

DIVISION VI: INTERSTELLAR MATTER

(*MATIÈRE INTERSTELLAIRE*)

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Commission 34: Interstellar Matter

1. INTRODUCTION

Division VI of the International Astronomical Union deals with Interstellar Matter, and incorporates Commission 34. It gathers astronomers studying the diffuse matter in space between the stars, ranging from primordial intergalactic clouds via dust and neutral and ionised gas in galaxies to the densest molecular clouds and the processes by which stars are formed. There are approximately 730 members. The working groups in *Planetary Nebulae* and *Cosmochemistry* have served us well in organising periodic seminars in these subject areas. However, the Organising Committee has recognised that other developing areas of the ISM are not properly represented in the current organisation. In January 1997, the Division formed a new ISM working group on *Star Forming Regions* including cross-divisional representation to monitor progress in their fields and to help develop proposals for future IAU Symposia or Colloquia. In the future, especially in view of the rapid developments in spaceborne X-ray and IR astronomy, Division VI also hopes to form other working groups on the Hot ISM and the Extragalactic ISM.

2. SCIENTIFIC HIGHLIGHTS 1997 - 1999

2.1. Planetary Nebulae:

Since the last IAU symposium on planetary nebulae held in Groningen in 1996, significant new results on planetary nebulae have emerged from observations made with the HST and ISO satellites. High resolution imaging observations have revealed new morphological features, and infrared spectroscopic observations have detected new molecular and solid-state features. The imaging results and their implications on the morphological shaping of planetary nebulae were reported in the conference on asymmetric planetary nebulae held at MIT in August, 1999. The HST data reported at that conference on the young compact PNe has revealed some remarkable structures, and in strongly bipolar PNe a number of clear examples of jets have been found. These have no theoretical explanation at the current time.

The infrared spectroscopic observations of planetary nebulae were discussed in several of the ISO conferences, as well as the IAU Symposium 191 on asymptotic giant branch stars and IAU symposium 197 on astrochemistry. The Working Group held a meeting during the IAU General Assembly in Kyoto, where a number of scientific papers were presented in addition to the business meeting. The Working Group is proposing to hold its next IAU symposium on planetary nebulae; subject to EC approval, in Canberra, Australia, in 2001.

2.2. Supernova Remnants:

Continuing investigations of the gamma ray emission from SN1006 and the non-thermal X-rays from SN1006 and other supernova remnants are providing reliable separation of the thermal and non-thermal X-ray components. Following the discovery of TeV gamma rays from SN1006 by the CANGAROO experiment (Tanimori et al. 1998, *ApJ* 497, L25), theoretical models of electron acceleration in shock waves have been much more strongly constrained. While ambiguities remain, for instance between the particle diffusion coefficients and the magnetic field strengths in the shocks, the theory of particle acceleration in very high Mach number shocks can be put on a more solid observational footing.

Recognition of the importance of non-thermal tails also improves the understanding of the thermal components of supernova remnants. The high quality X-ray spectra from ASCA and the sensitivity to harder X-rays of BeppoSAX have forced the reinterpretation of the X-ray spectra of a number of remnants, such as Cas A (Vink et al. 1999, *A&A* 344, 289). The elemental abundances and the temperature and density of the thermal plasma are affected.

Infrared observations of supernova remnants with the ISO satellite have provided exquisitely detailed spectra and images. It has become clear that much of the IR radiation observed by IRAS and interpreted as radiation from hot dust actually arises from fine structure transitions in neutral or singly ionized species (e.g. Oliva et al. 1999, *A&A* 341, L75). The ISO spectra greatly increase the number of ions available for determination of elemental abundances and shock speeds.

With the launch of the Chandra Observatory, and the imminent launch of the European XMM Mission, we look forward to seeing a rapid advance in our understanding of supernova remnants.

2.3. Astrochemistry

This field has continued to advance rapidly. Indeed, both of the Annual Reviews of Astronomy & Astrophysics articles reported below are in this area. As of August 1999, some 120 chemical species have been identified. The list is maintained at www.cv.nrao.edu/~awootten/allmols.html and can be reached via the Astrochemistry Working Group home page referred to below. The detailed report of the Astrochemistry Working Group is given separately.

3. WORKING GROUPS

Planetary Nebula Working Group: Chair: Sun Kwok (USA)

Members: Agnes Acker (France), Michael J. Barlow (UK), George Jacoby (USA), Jim Kaler (USA), Walter Maciel (Brasil), Dipankar C.V. Malick (India), Mario Perinotto (Italy), Stuart Pottasch (Netherlands), Luis Rodriguez (Mexico), Detlef Schönberner (Germany), Yervant Terzian (USA), Roumald Tylanda (Poland) & Peter Wood (Australia)

Astrochemistry Working Group: Chair: D.A. Williams (U.K).

