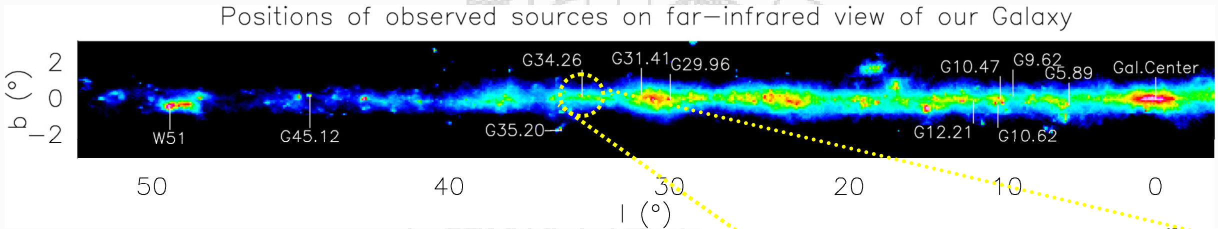
APEX Peaks into the Cradles of Massive Stars

highest angular sub-millimeter observations on the southern hemisphere

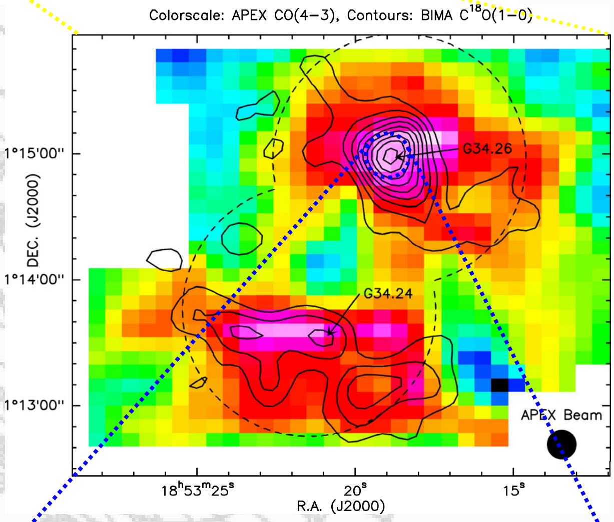
Summary:

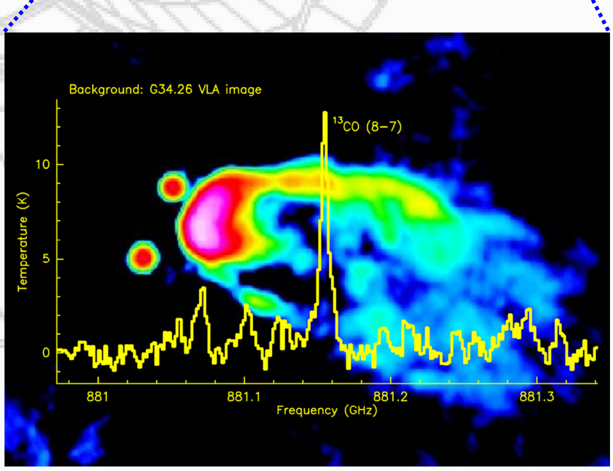
The APEX telescope took a first glimpse deep into cradles of massive star birth with its highest frequency observations so far. A high lying transition of carbon monoxide was observed toward a sample of massive star forming cores with the highest angular resolution (7 seconds of arc) on the southern hemisphere in the submillimeter achieved to date. These observations allow to constrain the dynamics and conditions during the formation of massive stars.



Massive stars:

Stars with masses more than eight times the mass of our sun have a tremendous influence on their environment – the interstellar medium: during their process of formation they are sources of luminous, bipolar outflows (see flyer on NGC6334), their strong ultraviolet and far-ultraviolet radiation fields give rise to bright ionized emission nebulae, so-called HII regions like the famous Orion Nebula, and during their whole lifetime powerful stellar winds interact with the surroundings. In the course of time, this leads to the destruction of the parental cloud. Finally, their short life ends culminating in a violent supernova explosion, injecting heavy elements into the interstellar medium and possibly triggering further star formation with the accompanying shock waves. All these points together underline the importance of understanding the formation and evolution of massive stars, since they effectively shape the appearance of whole galaxies (see flyers on APEX extragalactic astronomy).





