

Name of research institute or organization:

**I. Physikalisches Institut, Universität zu Köln,
Radioastronomisches Institut, Universität Bonn**

Title of project:

KOSMA - Kölner Observatorium für Submm-Astronomie

Project leader and team:

Prof. Dr. Jürgen Stutzki, project leader

Dr. M. Miller, station manager

Universität zu Köln: M. Brüll, H. Jakob, Dr. U.Graf, PD Dr. C. Kramer, Dr. B. Mookerjea, PD Dr. V. Ossenkopf, Dr. M. Röllig.

Universität Bonn: Prof. Dr. U. Mebold, PD Dr. A. Heithausen, C. Böttner, Dr. C. Brüns, P. Müller, J. Pineda, Dr. S. Stanko, T. Westmeier.

Project description:

The large scale distribution, physical and chemical conditions of the interstellar matter

The central topic is the spectrally resolved observation of the global distribution of the interstellar matter in the Milky Way and nearby external galaxies, using the important mm-, submm-lines of CO (and its isotopomers), and atomic carbon ([CI] 492 and 809 GHz. These observations have been carried out with the KOSMA 3m-telescope. Two SIS receivers were used, a dual channel receiver operating at 230 GHz and 350 GHz, and the dual frequency array receiver SMART which allowed a series of successful observations of both [CI]-lines simultaneously and the transitions CO(4-3), (7-6), and ¹³CO(8-7).

Observations were done in L1457, DR21, W3 Main, W75, W51, MBM32, Cepheus B, Rosette, TMC1, IRAS sources, HH objects and other sources, in the Cygnus X region, in the Draco region, IVCs, HVCs, and in the galactic plane near $l=45^\circ$ (galactic ring survey).

Long-term observations at KOSMA:

Institute	Project name	Status
1. Physikalisches Institut, Universität zu Köln	KOSMA survey of molecular clouds in the Galactic Ring	An area of $\sim 1.4^\circ \times 1.4^\circ$ has been mapped.
1. Physikalisches Institut, Universität zu Köln, Observatoire Bordeaux	Cygnus X survey	4 square degrees have been finished.
1. Physikalisches Institut, Universität zu Köln	High mass star forming regions	DR21 has been finished, we need ¹³ CO 8-7 observations, W3 observed in CO 4-3, 7-6, [CI] 1-0, 2-1
1. Physikalisches Institut, Universität zu Köln	Infrared dark clouds in the galactic ring	Observations in CO 2-1, 3-2.
1. Physikalisches Institut, Universität zu Köln	Cepheus B	To be continued

Institut für Radioastronomie, Universität Bonn	Interplay between turbulence and gravity in dense cirrus cloud cores	6 cores mapped in $^{12/13}\text{CO}3-2$ and 2-1, [CI] detected in all cores, 2 cores mapped in [CI]
Institut für Radioastronomie, Universität Bonn	Search for molecular gas in intermediate velocity clouds (IVC) and high velocity clouds (HVC)	$^{12/13}\text{CO} 3-2, 2-1$ observations in IVCs, [CI] detected in 2 clouds, marginal detection of CO in HVCs
Institut für angewandte Physik, Universität Bern, Switzerland	Solar flares in the submm range	Ongoing ; the most intense flare of the last years could be observed in Oct 2003.
Observatoire Bordeaux, 1. Physikal. Institut, Universität zu Köln	Rosette	First [CI] lines in Nov. 2003
University Johannesburg, South Africa	High mass star formation in low mass clouds	Several clouds were observed in low-J CO lines.
University Seoul, Korea	Supernova remnants	IC443 and Tycho finished in $^{12}\text{CO}2-1, 3-2$
SRON	IRCDs in W51	First observations
Astronomy Department, Peking University	Outflows in IRAS point sources	Some $^{13}\text{CO}2-1$ data missing
Astronomy Department, Peking University	Energy sources of HH objects	Finished
MPIfA Heidelberg,	C^{18}O in TMC1	15 position measured

In the following, we will briefly present two of our projects to highlight the science being done at the KOSMA telescope.

