Chemical evolution of Bok globules - CCS and NH_3

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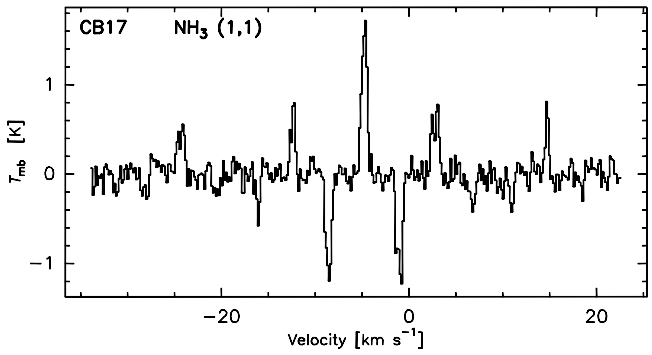
Relatively small and isolated molecular clouds, commonly referred to as Bok globules, are characterized by cold, dense cores. These clouds may form single or few low-mass stars or may not form stars at all. Because of the relatively simple structure (in contrast to e.g. giant molecular clouds), globules have been recognized as particularly suitable targets for a study of isolated star formation. The evolution of such clouds is accompanied by complex chemical processes, and an investigation of the molecule properties can give information about the physical conditions of the environment in which stars form.
The radical CCS was found to be abundant in quiescent dark cloud cores, but not in starforming regions. In contrast, NH_3 tends to be more abundant in clouds with ongoing star formation; this fact is supposed to be the result of different production pathways and timescales (Suzuki et al. 1992). Therefore, the CCS/NH_3 abundance ratio was proposed to be a possible indicator of the age and evolutionary stage of globules (van Dishoeck & Blake 1998).

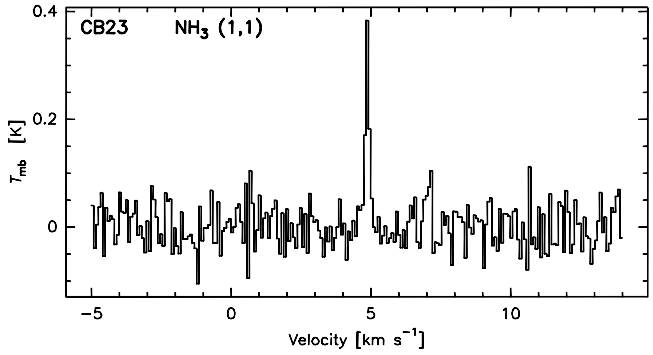
In this project the CCS abundance of a larger sample of globules in four different evolutionary groups (characterized by Launhardt & Henning 1997) will be analyzed and compared with NH_3 measurements available in the literature (Lemme et al. 1996), as well as with other indicators for the star formation process (e.g. infrared colours, presence of molecular outflows). Therefore, a sample of 22 Bok globules has been observed in the CCS (2_1-1_0) line at 22.344 GHz using the Effelsberg 100m Radio Telescope. For the globules CB6, CB17 and CB222 additional observations in the NH_3(1,1) and (2,2) lines have been carried out. While all of the globules show NH_3(1,1) emission, CCS was detected only in half of the cases. Depending on the evolutionary stage CCS has been detected in:

- 60% of the globules being quiescent cores without any internal infrared sources
- 66% of the globules being pre-protostellar cores with weak (or cold) infrared sources
- 50% of the globules being protostellar, star-forming cores, and
- 0% of the globules with internal infrared sources being candidates for evolved young stars.

The derived total column densities of CCS lie in the range of $\sim$ 1.0 and 3.5 x 10^{12}cm^{-2}. Line widths vary from 0.14 to 0.51 km/s ($\pm$ 0.04 km/s) and quiescent globules without any signs of current star formation tend to show particularly narrow lines. Our preliminary result supports in general the proposal that the ratio CCS/NH_3 is an indicator of the chemical evolution during star formation in isolated cloud cores.



Ammonia spectrum of the globule CB17 obtained in Effelsberg; the hyperfine structure is clearly visible.



CCS spectrum for the quiescent globule CB23, the FWHM of the emission line is only 0.16 $\pm$ 0.03 km/s.