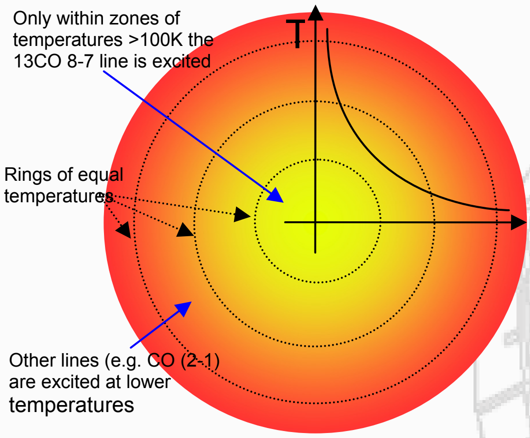
The giant molecular cloud G34:

Almost all massive star-forming regions are located in a thin disk, seen in the far-infrared view of our Galaxy (top figure, see also flyer on the ATLASGAL survey). G34.26+0.15 is a newly formed high-mass star ionizing the placental environment nearest to him (the name stands for the object's galactic coordinates). Further away, the gas remaining after its formation is still neutral and in molecular form. Using APEX to zoom in on a 3 parsec scale (9 light years), we find several intensity peaks. Their elevated temperatures mean either yet more ongoing star formation, e.g. the massive protostar G34.24) or an interaction of already formed massive stars with the molecular cloud. The contours trace in a different carbon monoxide transitions the amount of material on the line of sight. One core clearly stands out: Zooming now with the highest angular resolution for a single dish telescope on the southern hemisphere into this core at a record holding frequency of 881 GHz, the physical conditions of the inner starfoming cradle can now be derived from the spectrum shown above: a hot and dense molecular core with complex kinematics and rich chemistry, leading to the formation of even complex organic molecules, seen as the weaker lines in the spectrum.

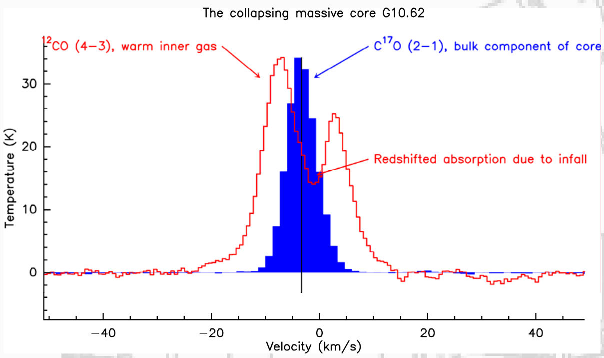
MPIfR Bonn, 14.07.05

Max-Planck-Institut
für Radioastronomie

Schematics of the temperature



The temperature within the molecular cloud is increasing towards the center. Observations of molecular lines with higher excitation temperatures (e.g. ^{13}CO 8-7) give information about the inner parts of the cloud.



Probing the dynamics of star formation:

The dynamics within the cores shows up in the observed line profiles (see Figure above on G10.62). Comparing profiles of different transitions shows the signature of infall motions due to gravitational contraction of the cores during the process of star formation. Also the signature of outflowing material is detected in many of the sources, showing the dynamical interplay between contraction and outflows, which enable through the removal of angular momentum the global collapse of the cores.

Conditions in the inner cradle:

12 massive star-forming cores in the inner Galaxy were observed in several transitions of carbon monoxide, CO (4-3), (7-6) and 13CO (8-7), and the lower fine structure transitions of atomic carbon. These new observations can then be compared to a lower lying transition of carbon monoxide, C17O (2-1), observed with the 30m telescope on Pico Veleta, Spain. The 13CO (8-7) line at 881 GHz was detected in each of the observed massive star forming cores, revealing the very dense and hot conditions in their central parts where star formation takes place. Spectra are shown in the lower figure. Temperatures and densities of the molecular gas, as well as the structure of the cores, can be derived from the observed intensity ratios of the lines.