

## COMMISSION H2

## ASTROCHEMISTRY

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**VICE-PRESIDENT**  
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**ORGANIZING COMMITTEE**

**Thomas J. Millar**  
**Edwin A. Bergin**  
**Maria R. Cunningham**  
**Yuri Aikawa, Paola Caselli,**  
**Jes Jørgensen, Satoshi Yamamoto**

## INTER-COMMISSION WORKING GROUP

**Commissions C1, F2, F3, H2**      **Education and Training in Astrobiology**

## TRIENNIAL REPORT 2015-2018

### 1. Introduction

Commission H2 Astrochemistry came into existence at the 2015 General Assembly following a proposal to the IAU from Tom Millar, Paola Caselli and Satoshi Yamamoto, having previously existed as a very active Working group since 1984. Tom Millar (UK) is the founding President, Ted Bergin (USA) is Vice-President. Five Ordinary Members were elected in 2015 – Yuri Aikawa (Japan), Paola Caselli (Germany), Maria Cunningham (Australia), Jes Jørgensen (Denmark) and Satoshi Yamamoto (Japan) – with Maria Cunningham elected by the OC as Secretary. Commission H2 currently has 179 members.

The Commission H2 has identified five key activities for development:

- advertising the role of astrochemistry in astronomy;
- emphasising the large amount of data coming from new facilities;
- participating in summer schools and other education programmes;
- maintaining interdisciplinary links with scientists in other fields including physical chemists, spectroscopists and astrobiologists;
- connecting the exploding field of exoplanet characterization to our field which has pioneered the astrophysical/chemical connections.

### 2. IAU Symposium 332

The major task undertaken by the OC over the triennium was the organisation of the seventh IAU Symposium on Astrochemistry – Astrochemistry VII: Through the Cosmos from Galaxies to Planets, held in Puerto Varas, Chile from 20-24th March 2017. In the years since our first IAU Symposium, S120, in Goa in 1985, the astrochemistry community has made very significant advances in understanding how molecules both respond to and influence local conditions. In particular, molecular lines are now widely used to probe key physical properties. The techniques of molecular astrophysics now permeate many branches of astronomy from studies of high-redshift galaxies to the study of exoplanet atmospheres, to the formation of both high-mass and low-mass stars, including planet formation in the latter, to the death of stars via stellar winds and supernovae.

To date, and neglecting isotopologues, some 200 molecules have been detected beyond our Solar System. The observations tell us that they are formed primarily in exothermic gas-phase, ion-neutral and neutral-neutral reactions together with a rich solid-state chemistry driven through the interaction of ultraviolet photons and cosmic-ray particles with ice-covered interstellar grains.

Since the processes of molecular synthesis involve fundamental chemical physics at temperatures of 10–20K, the linkage between observation, laboratory experiment and theoretical modelling remains essential to the development of our discipline. We were therefore pleased to refresh this close collaboration, now over 30 years old, at IAU S332. Some 169 scientists from 25 countries gathered to hear 21 invited reviews and 36 oral contributions, with a further 116 poster papers on display throughout the meeting. It was already evident at the meeting that ALMA is changing our views on almost every aspect of observational astrochemistry through its phenomenal sensitivity and spatial resolution. It will be a challenge to chemists and modellers to advance at the same speed as that with which new observational results are being published.

The Symposium co-chairs were Ted Bergin, Maria Cunningham and Tom Millar, who with the other members of the OC formed the Scientific Organising Committee. The SOC was augmented by some external scientists, including Farid Salama (President, Commission B5, Laboratory Astrophysics) and Sun Kwok (President, Commission F3, Astrobiology). We envisage a close cooperation with both of these Commissions in future IAU Symposia and other activities.

The Symposium benefited from the presence of the IAU President-Elect, Ewine van Dishoeck, who outlined 14 challenges for Astrochemistry in the coming decades as well as giving a special presentation on ‘Women in Astronomy’ summarising the recent IAU survey on this topic. The LOC was ably led by Gautier Mathys and the proceedings, co-edited by Maria Cunningham, Tom Millar and Yuri Aikawa, will be published by Cambridge University Press.

### 3. XXIX General Assembly

Members of the OC were involved in the SOCs of two meetings at the General Assembly in 2015. Yuri Aikawa in that of IAU S315 ‘From Interstellar Clouds to Star-forming Galaxies’ and Tom Millar in that of Focus Meeting 12 ‘Bridging Laboratory Astrophysics and Astronomy’. The FM brought together expert providers and users of laboratory and astronomical data, including theoretical and experimental chemists and physicists, to discuss state-of-the-art in their respective disciplines and to investigate how their combined expertise can address important questions in astrophysics. Particular sessions focused on several areas of interest to astrochemistry, including atoms, molecules, dust, ices, and Solar System and interstellar objects.

### 4. Inter-Commission Working Group

Ted Bergin and Tom Millar represent H2 on the ICWG on ‘Education and Training in Astrobiology’, chaired by Muriel Gargaud, and with other members drawn from Commissions C1, F2 and F3. This new WG was established in October 2015 and has been very active since then. It is involved in the production of Massive Open Online Courses (MOOCs), in the collection of all recorded lectures and conferences in astrobiology over the past decade (see <http://astrobiovideo.com>) in French, English and Spanish. It also provides outreach to high school teachers and the general public, has started an annual

astrobiology training school, and runs a 2-day training school before or after major conferences. The first International Symposium on Education in Astronomy and Astrobiology was organised in Utrecht in 2017 with the next planned for Malaga in 2020. Commission H2 is supporting the continuation of this WG for the period 2018-2021.

## 5. James Craig Watson Medal

The OC is very pleased to note that on 17 January 2018, the US National Academy of Sciences awarded its James Craig Watson Medal for Astronomy to Ewine van Dishoeck, in recognition of her outstanding contributions to molecular astrophysics and astrochemistry. Ewine is a Past President of the Astrochemistry WG. Well done Ewine!

## 6. Commission H2 Web Site

The Commission's web site has been set up and maintained by Maria Cunningham. We encourage all members of H2 to inform the Secretary of news, including meeting announcements, prizes, job openings, etc. The website can be found at <https://h2.physics.unsw.edu.au>.

Tom Millar  
*President of the Commission*