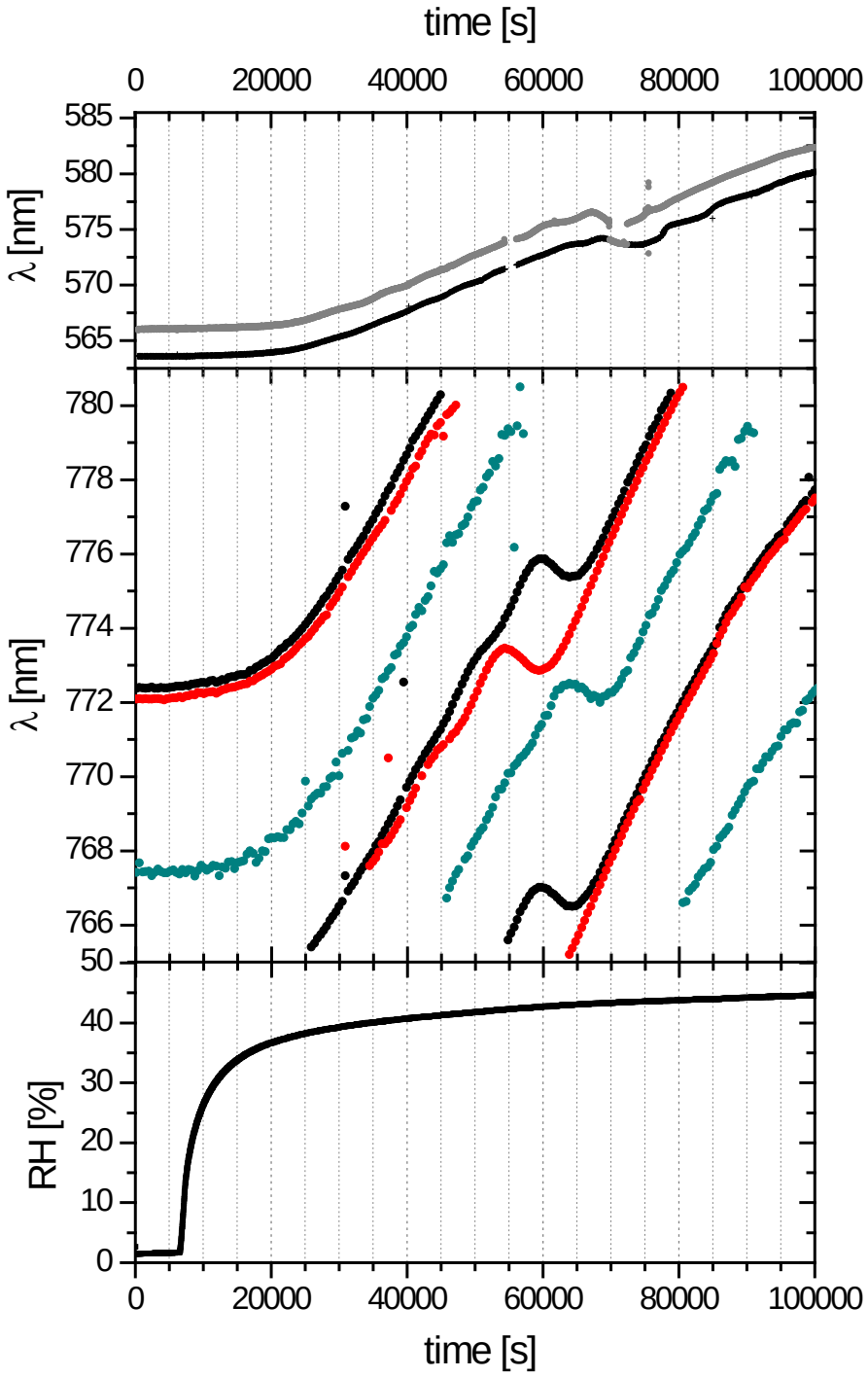


Mie resonance spectra upon humidification of glassy particle

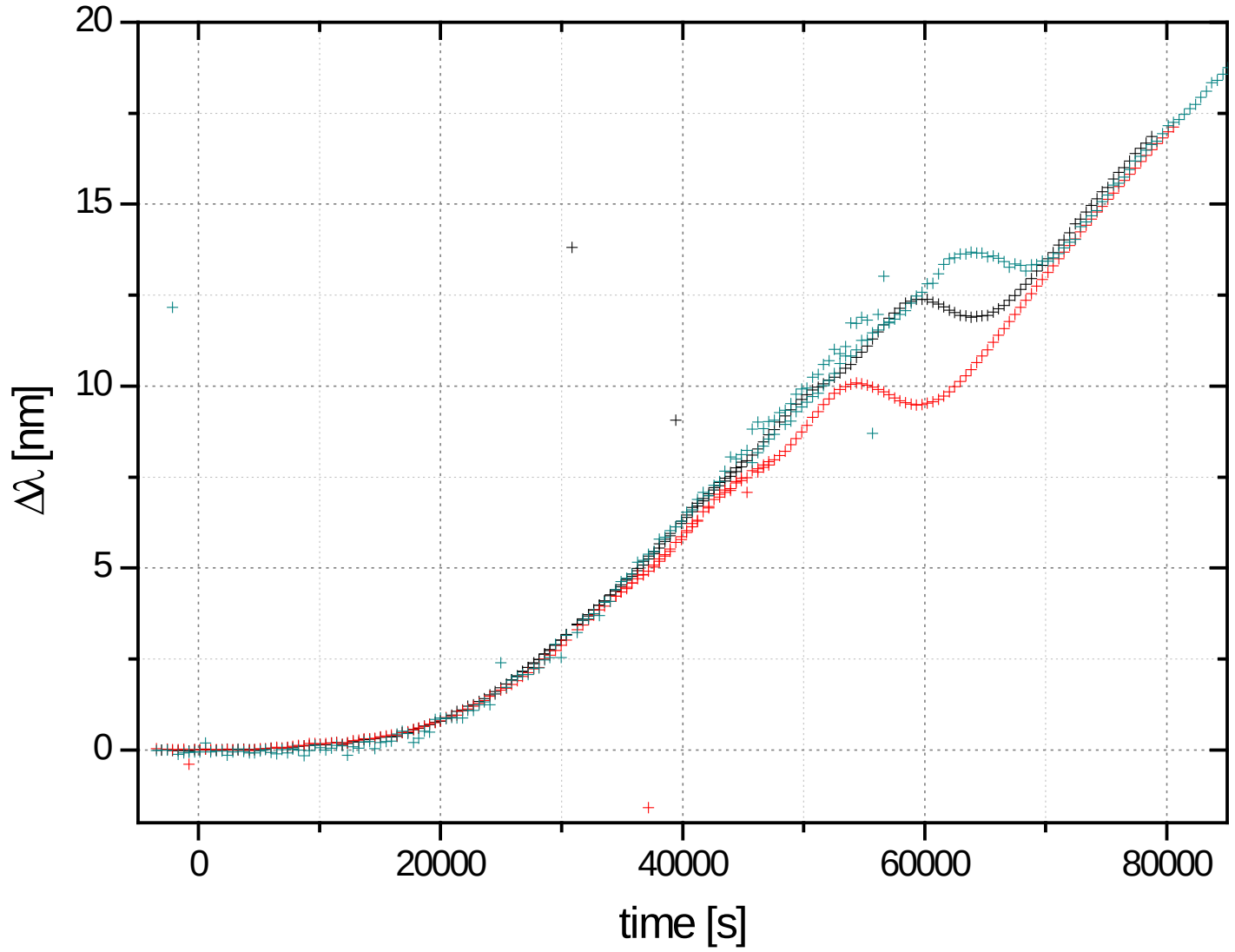


Humidification of glassy particle

