Name of research institute or organization:

I. Physikalisches Institut, Universität zu Köln

Title of project:

KOSMA

Project leader and team:

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Dr. C. Kramer, Dr. S. Jeyakumar , Dr. B. Mookerjea, M. Brüll, H. Jakob

Project description:

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

High spectral resolution observations where done with the KOSMA telescope and other telescopes in S106, in some regions of the galactic ring, in Cepheus B, and in the Orion region. These sources were observed in the transitions of ^{12}CO(3→2), (2→1), ^{13}CO(3→2), (2→1), and some in ^{12}CO(7→6) and CI (1→0), (2→1). Multi-line-analysis was done to get more information about heating and cooling mechanisms in these clouds.

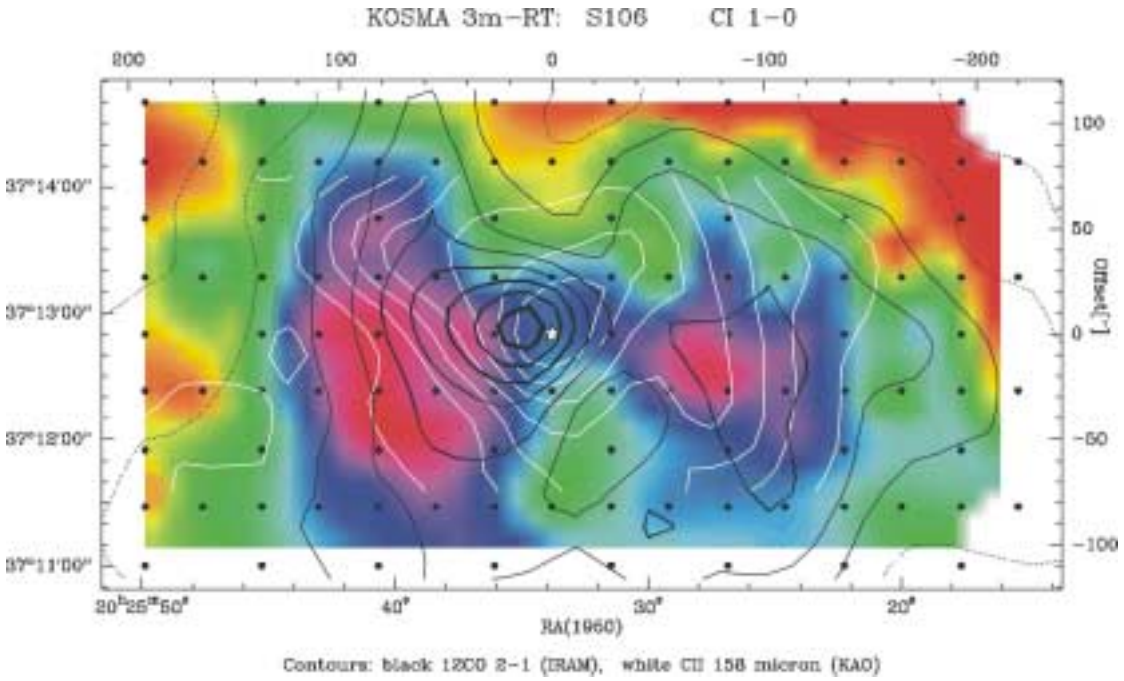

Figure 1: The star forming region S106. The colorized map of the integrated intensities of the line radiation of atomic Carbon [CI] shows two peaks east and west of the map center. The ^{12}CO (2→1) intensities (black contours) and the radiation of the ionizised atomic Carbon [CII] (white contours) are well correlated to each other and to the position of the exciting star (white star). The CI-measurements were done with the new KOSMA receiver SMART.

The KOSMA Galactic Ring observations:

This ongoing project, the KOSMA Galactic Ring multiline and -molecular observations, started in autumn 1999 in collaboration with the Boston University. It is based on on-the-fly observations of a 0.25 deg^2 extended region around the Galactic position l=45.0 / b=0.0deg. Using the KOSMA dual-frequency receiver we currently implement on a 30 arcsec grid otf-maps of the CO (3→2) and ^{13}CO (2→1) low-J transitions. In addition a multi-transitions- and chemistry-survey at selected positions is currently implemented.

