Bursting bubbles experiment for the understanding of microplastic particle exchange at the air-water-interface [333936]

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Objectives and relevance

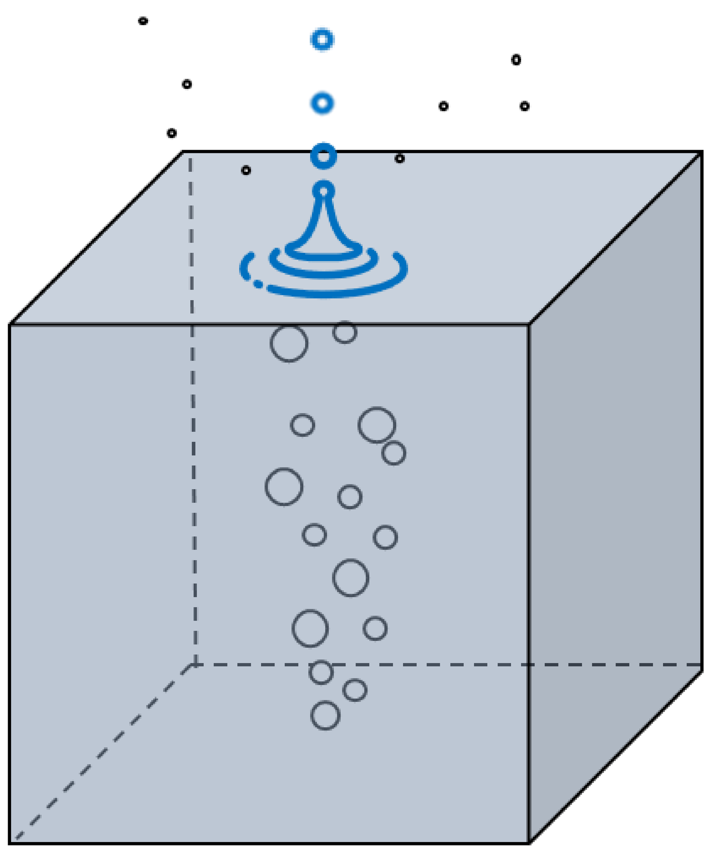

Fig. 1: Scheme of film- (black) and jet-drops (blue) after bubble bursting

We expect that water drops that are ejected into the air will transport Microplastic Particles (MPP) to the atmosphere. This is a well-known transition process for other components in the water such as salt.

Droplets can be generated by several mechanisms. One of the main processes is bursting of gas bubbles. Due to buoyant forces, gas bubbles formed in the water rise to the water surface and burst.

Bubble bursting: Droplet generation

1. Small film droplets develop
2. Bubble cavity collapses & a water jet arises vertically
3. Jet drops can develop

We investigate if film and/or jet drops lead to the transport of MPP into the air above.

Research questions

- Can airborne MPP be observed after bubble bursting?
- Does the MPP concentration in the water influence the transition rate?
- What fraction of MPP is transported into the air?
- Does the size of the particles influence the transition rate?

