Refractive Index of Supercooled Water between 535 nm and 670 nm

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The refractive index of water is the most important optical property in describing the refraction and reflection of light underlying the radiative processes occurring in clouds. As micrometer-sized supercooled water droplets are naturally present in the upper clouds of Earth's atmosphere, a detailed knowledge of the refractive index of water in the deeply supercooled region is essential to the development of more reliable climate models. Apart from the challenges related to sample preparation and observation at such deep supercooling, performing a measurement of the refractive index by light scattering is usually based on utilizing coherent light sources that are available only at very few wavelengths. Up to now, available data reached a minimum temperature of 237 K at $\lambda = 632.8$ nm [1,2], and above 260 K at other wavelengths [3]. Raman spectroscopy is a versatile method to acquire a detailed picture of atomic and molecular vibrations of liquid water. The presence of morphology-dependent resonances in the Raman spectra of micrometer-sized aqueous droplets allows for the determination of the refractive index of the liquid. The range of wavelengths is determined by the Raman excitation wavelength and the width of the liquid's Raman scattering band. In our experiment on pure water, wavelengths between 535 nm and 670 nm could be investigated. By combination with evaporative cooling of the water droplets in vacuum, we obtained the temperature dependence of the refractive index far into the deeply supercooled region down to 230.5 K. [4]

References

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