6 CM OH ABSORPTION IN MEGAMASER GALAXIES

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Absorption in the $^2\Pi_{1/2}$ J = 1/2 Λ doublet transitions of OH, 182 K above the ground state, is detected in the megamaser galaxies IC 4553 (Arp 220), MK 231, MK 273, NGC 3690, and IRAS 17208-0014. The 4660, 4751, and 4766 MHz lines have intensity ratios moderately deviating from the LTE values (1:2:1). The OH rotational temperatures appear to be close to the temperature of the dust, ~60 K. The common characteristics of these galaxies (absence of 6 cm inversion, the optical depths, the infrared properties, the systematic trends in the line parameters, and the rotational temperatures) all suggest that the same pump process is responsible for the 18 cm line inversion in the five megamaser sources. The inversion is probably not due to an excitation mechanism involving collisions with HI or H_2. While excitation via photodissociation of H_2O cannot entirely be ruled out, we consider the most likely mechanism to be a combination of the intense FIR field (populating higher excited OH rotational states) and the non-thermal radiation from the nuclei of the parent galaxies (affecting the excitation within the Λ-doublets). According to an LVG model of the OH excitation of IC4553, the OH-cloud(s) have to be located close, within 200-300 pc, to the center of the galaxy. The excitation of the individual 18 cm lines depends critically on the effective background radiation field and hence on the galactocentric distance of the masing clump. With increasing distance first the 1720 MHz and then the 18 cm main line inversion is quenched, while 1612 MHz inversion is obtained up to ~600 pc. The 1612 MHz satellite line is predicted to be more intense than the 1720 MHz line. A critical test for our excitation model is to observe the $^2\Pi_{3/2}$ J = 5/2 Λ-doublet transitions which are predicted to be detectable in absorption.

A more detailed discussion of the data and their interpretation is given in Astron. Astr. (in press).