Interstellar matter and massive stars

In this project we study the influence of the UV radiation field of massive stars to the surrounding molecular clouds. Because of the intense UV radiation a photon dominated region (PDR) is formed where we can observe the fine structure lines of atomic Carbon and the rotation transition lines of CO. With the new array receiver SMART we can measure the relative line strenghts of CI(1→0) and CI(2→1) simultanously with a very good calibration accuracy. This gives us informations about physical parameters in the clouds: temperature and density. Observations were done e.g. in the W3 giant molecular cloud.

Structure of interstellar clouds

In molecular clouds we observe a very complex structure related to the star forming process. We try to understand the formation of these fractal structures with simulations of numerical models comparing the observed line intensities of molecular transitions with the predicted intensities of the model. The models were tested with large maps of the Polaris flare, the S106 region, S140, W3, and of the Orion starforming regions: BN/KL, NGC1977, NGC2024, NGC2068, Orion Bar. These sources were observed with the KOSMA telescope in the transitions of ^{12}CO, ^{13}CO, J=2→1 and J=2→1.

Study of the structure and chemistry of galactic cirrus clouds

For this project of the Radio Astronomical Institute of the University of Bonn we made observations of ^{12}CO (3→2), (2→1) in the Draco Nebula and in several IVC's. The observations will be continued in the next winter period with measurement in ^{12}CO (4→3) and inCI(1→0).

SMART, the new Sub-Millimeter Array Receiver for Two Frequencies

The new dual frequency SIS array receiver SMART is operational since September 2001 at the KOSMA 3 m telescope on Gornergrat. The receiver consists of two 2x4 pixel subarrays. One subarray operates at a frequency of 490 GHz, the other one at 810 GHz. Both subarrays are pointed at the same position in the sky. We can thus observe eight spatial positions in two frequencies simultaneously. For the first year of operation we installed only one half of each subarray, i.e. one row of 4 mixers at each frequency. This is worldwide the first two frequency channel array receiver. It allows the observation of the two astrophysical important transitions of CI (1→0) and CI (2→1) simultaneously. We can thus measure the relative intensity of the two lines with a very high accuracy.

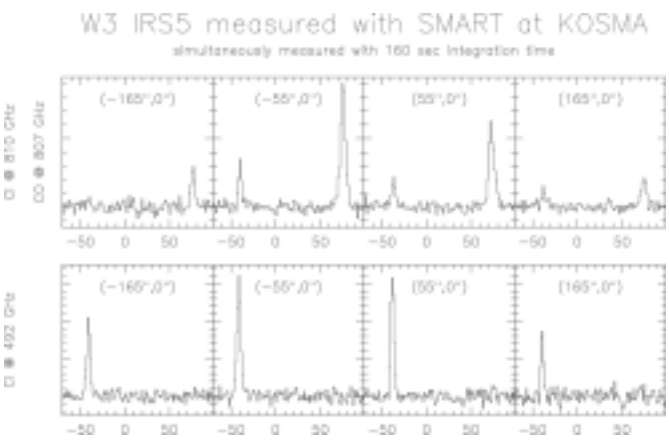

Figure 2: Sample spectra obtained simultaneously toward W3 IRS5 during a single 160 sec integration with SMART at the KOSMA telescope. The lower row of panels shows the 492 GHz fine structure transition of neutral atomic carbon (CI) at v_{lsr}≈-40 km/s, the upper row shows the 810 GHz fine structure line of CI and the 807 GHz J=7→6 transition of CO from the other sideband (at an apparent v_{lsr}≈75 km/s).

A project in collaboration with the University of Bern: Observation of Solar flares in the Submillimeter range with KOSMA

The university of Bern operates six telescopes dedicated to solar flare monitoring at frequencies from 8.4 to 89.4 GHz. During early April 2001 additional observations at 230 GHz and 345 GHz were made using the KOSMA telescope. On April 12, a X-class flare was observed at all 8 frequencies, extending the frequency range of solar flare observations into the high millimeter- and submillimeter region which is still nearly unexplored.

