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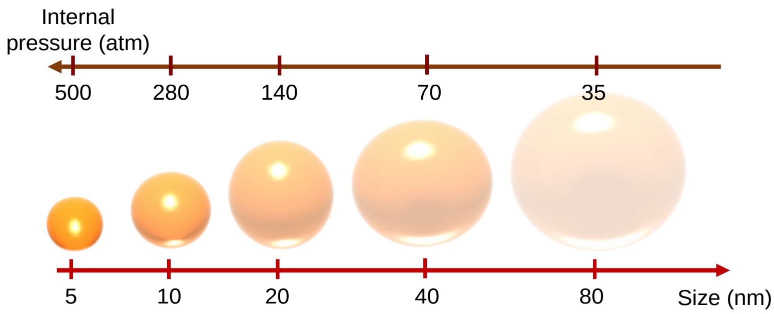
Effect of pressure on chemical reactions in atmospheric aerosols

The atmosphere is made of gases and suspended particles, aerosols, whose size falls in the 1 nm - 10 µm range. These aerosols have a very diverse nature (liquid, solid, both) and composition (salts, organic matter, metal oxides…). Some aerosols reside in the atmosphere for weeks and have a global impact on Earth. This impact can be direct (e.g. radiative balance) or indirect (e.g. aerosols act as cloud condensation nuclei). This project deals with the chemical reactions taking place inside aerosols. One important example is oligomerization in which small molecules condense into a bigger one, such as in the reaction between alcohol and aldehyde (acetalization) or between carboxylic acid and alcohol (esterification).

Up to now, one major parameter involved in aerosol chemistry has been overlooked: **internal pressure**. Indeed, pressure can affect both the chemical reaction constant and its kinetics. Because of surface tension and the associated Laplace pressure, the pressure inside a small aerosol can be much higher than the air pressure: 35 to 800 times higher for particles from 80 to 5 nm (see figure).



The internship will consist in assessing this pressure effect on representative reactions, using several methods:

- the reaction will take place in a bulk solution sample, placed for a given amount in a high pressure vessel. The final reaction products will be characterized by UV-visible spectroscopy, and high resolution mass spectroscopy

- the reaction will be directly monitored using "live" Raman spectroscopy, which gives information on the molecular vibrations, and can be used to identify chemical species and measure their concentration. This part will use the micro-spectroscopy setup available at ILM, together with a microscope stage in which high pressure capillary connected to a high pressure system.

One interesting direction is also to study the dependence on temperature, including the low temperatures occurring in the atmosphere, at which the solutions might become metastable with respect to ice.

This work is a collaboration between Institut Lumière Matière (F. Caupin) and Institut de Recherches sur la Catalyse et l'Environnement de Lyon (M. Riva, C. Georges). The internship can be extended into a PhD.