1) Multiwavelengths survey of the Cygnus X complex:

In order to probe the processes by which rich clusters and high-mass stars form, the most active nearby Giant Molecular Clouds need to be studied in different wavelengths. Observations of molecular lines (in particular CO isotopomers) yield important clues to the excitation conditions, the kinematics and the

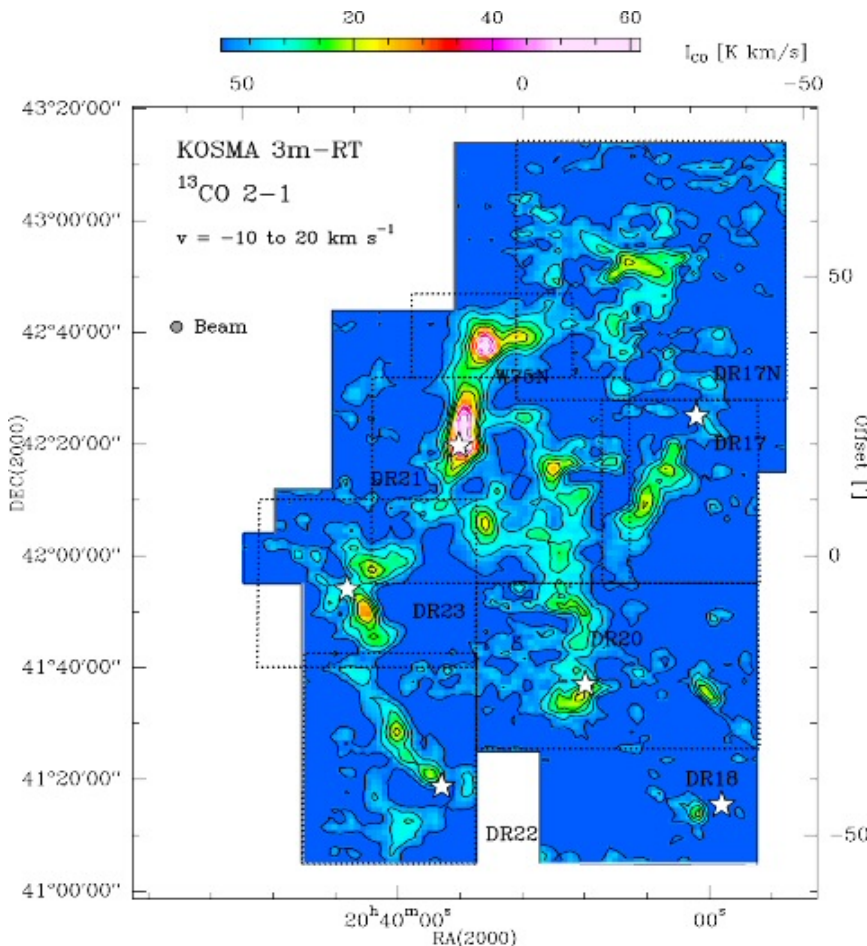


Fig. 1: This Cygnus X map in the $^{13}\text{CO}(2-1)$ rotational transition in-

cludes all observations up to Dec. 2003.

chemistry of star formation sites in the clouds. A region of $\sim 2 \times 2 \text{ deg}^2$ has been surveyed at KOSMA in the ^{13}CO 2-1 and 3-2 lines at $120''$ and $80''$ angular resolution. We have started to study individual regions in more detail. The DR21 region was mapped in CO 4-3 and 7-6, as well as in [CI] 1-0 and 2-1 using the 8 pixel array receiver SMART. We have also started to study W75. These data will be combined with ISO/LWS and KAO data.

2) The photon dominated region W3 Main:

The W3 complex is a massive star forming region in the Perseus arm at the rim to a Giant Molecular Cloud complex. This region shows many evidences of massive star formation, such as maser and outflow sources, associated NH_3 emission, and dense molecular clouds. Observations of the core region W3 Main show high ^{13}CO and [CI] column densities corresponding to a total mass of $\sim 5 \times 10^3$ solar masses. Our observations of W3 Main are covering a region of $360'' \times 220''$. We observed the two [CI] fine structure lines and in the ^{12}CO 4-3 and 7-6 rotational lines and in the ^{13}CO 8-7 line at 881 GHz, which was the highest frequency observed until now with the SMART receiver on Gornegrat. We have included ISO/LWS observations of the FIR lines of CII, OI, and high-J CO to improve on our analysis of the excitation conditions. The submm line observations were done in Dual-Beam-Switch mode with $6'$ chop throw in azimuth. Additional large scale observations at low-J CO transitions were done in On-The-Fly mode with the dual channel 230/345 GHz SIS receiver.