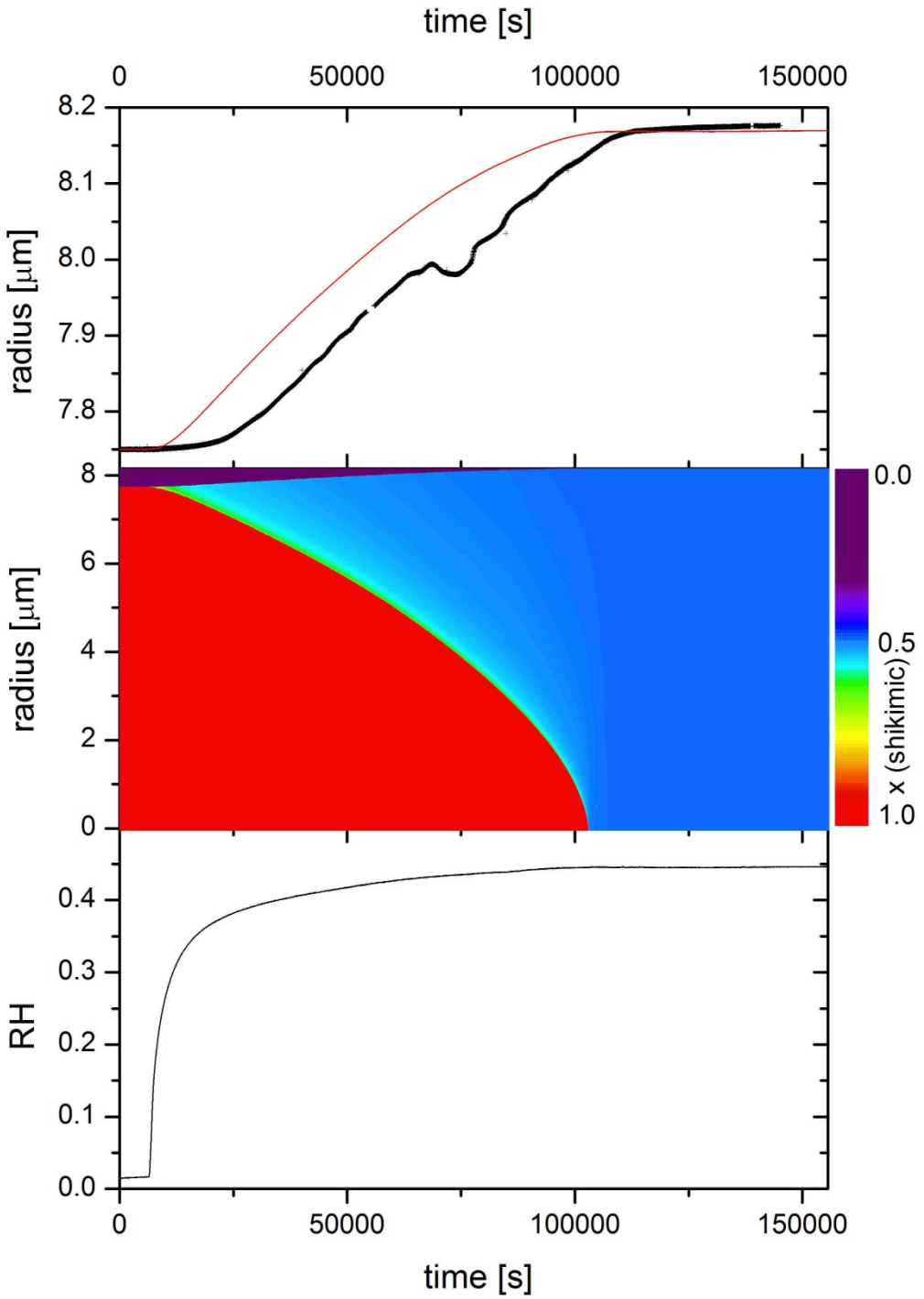




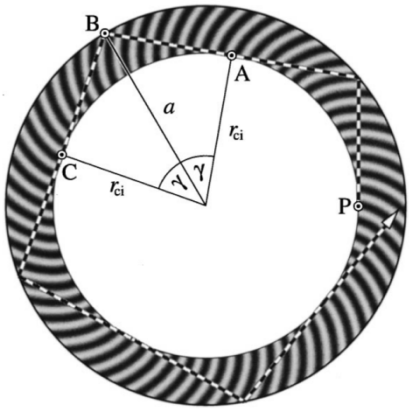
Humidification of glassy particle



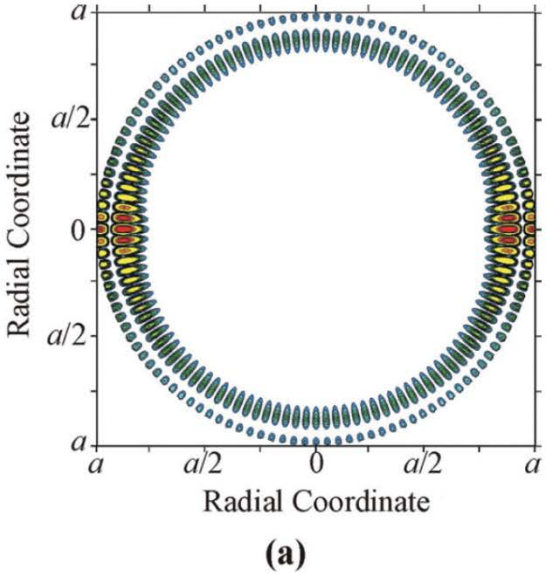
Diffusion model