Experimental setup

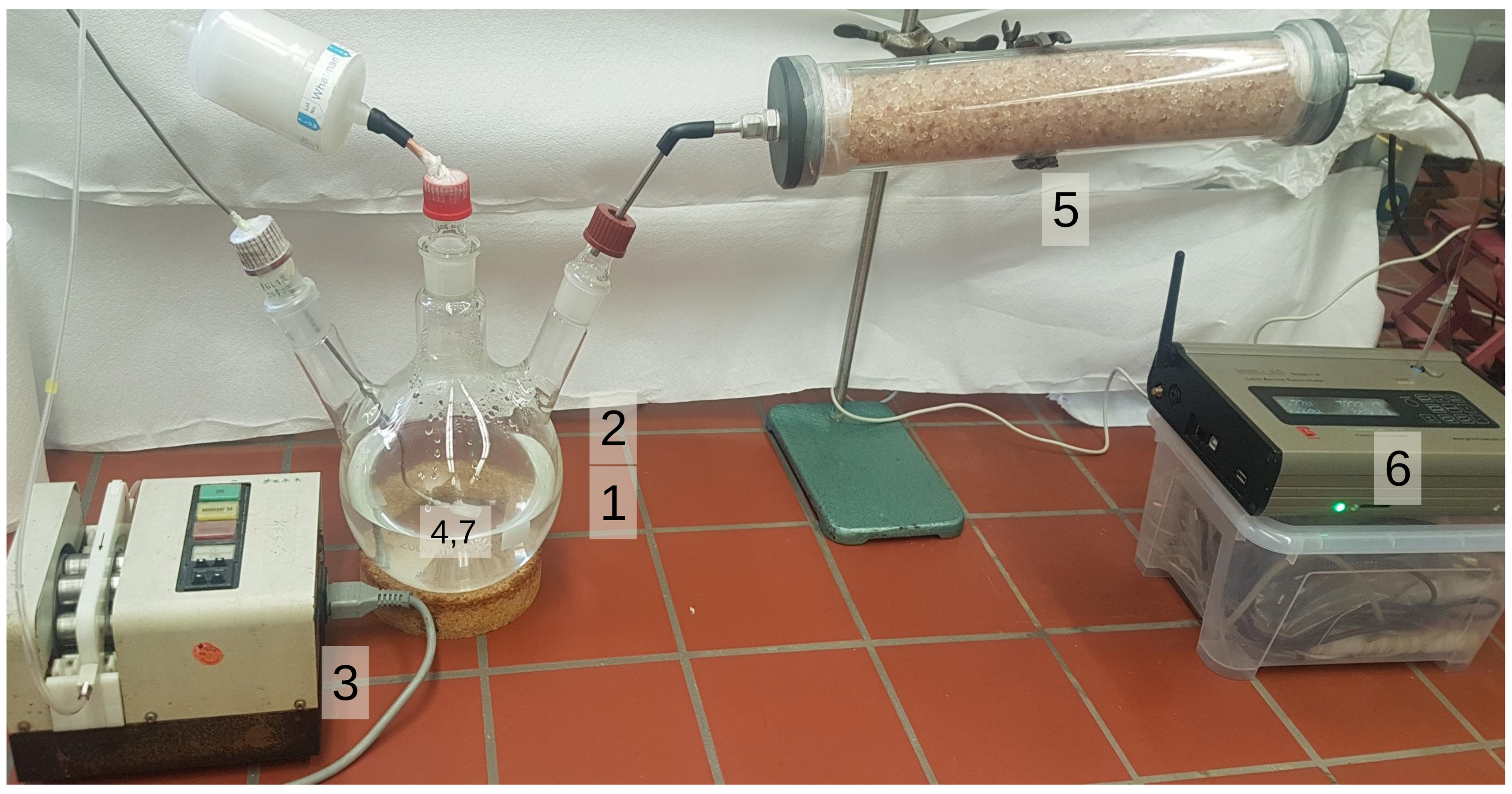

Fig. 2: Experimental setup for the bubble bursting experiments with MPP. The numbers are explained in the description above.

- Glass flask containing 1 liter of de-ionized water **(1)**
- Particle-free headspace (volume of 1 liter) **(2)**
- Peristaltic pump pumping **(3)** filtered air through a stainless-steel frit (2 µm/ 5 µm/ 10 µm diameter) **(4)** for bubble generation and film drop production
- Diffusion dryer **(5)** and optical particle counter (Grimm Mini-LAS 11-R) **(6)** for particle sizing and detection
- Spherical polystyrene particles (diameter 0.5 µm , 0.75 µm, 1 µm, 2 µm) **(7)**

Methods

We prepare MP suspensions of different particle number concentrations and sizes in multiple experiments. The optical particle counter measures the number of particles ejected into the air after diffusion-drying in different size ranges. Subsequently, we compare the results of different particle sizes measured by the OPC (air environment) and particle concentrations in suspension (water). The volume flow rate of filtered air for bubble generation is 20 ml min^{-1}.

