Pioneering Novel Single Droplet Mass Spectrometry Tools to Investigate Aerosol Chemistry

About the project or challenge area: Atmospheric aerosols impact global climate directly by scattering sunlight and indirectly by serving as the seeds for cloud droplets. The aerosol indirect effect is the largest negative (i.e. cools the planet) and most uncertain radiative forcing. With respect to health, aerosols are a major component of air pollution. Chemical reactions in microscopic aerosols are complex: they can occur at rates much faster than in macroscopic solutions and have unique reaction intermediates and products relative to gas and aqueous phase reactions. However, few approaches exist to study the chemical composition of droplets >1 μm diameter.

The goal of this project is to develop new tools to study the surface and bulk molecular composition of microscopic droplets so that we can eventually investigate photochemistry at droplet surfaces. At Bristol we have already developed instruments (e.g. holographic optical tweezers and electrodynamic balances) to capture and study individual droplets in the size range of growing cloud droplets (~5-10 μm radius), providing information about droplet size, refractive index, surface tension, and viscosity. In this project, these tools will be coupled to a time-of-flight mass spectrometer by developing novel ionisation approaches to measure the molecular composition of individual picolitre droplets. Specifically, we will develop a voltage-free droplet assisted ionisation setup to measure the bulk composition of individual levitated droplets as well as a field-induced droplet ionisation setup to selectively measure the surface composition of levitated droplets. This research project will contribute to a major European Research Council funded grant aimed at investigating the surface composition of aerosols and their impacts on climate and health.

Why choose this opportunity? Aerosols are important to many aspects of our lives, including climate, air pollution, disease transmission, pharmaceutical interventions, and industrial formulations. The focus of this project is on developing new analytical technology. Although the primary application of this technology is in atmospheric chemistry, the approaches developed will be transferable to any domain where aerosols play a role. You will develop expertise in analytical and physical chemistry, particularly in the highly employable fields of mass spectrometry and aerosol science. The project will require collaboration across a team of individuals working on this and other related projects, along with collaborators across the globe. Your project will be aligned with the Centre for Doctoral Training in Aerosol Science, which hosts a reservoir of training materials in aerosol science and provides many networking opportunities. Furthermore, this project will require your collaboration with other members across other research groups, thus improving your teamwork and networking skills. Additionally, you will be able to develop a range of transferable skills, including presentation, scientific writing, and project and time management. Finally, you will be interacting with students from all over the world learning from their culture and skills, adding to your professional and personal development.

Full training will be provided for all aspects of this project. You will be embedded within the Supervisor's research group, who will provide support. In addition, you will be assigned a mentor for the duration of your project, who will provide extra support and help you identify any additional training needs or opportunities.

About you: Ideally you will already have skills and knowledge in analytical, physical, or atmospheric chemistry, teamwork and time management.

Bench fees: A bench fee of £3.5k is required.

How to apply: Applications are accepted throughout the Academic Year, and you should complete the online application form for Chemistry (MSc by Research).

Supervisor: Your supervisor for this project will be Bryan Bzdek, Proleptic Senior Lecturer in the School of Chemistry. You can contact him at b.bzdek@bristol.ac.uk.

Find out more about your prospective research program: For further background information on the analytical approaches to be developed, see these articles on droplet mass spectrometry: 1) Horan et al. *Analytical Chemistry*, **2017**, *89*, 1059-1062; 2) Grimm and Beauchamp, *Journal of Physical Chemistry B*, **2003**, *107*, 14161-14163. For further information on the Supervisor's recent research see the following publications: 1) Bzdek et al., *Communications Chemistry*, **2020**, *3*, 105; 2) Bzdek et al., *Proceedings of the National Academies of Science*, **2020**, *117*, 8335-8343.