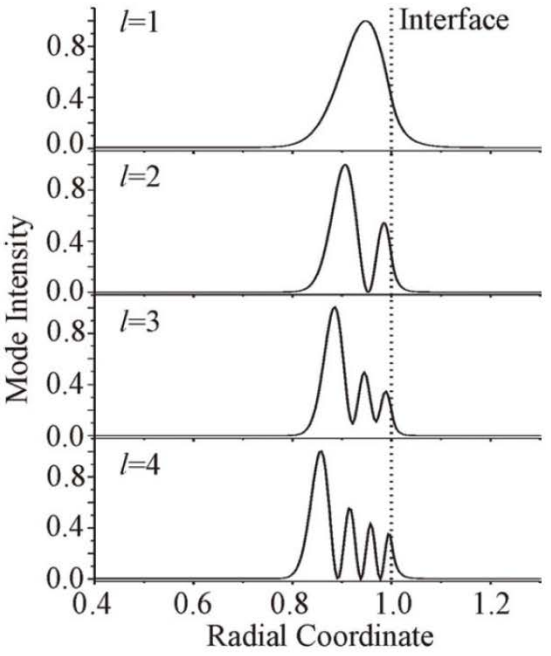


Internal intensity distribution



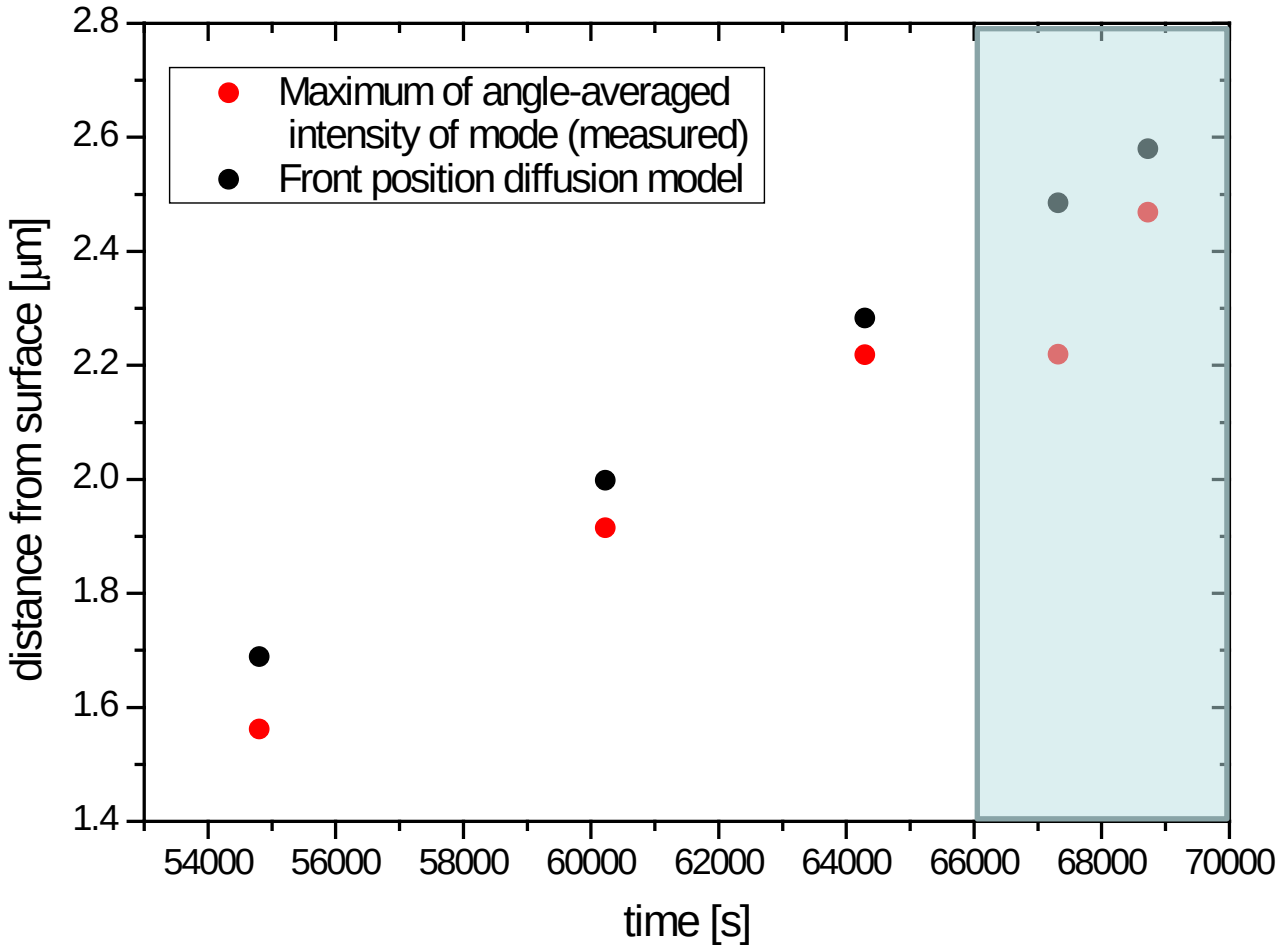
Roll and Schweiger., *J. Opt. Soc. Am. A.*, **17**, 1301 (2000)





Symes et al., *Phys. Chem. Chem. Phys.*, 6, 474 (2004)

Comparison diffusion model with resonance intensity location



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