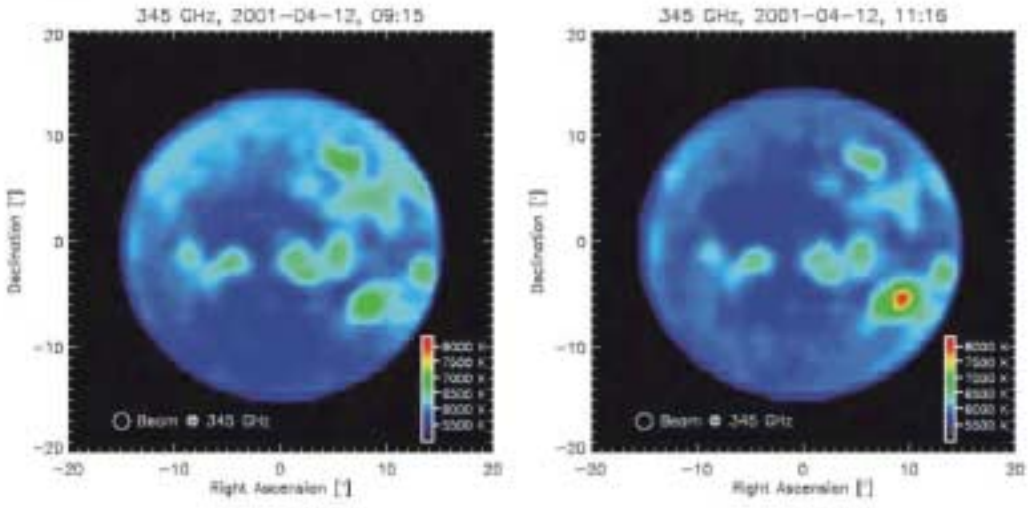

Figure 3: Unlike the patrol telescopes which cover the whole sun with their beams, KOSMA produces also spatially resolved images of the sun. This feature is used to find the most active region which will then be tracked to obtain flux time profiles simultaneously at 230 and 345 GHz. Roughly one hour before and after the flare two maps were made which clearly show a strongly increased brightness temperature following the impulsive phase of the event.

Key words

Interstellar matter, millimeter, submillimeter wave telescopes, solar flares, SIS receiver, array receiver

Collaborating partners/networks:

Astronomisches Institut der Universität Bonn; MPI für Radioastronomie Bonn; Universität Bern, Institut für angewandte Physik; Center for Astrophysics, Boston, USA

Scientific publications and public outreach 2001:

Diploma Thesis:

S. Bedorf: *Strukturanalyse von Molekülwolken am Beispiel der Sternentstehungs-region S106*, Mai 2001

A. Müller*: Kohlenstoff in Photonen-dominierte Regionen*, Juli 2001

Ph.D. Thesis:

M. Brüll: *Großräumige CO-Kartierung von Teilen des Galaktischen Rings mit KOSMA*

KOSMA relevant publications:

Bensch F., Panis J.-F., Stutzki J., Heithausen A., Falgarone E.: 2001, *The IRAM key-project: Small-scale structure of pre-star forming regions. III. Influence of and correction for the error beam pick-up*, A&A, 365, 275

Bensch F., Stutzki J., Heithausen A.: 2001, *Methods and constraints for the correction of the error beam pick-up in single dish radio observations*, A&A, 365, 285

Stutzki J.: 2001, *The structure of molecular clouds and their global emission properties*, APSS, 277, 39

Tieftrunk, A., et al., 2001, *^{13}CI in high-mass star-forming clouds*, A&A 375, L23

Tieftrunk, A., S. Thorwirth, T. Megeath, 2001, *High-Mass Stars as Early Signpost of Cluster Formation*, The Earliest Phases of Massive Star Birth, ASP Conf. Series, Boulder 2001

Wilson T. L., Muders D., Kramer C., Henkel C.: 2001, *Submillimeter CO Line Emission from Orion*, AP.J., 557, 240

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