CENTRAL 300 PC OF THE GALAXY PROBED BY THE INFRARED SPECTRA OF H_3^+ AND CO: I. PREDOMINANCE OF WARM AND DIFFUSE GAS AND HIGH H_2 IONIZATION RATE

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A low-resolution 2.0-2.5 μm survey of $\sim$500 very red point-like objects in the Central Molecular Zone (CMZ) of our Galaxy, initiated in 2008, has revealed many new bright objects with featureless spectra that are suitable for high resolution absorption spectroscopy of H_3^+ and CO.[a] We now have altogether 48 objects mostly close to the Galactic plane located from 142 pc to the west of Sgr A* to 120 pc east allowing us to probe dense and diffuse gas by H_3^+ and dense gas by CO. Our observations demonstrate that the warm ($\sim$250 K) and diffuse ($\leq$100 cm^{-3}) gas with a large column length ($\geq$30 pc) initially observed toward the brightest star in the CMZ, GCS3-2 of the Quintuplet Cluster,[b] exists throughout the CMZ with the surface filling factor of $\sim$ 100% dominating the region.

The column densities of CO in the CMZ are found to be much less than those in the three foreground spiral arms except in the directions of Sgr B and Sgr E complexes and indicate that the volume filling factor of dense clouds of 10% previously estimated is a gross overestimate for the front half of the CMZ. Nevertheless the predominance of the newly found diffuse molecular gas makes the term "Central Molecular Zone" even more appropriate. The ultra-hot X-rays emitting plasma which some thought to dominate the region must be non existent except near the stars and SNRs.

Recently the H_2 fraction $f(H_2)$ in diffuse gas of the CMZ has been reported to be $\sim$0.6[c]. If we use this value, the cosmic ray H_2 ionization rate ζ of a few times 10^{-15} s^{-1} reported earlier[b] on the assumption of $f(H_2)$=1 needs to be increased by a factor of $\sim$3 since the value is approximately inversely proportional to $f(H_2)^2$.

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[a] Geballe, T. R., Oka, T., Lambridges, E., Yeh, S. C. C., Schlegelmilch, B., Goto, M., Westrick, C. W., WI07 at the 70th ISMS, Urbana, IL, USA,2015

[b] Oka, T., Geballe, T. R., Goto, M., Usuda, T., McCall, B. J. 2005, ApJ, 632, 882

[c] Le Petit, F., Ruaud, M., Bron, E., Godard, B., Roueff, E., Languignon, D., Le Bourlot, J. 2016, A&A, 585, A105