THE EXCITATION MECHANISM WITHOUT INVERSION FOR INTERSTELLAR CLASS II 107GHz METHANOL MASERS

HANPING LIU and JIN SUN, *Department of Physics, Beijing Normal University, Beijing 100875, China*.

Dozens transitions of interstellar methanol masers have been found toward star-forming regions so far. All methanol masers sources can been divided into two classes. These two Maser sources are distinctive. Their excitation mechanism has become a puzzle up to now. We notice that the interstellar 107GHz methanol masers are always associated with 4.77GHz OH masers and coexist toward ultracompact H II regions. Both masers appear to be spatially coincident, covering similar velocity ranges. Those remind us a model for lasers without population inversion. That was a three-level ladder system with coherent pumping proposed by Prasad [a]. We argue that the energy levels of methanol 4_0^+, 3_1^+, and 3_1^- consist of a three-level ladder system with coherent pumping for gain without inversion. This conclusion has been verified by through calculating the equations of motion for density matrix in the rotating frame. In interstellar H II region, the strong thermal emission of central star populates fairly the excitation levels of methanol molecule and the 107 and 4.77GHz masers are associated well each other. The 4.77GHz OH masers drive strongly 3_1 doublet. Those create the 3_1 $4_0 A^+$ methanol masers without inversion. We propose that the excitation mechanism and physical conditions of interstellar methanol masers might be different from each other. In compact H II regions, the radiation processes are likely to be a main source of pumping energy of methanol masers. Furthermore, we argue that the mechanism we proposed here is associated with astrophysical conditions. The bright future can be predicted.

[a] G. Prasad, and G. Agarwal, Optics Comm. 86, 409 (1991)