Secretary: E.F. van Dishoeck (The Netherlands), L.W. Avery (Canada), J.H. Black (Sweden), V. Buch (Israel), A. Dalgarno (U.S.A), J.M. Greenberg (The Netherlands), C. Henkel (Germany), W.M. Irvine (U.S.A), J.P. Maier (Switzerland), K.M. Menten (U.S.A.), Y.C. Minh (Korea), M. Ohishi (Japan), B. Rowe (France), P.D. Singh (Brazil), L.E. Snyder (U.S.A), & Qin Zeng (China P.R.).

Working Group on Star Forming Regions: Chair: R. Bachiller (Spain),

Members: M. Burton (Australia), Y. Fukui (Japan), G. Garay (Chile), T. Henning (Germany), S. Lizano (Mexico), F. Palla (Italy), B. Reipurth (USA), A. Sargent (USA), & S. Strom (USA).

Liasing Members: Division IV: L. Cram (Australia), Div VII: J. Palous (Czech Republic)

4. MAJOR SCIENTIFIC CONFERENCES 1997 - 1999

The Division sponsored the following meetings in the period 1997-99: IAU Symposium 193 on "*Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies*", Puerto Vallarta, 3-7 November 1998. Proceedings published 1999, ASP (ISBN: 1-58381-004-8), eds Karel A. van der Hucht, Gloria Koenigsberher & Phillippe R. J. Eenens and IAU Symposium 190 on "*New Views of the Magellanic Clouds*" 13-19 July 1998, Victoria, Canada. In addition, it sponsored the IAU Colloquium 166 on "*The Local Bubble and Beyond*" (1997), Ed. D. Breitschweidt, Lecture Notes in Physics, 506, Springer Verlag (ISBN: 3540643060).

In the general subject area of the ISM there were conferences on "*The Formation and Evolution of Solids in Space*" (NATO ASI Series. Series C, Mathematical and Physical Sciences, No. 523.), 1998 Eds. J. Mayo Greenberg & Aigen Li, Kluwer: Dordrecht, ISBN: 0792354745, on "*Prospects for the AAO/UKST Southern Sky H α Survey*", eds. M. Storey, Q.Parker and S. Phillipps, Publications of the Astronomical Society of Australia, Vol. 15, (1997), (Sydney, Australia, Anglo-Australian Observatory, 16-18 April 1997), "*The ORION Complex Revisited*", ed. M.J. McCaughrean and A. Burkert, San Francisco, ASP Conference Series, 1998, in press (Munich, Tegernsee, Germany, Ringberg Castle, 2 - 6 June 1997), "*Interstellar Turbulence*", ed. J. Franco and A. Carraminana, Cambridge Contemporary Astrophysics, Cambridge University Press 1999, ISBN 521 65131 X (hard-back), "*The Physics and Chemistry of the Interstellar Medium*", the proceedings of the 3rd Cologne-Zermatt Symposium, ed. G. Winnewisser, J. Stutzki, and V. Ossenkopf, Aachen: Shaker-Verlag, 1999, in press (Zermatt, Switzerland, September 22-25, 1998), and "*Origins*", 1998, eds. C.E. Woodward, J.M. Shull, and H.A. Thronson, ASP Conference Series, vol. 148.

In the field of star formation the major conferences have been IAU "*Star formation with the ISO satellite*", 1998, eds. J. Yun and R. Liseau, ASP, vol. 132, "*Protostars and Planets IV*", eds. V. G. Mannings, A. P. Boss, and S. S. Russell, Univ. Arizona Press, (from the conference at Santa Barbara, CA, held July 6-11, 1998). A conference sponsored by the National Astronomical Observatory of Japan on "*Star Formation*", was held 1999 June 21 - June 25, 1999 at Nagoya University.

Infrared and millimetre aspects of the ISM were covered by the following conferences: "*The far-infrared and submillimetre universe*", 1997, ESA SP-401 (ESTEC, Noordwijk), "*The Universe as seen by ISO*", eds. P. Cox and M. Harwit, ESA-SP 427 (Estec, Noordwijk), "*Solid interstellar matter: the ISO revolution*", 1999, eds. L. d'Hendecourt, C. Joblin and A. Jones, Centre des Physique des Houches no. 11 (Berlin: Springer) and "*Diffuse Infrared Radiation and the IRTS*" (1997) eds. H.Okuda, T. Matsumoto and T.L. Roellig which appeared in Astronomical Society of the Pacific Conference Series V124.

The field of astrochemistry has been particularly well-served, with conferences on "*The Molecular Astrophysics of Stars and Galaxies*", 1998, eds. T.W. Hartquist and D.A. Williams (Oxford University Press), "*Chemistry and physics of molecules and grains in space*", 1998, Faraday Discussions, volume 109 (London: Royal Society of Chemistry), "*Molecular hydrogen in the early Universe*", 1998, eds. E. Corbelli, D. Galli and F. Palla, *Memorie della Societa Astronomica Italiana*, vol. 69, "*Formation and evolution of solids in space*", 1999, ed. J.M. Greenberg and A. Li (Kluwer, Dordrecht), "*Laboratory astrophysics and space research*", 1999, eds. P. Ehrenfreund, C. Craft, H. Kochan and V. Pirronello, *Astrophysics and Space Science Library*, V.236 (Dordrecht: Kluwer) and "*Astrochemistry: from molecular clouds to planetary systems*", in press eds. Y. Minh and E.F. van Dishoeck (ASP Conference Series).

