PREFACE

Molecules are found in a large variety of astronomical environments, ranging from comets in the solar system to starburst galaxies at high redshifts. They are widely used as diagnostic probes of the physical conditions in which they occur, owing to their rich energy level structure. Moreover, interstellar space provides a unique chemical laboratory in which molecular processes can be studied under conditions that are different from those normally found in a laboratory on Earth. These two aspects of interstellar molecules — their use as physical and chemical diagnostics and the study of chemical processes in space — formed the scientific focus of IAU Symposium 178.

The Symposium was held in the excellent conference center "De Leeuwenhorst" in Noordwijkerhout, about 10 km north of Leiden, from July 1–5 1996, under the sponsorship of IAU Commission 34 (IAU Division VI), with co–sponsorship of IAU Commissions 14, 15, 28, 36 and 40. The scientific program was organized by the IAU Working Group on Astrochemistry (chair: D.A. Williams, secretary: E.F. van Dishoeck). The Symposium was attended by 231 participants with 11 accompanying guests from at least 27 different countries and nationalities. The scientific program consisted of 16 review talks, 25 invited talks, 7 short oral contributions on "hot topics", and 174 contributed poster papers. The number of participants and posters more than doubled those of the previous IAU Symposium on Astrochemistry in Brazil in 1991, illustrating the growth of the field. A novel feature of the meeting was a one–minute poster introduction by each presenter before the poster sessions. This experiment, which initially met with much scepticism, proved to be a success, and significantly enhanced the discussion among the participants, as well as the liveliness of the meeting.

The scientific program covered most aspects of molecular astrophysics, and was of a very interdisciplinary nature. A substantial part of the program was taken up by the exciting recent results on molecules in star-forming regions, which illustrate the enormous observational and theoretical advances. High-angular resolution data obtained with large aperture (sub–)millimeter telescopes and millimeter interferometers now provide insight into the physical and chemical structure of envelopes and disks around young stellar objects on the scale of the (proto-)solar nebula. At the Brazil meeting, most observations were still probing mostly the surrounding cloud.

The link with comets and the solar system was made through reviews of the comet D/Shoemaker–Levy 9 collision with Jupiter and the brand–new observations of comet C/1996 B2 Hyakutake.

Diffuse and translucent clouds continue to provide good testing grounds for basic processes and models. Stimulating new ultraviolet observations from the Hubble Space Telescope and millimeter absorption line data were presented. The progress in research on molecules in stars and circumstellar envelopes was discussed, and the importance of accurate, complete atomic and molecular data bases for modeling was emphasized.

Outside our own Galaxy, molecular observations make significant contributions to our understanding of the interstellar medium of galaxies ranging from the nearby, metal poor Magellanic Clouds to distant starburst galaxies and active galactic nuclei. Molecules were detected at z=2.3 only a few years ago, and a new record was presented at the meeting: CO in a quasar at z=4.69.

The first results of the *Infrared Space Observatory*, launched in November 1995, formed a highlight of the meeting. The data beautifully illustrate the diagnostic value of infrared atomic and molecular lines in both galactic and extragalactic objects. Of particular importance to astrochemistry are the observations of gas–phase water, a major species in the chemistry networks, and of solid–state features. ISO provides the first complete inventory of ices, PAH's and amorphous and crystalline silicate material.

The subject of molecular astrophysics makes enormous demands on laboratory and theoretical chemistry, and the symposium was well attended by people from the chemical physics community. Several sessions on basic molecular processes, both in the gas and on surfaces, emphasized the enormous progress in experimental techniques and computing power, which is essential to study the intricate details of the reactions under interstellar conditions. Particularly impressive was the elegant microprobe laser mass spectrometry analysis of surface adsorbates such as PAH's in interplanetary dust particles and meteorites at 40 μm^2 spatial resolution.

H.C. van de Hulst provided a thoughtful historical introduction about molecular astrophysics half a century ago. The field was put in perspective by the excellent conference summary of E. Herbst, who stressed its diversity. It is clear that molecular astrophysics has become a mature, integral part of astronomy and is essential to determine our place in the universe.

The social events provided much needed relaxation in between the busy scientific schedule. Highlights included a reception in the National Museum of Antiquities in Leiden, containing an authentic Egyptian temple, and an all-afternoon excursion to the Kröller–Möller museum in the national park "De Hoge Veluwe", which houses a large collection of van Gogh and other impressionist's paintings as well as a renowned sculpture garden. The

excursion was concluded by a lively conference dinner in a renovated farm near Arnhem, which featured an after-dinner speech by T.G. Phillips about the future of our field from the instrumental point of view.

The Symposium greatly benefitted from the excellent and efficient efforts by the Local Organizing Committee, in particular David Jansen, Michiel Hogerheijde and Janet Soulsby. It was made possible financially thanks to support from the IAU, the Royal Dutch Academy of Sciences (KNAW), the Leids Kerkhoven Bosschafonds (LKBF), the Netherlands Foundation for Research in Astronomy (NFRA), the Space Research Organization Netherlands (SRON), the Sterrenkundig Studiefonds J.C. Kapteyn, the Stichting voor Fundamenteel Onderzoek der Materie (FOM), the Stichting Leids Universiteits Fonds (LUF) and Leiden Observatory.

EDITOR's NOTE

This volume contains only the review and invited papers presented at IAU 178, as well as the short oral presentations on "hot topics". As such, it covers most, but not all, aspects of Molecular Astrophysics. Because of space limitations, the contributed papers are contained in the IAU 178 Abstract book (340 pages), edited by D.J. Jansen, M.R. Hogerheijde and E.F. van Dishoeck and printed at Leiden Observatory (1996). It is available through the WWW: `http://www.strw.leidenuniv.nl/~symp96`. A complete list of poster papers (including page numbers in the abstract book) is given at the end of this volume.

The papers in this volume are organized according to scientific topic, with the exception of the ISO papers, most of which have been kept together in a separate section. An effort has been made to update all "in press" references up to December 1996.

In order to make this volume more accessible to an interdisciplinary audience, a set of often–used abbreviations is supplied at the end of this volume. In addition, two appendices have been added to summarize some useful information which is scattered throughout the chapters. Appendix 1 gives references to complete lists of detected molecules, whereas Appendix 2 provides some starting points for searches of molecular data bases.

This volume would not have been possible without the enormous technical support by David Jansen, for which I am most grateful.

Ewine F. van Dishoeck, January 1997
Leiden, The Netherlands

Scientific Organizing Committee

L.W. Avery, L. Blitz, R.D. Brown, A. Dalgarno, E.F. van Dishoeck, J.M. Greenberg, Å. Hjalmarson, W. Irvine, H. Kroto, A. Léger, Y.C. Minh, P.D. Singh, L.E. Snyder, S.P. Tarafdar, T. Tsuji, D.A. Williams (chair), Q. Zeng

Sadly, Dr. Tarafdar passed away on September 7, 1996. His efforts for the IAU working group on Astrochemistry, in particular the organization of IAU Symposium 120, will be remembered.

Local Organizing Committee

E.F. van Dishoeck (chair), F.P. Helmich, M.R. Hogerheijde, D.J. Jansen, J.R. Soulsby, F. van der Tak