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Detection of Class I Methanol Masers in some IRDCs at 44 GHz with 20-m Onsala Radio Telescope

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One of the most important and informative phenomenon accompanying star formation process is molecular maser emission. Interstellar masers, formed on different molecules such as water vapor H_2O, hydroxyl OH, methanol CH_3OH, indicate the conditions that give rise to it, and therefore trace different stages of star formation. Class I methanol masers (cIMM) are believed to accompany the earliest phase of star evolution [1]. However, cIMM are much less common than H_2O and class II methanol masers (cIIMM). One of the reasons is that cIMM are formed under purely collisional pumping provided by a shock wave front of a bipolar outflow from a forming protostellar object in the "pre-UCHII" stage. cIIMM occur under collisional-radiative pumping, which is due to radiation from the nearby UCHII region. Moreover, cIMM and cIIMM are incompatible with each other, so cIMM are located far away from cIIMM and UCHII, as well as from other types of masers suggesting their earlier stage of occurrence [2].

Nevertheless, cIMM searching surveys have been performed so far in the direction of known star formation regions, and usually other types of masers and UCHII have already been detected in these sources. Detection of cIMM in such cases means that a suitable molecular nucleus, sufficiently distant from the UCHII zone, got into the diagram of the telescope occasionally. In the present work we used other criteria to search for regions of formation of massive stars – searching for cIMM in molecular cores in regions located far away from UCHII or not containing those. It is known that such areas include IRDC/SDC clouds, in which there are indications of gas perturbed by a shock wave, the presence of which may be a necessary condition for the occurrence of cIMM. Thus, identification of such structures (EGOs – Extended Green Objects) with cIMM was demonstrated in [3, 4]. In [3] it was also concluded that there are two types of molecular cores – "active" cores which have smaller sizes, higher densities, and more pronounced water and methanol maser activity and "quiescent" cores which are in an earlier evolutionary state than the "active" cores.

We selected a sample of 34 sources in IRDCs containing both types of cores, active and quiescent, and observed them at 44 GHz with Onsala 20-m radio telescope. In 28 of 34 sources methanol maser emission at 44 GHz was detected. 14 sources were known to have cIMM at other frequencies, but detected at 44 GHz for the first time, and new cIMM was discovered in 5 IRDCs. Also we have started to observe our sample at 85 GHz in the lines of methyl acetylene CH3CCH in order to get a value of kinetic temperature in the emitting region. Since in Onsala there is an opportunity to observe at 85 and 97 GHz bands simultaneously, we will also observe in thermal lines of methanol at 97 GHz and get estimates of density in the regions of emission. This part of our work is in progress now.

References

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