# PREFACE

About 262 participants from at least 25 countries and nationalities gathered from August 23–27 1999 in South Korea to participate in IAU Symposium 197 on "Astrochemistry: From Molecular Clouds to Planetary Systems." The meeting was held in the Hyatt Regency Resort near Sogwipo, a small fishing port on the south coast of the beautiful Cheju Island, near the southern tip of the Korean peninsula. Thanks to the excellent and efficient local organization, chaired by Young Chol Minh, the 5–day Symposium proceeded very smoothly.

The Symposium was organized by the IAU Working Group on Astrochemistry under sponsorship of IAU Commission 34 (IAU Division VI), with co-sponsorship of Commissions 14, 15, 16, 40 and 44. This was the fourth symposium in a series starting with IAU Symposium 120 in India in 1985, followed by IAU Symposium 150 in India in 1991 and IAU Symposium 178 in the Netherlands in 1996. The increase in the number of participants by nearly a factor of three over this period testifies to the rapid growth of the field. As in previous symposia, scientists from many different disciplines including chemistry, physics and geology were brought together.

The scientific part of the program featured 48 oral review and invited papers and 170 posters. The opening address by A. Dalgarno emphasized the breadth of the subject, ranging from the early universe to planetary atmospheres in our own solar system. In contrast with previous IAU Symposia, however, the program was not able to cover all of these aspects but centered around the specific theme of the chemical evolution during star formation.

The program followed the gas-phase molecules and solid-state species on their journey from diffuse interstellar clouds to incorporation into solar-system bodies. It started with a discussion on the chemistry in low- and high-mass star-forming regions, where improved single-dish and interferometer (sub-)millimeter facilities as well as the *Infrared Space Observatory* (ISO) have provided a wealth of new information. Together, these data allow a much more complete inventory of the gas and solid-state composition, and reveal the chemical and physical characteristics ranging from the cold (pre-)collapse stage, where molecules are depleted onto grains, to the warmer, evolved phase where the ices evaporate and drive a rich chemistry. New diagnostics of the interaction of young stars with their surroundings through powerful outflows and copious ultraviolet radiation were presented.

The first results from the *Submillimeter Wave Astronomical Satellite* (SWAS) formed a highlight of the meeting. $H_2O$ has been detected in many star-forming clouds, but the $O_2$ molecule is still elusive. In contrast with ISO, the SWAS data are sensitive to $H_2O$ in cold gas, and the inferred abundances are surprisingly low, well below those predicted by traditional models.

Throughout the conference, it was stressed that a more quantitative determination and analysis of chemical abundances requires improved physical models coupled with sophisticated radiative transfer in continuum and lines. An overview of radiative transfer methods currently used by astrochemists was

presented, and a coordinated approach to compare and improve codes was called for.

Accurate information on basic molecular data continues to be essential for progress in Astrochemistry, as summarized in a panel discussion. Advances in instrumentation have provided new insight into many processes, ranging from the rates and products of gas-phase neutral-neutral reactions under ultra-cold conditions to microwave spectra of complex carbon-chain molecules. Heavy-ion storage rings, previously used only for atomic and nuclear physics, are now exploited to study the dissociative recombination of polyatomic ions. Compared with previous symposia, there was a substantial increase in the number of experimental studies of PAHs and surface processes. The wealth of features found in ISO spectra leaves little doubt that the carriers are some mix of PAHs. Thanks to increased computer power, realistic theoretical simulations of grain-surface processes can now be carried out as well.

The chemistry of circumstellar disks formed an entirely new subject, not discussed at previous symposia. It is well established that most low-mass young stars are surrounded by disks with sizes and masses comparable to that of our own primitive solar nebula. Reviews of the physical structure of disks and the time-scales for dissipation and formation of planetary bodies were presented. Observations of molecules other than CO are just becoming feasible and new single-dish and interferometer results were shown. ISO spectra of disks reveal solid-state features due to crystalline silicates and water ice, some of which are remarkably similar to those found in comets.