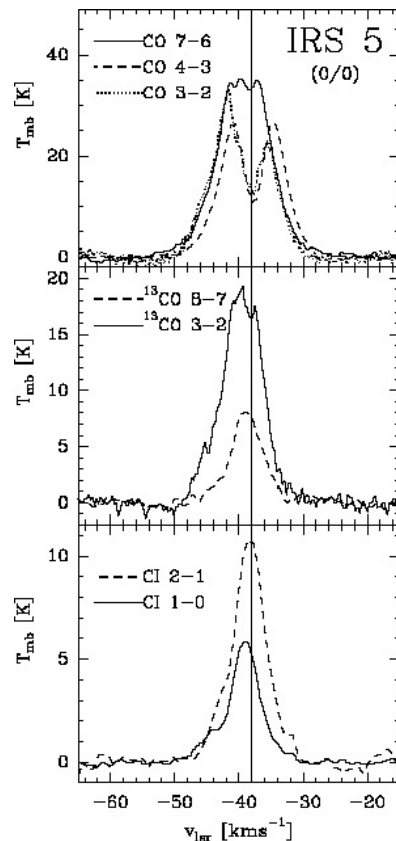


Fig. 2: Spectra of the CO- and [CI] transitions at the position of IRS5 in W3.

Key words:

Interstellar matter, ISM, PDR, millimeter, submillimeter wave telescope, SIS receiver, array receiver

Internet data bases:

<http://www.ph1.uni-koeln.de/gg>
<http://www.astro.uni-bonn.de/~webrai/index.php>

Collaborating partners/networks:

MPI für Radioastronomie Bonn, Institut für angewandte Physik, Universität Bern, Center of Astrophysics, Boston, USA, Observatoire de Bordeaux, Astronomy Department Peking University, China, Potchefstroom University, South Africa.

Scientific publications and public outreach 2003 (KOSMA relevant papers only):

Refereed journal articles

Bensch, F., Leuenhagen, U., Stutzki, J., Schieder, R. [CI] 492 GHz Mapping Observations of the High-Latitude Translucent Cloud MCLD 123.5+24.9, *Astrophys. Journal* **591**, 1013, 2003

Hafok, H., Stutzki, J., $^{12}\text{CO}(J=2-1)$ and $\text{CO}(J=3-2)$ observations of Virgo Cluster spiral galaxies with the KOSMA telescope: Global properties, *Astron. & Astrophys.* **398**, 959, 2003

Schneider, N., Simon, R., Kramer, C., Kraemer, K., Stutzki, J., Mookerjea, B., A multiwavelength study of the S 106 region. II. Characteristics of the photon dominated region, *Astron. & Astrophys.* **406**, 915, 2003

Conference papers

Graf, U. U., Heyminck, S., Michael, E. A., Stanko, S., Honingh, C. E., Jacobs, K., Schieder, R. T., Stutzki, J., Vowinkel, B., SMART: The KOSMA Sub-Millimeter Array Receiver for Two frequencies, *SPIE*, **4855**, 322, 2003.

Miller, M., Graf, U. U., Kinzel, R., Kramer, C., Lettau, M., Stenvers, K., Stutzki, J., Photogrammetric surface measurement of the KOSMA 3m-Telescope, *SPIE*, **4855**, 594, 2003.

Jakob, H., Simon, R., Kramer, C., Mookerjea, B., The Carbon content in the Galactic Cygnus X/DR21 star forming region, in " Proceedings of the 4th Cologne-Bonn-Zermatt-Symposium", ed. S. Pfalzner, C. Kramer, C. Straubmeier, and A. Heithausen (Springer Verlag), held September 22-26, 2003, in Zermatt, Switzerland, (in press).

Kramer, C., Jakob, H., Mookerjea, B., Schneider, N., Brüll, M., Simon, R., Stutzki, J., CII, CI, and CO in the massive star forming region W3 Main, in " Proceedings of the 4th Cologne-Bonn-Zermatt-Symposium ", ed. S. Pfalzner, C. Kramer, C. Straubmeier, and A. Heithausen (Springer Verlag), held September 22-26, 2003, in Zermatt, Switzerland, (in press).

Van der Walt, D.J., Nyambuya, G., Kramer, C., Holleran, M., Butner, H., High mass stars associated with lower mass molecular clouds, in " Proceedings of the 4th Cologne-Bonn-Zermatt-Symposium", ed. S. Pfalzner, C. Kramer, C. Straubmeier, and A. Heithausen (Springer Verlag), held September 22-26, 2003, in Zermatt, Switzerland, (in press).

Address:

1. Physikalisches Institut
Universität zu Köln
Zülpicher Str. 77
D-50937 Köln

Radioastronomisches Institut
der Universität Bonn
Auf dem Hügel 71
D-53121 Bonn

Contacts:

Jürgen Stutzki (observatory director)
Tel.: +49 221 470 3494
Fax: +49 221 470 5162
e-mail: stutzki@ph1.uni-koeln.de
e-mail: miller@ph1.uni-koeln.de
URL: <http://www.ph1.uni-koeln.de>
<http://www.astro.uni-bonn.de>

Martin Miller (station manager)
Tel.: +49 221 470 3558
Fax: +49 221 470 5162
e-mail: miller@ph1.uni-koeln.de