Results

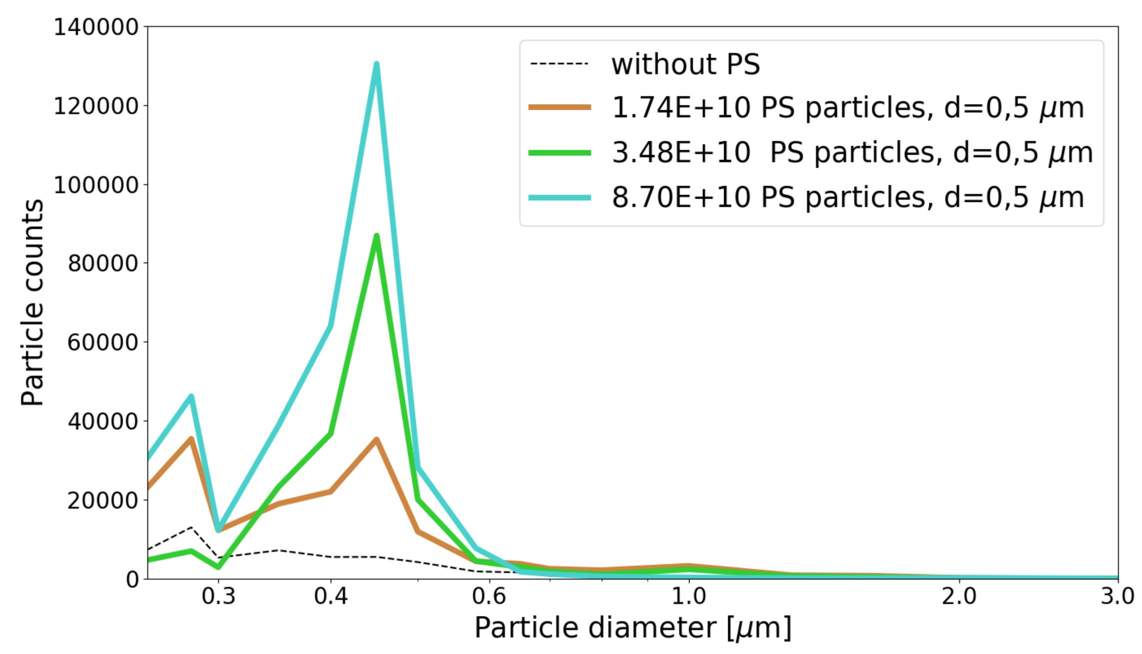

Fig. 3: Particle size distribution with different amounts of 0.5 µm PS particles suspended in 1 l water (experiment duration: 1 day)

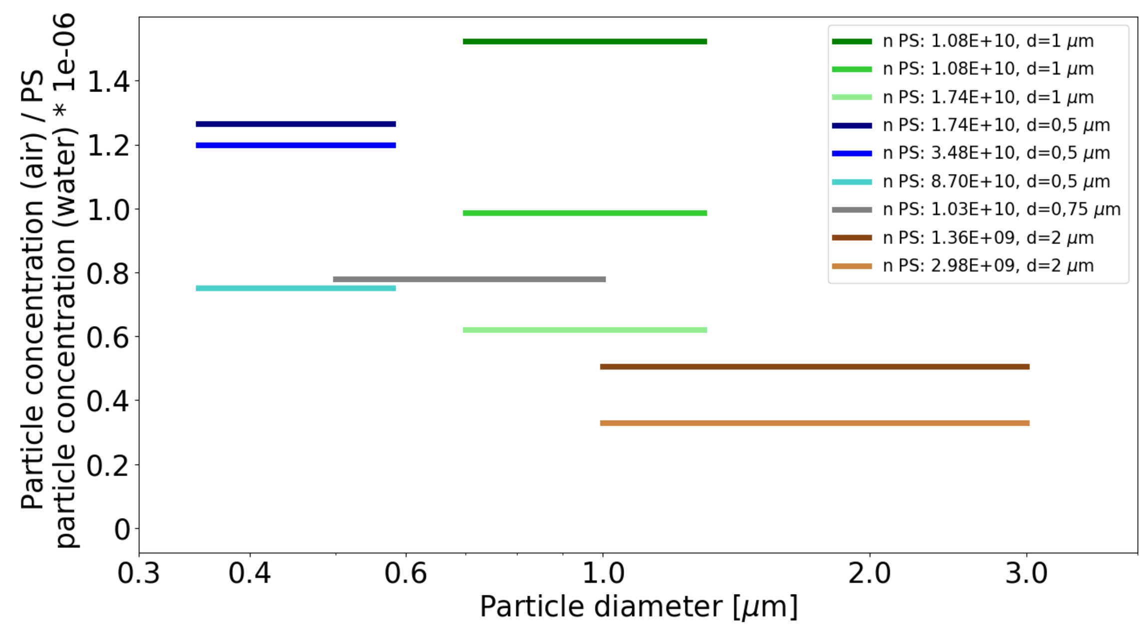

Fig. 4: Ratio of particle concentrations in the air headspace to PS concentrations suspended in water for different particle sizes (experiment duration: 1 day). The concentration in the headspace is a mean value of the displayed range for the equivalent particle diameter.

Conclusions and future tasks

- Strong enhancement of airborne particle concentrations in the diameter range of the suspended particles
- Concentration of the airborne particles depends on the MPP concentration suspended in water.
- The fraction of airborne MPP ranges between 0.3 - 1.5 per one million particles suspended in water using a volume flow rate of 20 ml min^{-1} for bubble generation.
- The transition efficiency seems to decrease with particle size
- Further experiments are ongoing to validate these preliminary results. Ongoing and future tasks are:
  - ➢ Experiments with different particle concentrations, sizes, polymer types, and bubbles with varying properties
  - ➢ Characterizing bubble size spectra and concentrations

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