Another new area of research is the study of the surface composition of small bodies in the outer solar system, including Kuiper Belt objects, Centaurs and Pluto/Charon, the remnants of our Sun's circumstellar disk. Near-infrared spectroscopy of these very faint objects has become possible with the advent of 8–10 m class optical telescopes. New results on variations in the spectra, albedos and colors, and the implications for the composition of ices, were presented at the Symposium, but are unfortunately not included in these proceedings. The wealth of new observational data on comets, especially the 'comet of the century' Hale-Bopp, were extensively discussed. The comparison with abundances found in interstellar ices and hot cores strengthens the connection between interstellar and solar-system material.

Closer in our solar system, new data on elemental abundances from the *Galileo* probe mass spectrometer were announced, which are inconsistent with conventional formation models of Jupiter. The D/H ratios in the giant planets measured by ISO suggest that their atmospheres originated from a mix of solar nebula gas, with enhancements due to evaporated gases from icy planetesimals. The detection of $H_2O$ requires an external source of oxygen, most likely provided by interplanetary dust particles. Meteorology is becoming a new subject in our discipline, and detailed discussions of cloud formation were presented.

A very exciting new topic is formed by the recent discovery of extrasolar giant planets and brown dwarfs, i.e., objects with masses ranging from 35–80 times the mass of Jupiter, which bridge the gap between planets and stars. The enormous progress made on observations and modeling of their atmospheres formed another highlight of the meeting.

Finally, studies of the inner solar nebula benefit from having some material 'in our own hands.' Sophisticated laboratory experiments of meteorites were presented, which provide increasingly accurate constraints on the events and time-scales of physical processes that occurred in the nebula. Interplanetary dust particles collected in the Earth's stratosphere show exciting evidence for preservation of interstellar material, opening up a new avenue to probe nebular processes. It is clear that the primitive solar nebula needs to be treated as a dynamical process rather than a static object.

N. Kaifu provided a thoughtful perspective of the history and future of our subject at the after-dinner talk, and illustrated the enormous progress that has been made in the last 30 years in reaching our dream of eventually linking interstellar chemistry with searches for life on other planetary systems. The symposium concluded with a stimulating summary by D. A. Williams, who emphasized the thrills and fun of the new discoveries. Although our understanding of many of the new phenomena is still incomplete, Astrochemistry has clearly come of age and is now an essential part of main-stream astronomy.

The non-scientific part of the program highlighted a tour of the Cheju island, including the beautiful Chongbang waterfall and an impressive sculpture garden, with a buffet dinner at a Bonsai garden. The symposium banquet consisted of a fantastic outdoor barbeque with many Korean and Japanese delicacies, and featured a truly spectacular performance of the Korean group 'Jin Soe', playing the traditional Samulnori ('four-things-play') on percussion instruments. The participants will long remember the true Korean beats!

The Symposium was made possible financially thanks to the support from the International Astronomical Union, Korea Astronomy Observatory, Korea Astronomical Society, Korea Science and Engineering Foundation, Korea Research Foundation, Korean Federation of Science and Technology Societies, and Korea National Tourism Organization.

## EDITORS' NOTE

This volume contains the review and invited papers presented at IAU 197. The contributed papers (up to 2 pages per poster) are contained in the IAU 197 abstract book, edited by J.S. Kim et al. and printed at Korea Astronomical Observatory (1999) (see <http://www.issa.re.kr/~iau197/>). A complete list of poster papers is given at the end of this book. An effort has been made to update all references up to December 1999.

Astrochemistry is a very interdisciplinary subject, and one of the greatest barriers is often the terminology used in different subjects. In order to make this book more accessible, a set of often-used abbreviations is given at the end of this volume. Some additional useful reference material is summarized in the Appendices.

January 2000
Ewine F. van Dishoeck and Young Chol Minh

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* Dr. Singh died on October 9, 1999 (see p. 512).

The current composition of the IAU Astrochemistry Working Group can be found at `<http://www.strw.leidenuniv.nl/~iau34>`.

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