Astrochemistry at high resolution: preface

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Preface

The journey that brought us to Space Telescope Science Institute in a warm and humid Baltimore in the early summer of 2023 began nearly seven years ago in 2016 with some preliminary discussions between members of the RSC Astrophysical Chemistry Group and the ACS Astrochemistry Sub-division committees at the Autumn ACS Meeting in Philadelphia. We recognised that our window on the Universe was rapidly expanding as new observational platforms were developed. With ALMA in operation, JWST then just about to fly, E-ELT breaking ground and several other resources well advanced in their planning, the chemically controlled cosmos is becoming even more open to our gaze. We were entering the age of *High Resolution Astrochemistry*. High resolution spectroscopically as these new platforms offer unique insight into chemically rich environments at higher spectral resolution and sensitivity than many previous platforms for studying both the astrophysical gas and solid states. High resolution spatially as these platforms offer unsurpassed chemical imaging capabilities in nearby astronomical objects at every evolutionary stage.

Astrochemical research truly requires a multidisciplinary approach, bringing together researchers from astronomy, and the gas phase, solid state and surface physics and chemistry communities of a range of flavours. Previous Faraday Discussions in this young discipline have explored aspects of the gas phase chemistry in astronomical environments (Faraday Discussions 109 and 133); have addressed the multitudinous roles of dust and ice found in large abundances in star and planet forming environments (Faraday Discussion Number 168); and have revealed the chemical complexities of planetary science (Faraday Discussion Number 147) in our own astronomical backyard and more widely.

We agreed that it was timely that a Faraday Discussion should seek to address the wide-ranging roles of chemistry in astronomy in the light of the wealth of observational detail becoming available in this era of *High Resolution Astrochemistry.* The discussion should explore the role of chemical spectroscopy in identifying chemical species and probing their environments; should attempt to understand the complex combination gas phase and surface and solid-state chemistry that drives the chemical evolution of our Galaxy and others; explore how this chemical evolution is intimately involved in controlling the process of star and planet formation; and how chemistry brings us to the edge of biology. The scientific programme would bring together leading computational and experimental scientists working to unlock the secrets of astrochemistry with astronomers engaged in observing and understanding star and planet

formation; and potentially chemists and biologists seeking to understand the first tentative steps toward life on our own planet and others!

Such a discussion meeting would be very timely. Existing and new observational platforms are delivering and will deliver increasingly detailed information on the chemical composition of our Galaxy and beyond. We are beginning to reveal in intimate detail the progress of cold and dense gas and dust through to stars and planets and onwards. We may even have the tools to detect the signatures of life on planets in nearby star systems. This is naught but stamp collecting unless we can understand what we see! The key role played by astrochemistry in this story is thoroughly accepted. Indeed, over the last two decades more than 25 MEuro have been invested in developing structured astrochemical research programmes across Europe at national and international level. One can point to the Molecular Universe and LASSIE training networks in Framework 7; and to the EuroPAH training network in Horizon 2020 which played a powerful coordinating role in driving cross-Europe collaboration in astrochemistry by providing the necessary manpower to pursue astrochemical research objectives funded in part by national investment. These, of course, parallel in time the multi-billion Euro investment in new observational platforms which are now beginning to deliver on their astronomical promise. A Faraday Discussion timed to coincide with the first tranche of observations from JWST and building on the insights provided by ALMA will attract a substantial audience and significant attention worldwide It will also provide ideal opportunity to discuss the future direction of such research by identifying the still unanswered questions – many of which can only be derived from new observational data.

Little did we appreciate in 2018 when this proposal was accepted by the RSC that it would be 5 years before we met in Baltimore. Delays in launching JWST and the COVID pandemic ensured that this discussion was a moveable feast. However, we finally made it! I hope that the readers of this Discussion volume will feel the real excitement that those of us in attendance, both physically on site and remotely via internet connections, felt during this discussion in being part of the rising tide of astrochemical research prompted by the observational revolution that we have seen with JWST.

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