Ion-molecule reactions and their implications on past, present and future space missions

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Aim: The Rosetta mission was an ESA (European Space Agency) mission to orbit and deploy a lander – Philae – onto the surface of comet 67P/Churyumov-Gerasimenko. The Open University's Ptolemy MS (mass spectrometer) successfully acquired and returned to Earth data from the cometary surface suggesting the presence of water, carbon dioxide and an array of organic compounds [1]. A consequence of the non-nominal landing was that the organics were not separated by gas chromatography as intended but detected as a mixture of compounds to form a complicated mass spectrum.

During the landing sequence, organics were also detected by the COSAC MS on Philae and the ROSINA MS on the Rosetta orbiter. The range of analytical technique has allowed cross comparison of the retrieved data, and helped to investigate the heterogeneity of the chemical compositions of the comet surface and its coma e.g. [2]. A more detailed comparison between these data sets is complicated by differences between the instruments (a result of individual science goals and spacecraft constraints). In the case of the Ptolemy these are the presence of ion-molecule reactions and the use of a unique low power FED (Field Effect Device) ionisation source.

In order to properly understand the analyses made at the surface of 67P and how they relate to the true cometary composition, we first need to re-purpose the QM (Qualification Model) of the Ptolemy ion trap MS, from its use of supporting spacecraft operations to an instrument suitable for lab research. The reconfigured Ptolemy QM will be used to:

- analyse individual compounds to understand the effects of ion-molecule reactions on individual species
- investigate the mass spectral differences between the Ptolemy and normal filament ionisation sources
- study the interaction of mixtures of chemicals within an ion trap

The project involves laboratory work with a range of disciplines, physics, electronics, engineering and chemistry. The candidate will be working with the Space Instruments Group at The Open University as part of the team that landed a MS on a comet and is continuing to developing ion trap MS for missions to the Moon and Mars.

References:

1) Wright I.P. *et al.* (2015) *Science, 349*.
2) Krüger H. et al (2017) Astronomy & Astrophysics, 600, A56

Qualifications required: A first class or upper second class degree in a relevant degree e.g. Physics/Electrical Engineering or Space masters MSc.