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 $^{13}$CO(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° (galactic ring survey).

Long-term observations at KOSMA:

<table>
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<tr>
<th>Institute</th>
<th>Project name</th>
<th>Status</th>
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<tbody>
<tr>
<td>1. Physik. Institut, Universität zu Köln</td>
<td>KOSMA survey of molecular clouds in the Galactic Ring</td>
<td>An area of $\sim$1.4°x1.4° has been mapped.</td>
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<tr>
<td>1. Physik. Institut, Universität zu Köln, Observatoire Bordeaux</td>
<td>Cygnus X survey</td>
<td>4 square degrees have been finished.</td>
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<tr>
<td>1. Physik. Institut, Universität zu Köln</td>
<td>High mass star forming regions</td>
<td>DR21 has been finished, we need $^{13}$CO 8-7 observations, W3 observed in CO 4-3, 7-6, [CI] 1-0, 2-1</td>
</tr>
<tr>
<td>1. Physik. Institut, Universität zu Köln</td>
<td>Infrared dark clouds in the galactic ring</td>
<td>Observations in CO 2-1, 3-2.</td>
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<tr>
<td>1. Physik. Institut, Universität zu Köln</td>
<td>Cepheus B</td>
<td>To be continued</td>
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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 $^{13}$CO(2-1) rotational transition in-](image-url)
includes all observations up to Dec. 2003.

chemistry of star formation sites in the clouds. A region of ~2x2 deg² has been surveyed at KOSMA in the 13CO2-1 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 NH₃ emission, and dense molecular clouds. Observations of the core region W3 Main show high 13CO and [CI] column densities corresponding to a total mass of ~5x10³ solar masses. Our observations of W3 Main are covering a region of 360”x220”. We observed the two [CI] fine structure lines and in the 12CO 4-3 and 7-6 rotational lines and in the 13CO 8-7 line at 881 GHz, which was the highest frequency observed until now with the SMART receiver on Gornergrat. 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**


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


**Conference papers**


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
URL: http://www.ph1.uni-koeln.de
http://www.astro.uni-bonn.de