Conferences which dealt with the interstellar Medium in galaxies were "*The Interstellar Medium in Galaxies*" (1997) Ed. J. M. Van Der Hulst, *Astrophysics and Space Science Library*, V219, Kluwer: Dordrecht; ISBN: 0792346769, "*Abundance Profiles: Diagnostic Tools for Galaxy History*", eds. D. Friedli, M. Edmunds, C. Robert, and L. Drissen, San Francisco: Astronomical Society of the Pacific Conference Series, 1998, Vol 147, "*When and how do bulges form and evolve?*", ed. Marcella Carollo, Cambridge University Press,

in press (1999) (Baltimore, Maryland, Oct 5-7, 1998) and *"The Evolution of Galaxies on Cosmological Timescales"*, ed. J.E. Beckman and T.J. Mahoney, ASP Conference Series, San Francisco, 1999, in press (Puerto de la Cruz, Canary Islands, Spain, November 30 - December 5, 1998).

5. MAJOR PUBLICATIONS 1997 - 1999

In the reporting period, three new textbooks on the ISM have been published. These are the second edition of Dyson, J.E. & Williams, D.R. *"The Physics of the Interstellar Medium"*, (Institute of Physics Publications: Bristol), ISBN: 075030460X; a reprinting of the classical book by Lyman Spitzer: *"Physical Processes in the Interstellar Medium"* (Wiley Classics Library Editions) 1998, John Wiley & Sons; ISBN: 0471293350 and a nice little monograph: *"The astrochemical evolution of the interstellar medium"*, 1997, by Emma L.O. Bakes, Vliedder: Twin Press, ISBN 90-5598-002-1 (hard) or 90-5598-003-X (paper).

Two major reviews have been: *"Photodissociation regions"*, by D. Hollenbach and A.G.G.M. Tielens, 1997, Ann. Rev. Astr. Astrophys. 35, 179 and *"Chemical evolution of star-forming regions"*, by E.F. van Dishoeck and G.A. Blake, 1998, Ann. Rev. Astron. Astrophys. 36, 317-368.

6. SOURCES OF FURTHER INFORMATION

The Star Formation Newsletter at: www.eso.org/gen-fac/pubs/starform/ is a monthly electronic publication which provides abstracts of recently accepted papers in the field of star formation, molecular clouds and the interstellar medium. Other useful newsletters relating to the ISM are the *Hot Star Newsletter* maintained by Phillipe Eenens at: www.astro.ugto.mx/~eenens/hot/, the *AGB Newsletter* produced by Claudine Kahane & Thierry Forveille at www-laog.obs.ujf-grenoble.fr/heberges/agnnews/agnnews.html, the *Magellanic Clouds Newsletter* put out by Eva Grebel and You-Hua Chu at: www.astro.uiuc.edu/projects/mcnews/MCNews.html (for US readers) or: www.astro.uni-bonn.de/~mcnews for the European region. Finally, the *Active Galaxies Newsletter* edited by Matthew Redman and which can be found at www.ast.man.ac.uk/~mpr/agn/ often contains items of interest to the ISM community.

An general search area for astrochemistry is maintained by the Astrochemistry Working Group of the Division at: www.strw.leidenuniv.nl/~iau34/. This contains links to a list of molecules detected in space, molecular gas-phase spectroscopy data-bases, chemical kinetics and reaction rates databases, solid-state databases (ices, silicates), observational facilities and astrochemistry groups world-wide. In Atomic physics we refer the reader to the database for radiative transition rates & energy levels for atomic spectral lines at: physics.nist.gov/PhysRefData/ASD1/, or to search for lines in a specific wavelength region see: physics.nist.gov/cgi-bin/AtData/lines_form.

A number of useful catalogs are maintained on the web. Dave Green's catalogue of *"Galactic Supernova Remnants"* is at: www.mrao.cam.ac.uk/surveys/snrs/, *"A General Catalogue of Herbig-Haro Objects"* is maintained at: casa.colorado.edu/hhcat. This is a complete list of all known Herbig-Haro objects, with coordinates, extensive notes and a full list of references to the literature for each object. The catalogue, which is now in its second edition, will be updated approximately once a year. Finally the *"The Herbig-Bell Catalogue"* at: www-astro.phast.umass.edu/catalogs/HBC/HBC.html lists coordinates, information and references to the literature on 735 pre-main sequence stars. Finally, a complete database on upcoming international astronomy meetings is to be found at: cadwww.dao.nrc.ca/meetings/meetings.html.

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