RADIAL LOCATION OF SGR B2 MEASURED FROM H_3^+ AND H_2O^+ ABSORPTION SPECTRA

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The giant molecular cloud Sgr B2 in the ~ 150 pc radius Central Molecular Zone (CMZ) of the Galactic center has played a central role in molecular radio astronomical observations. In spite of its large distance, over 70 molecules have been first detected in Sgr B2 since the discoveries of NH_3 and H_2O. Nevertheless there seems to be no consensus on the depth within the CMZ of this well observed cloud. It has not even been known whether Sgr B2, which is 101 pc distant on the plane of the sky from the central black hole Sgr A*, is to the front or the rear of Sgr A*. A trigonometric parallax measurement by Reid et al. (2009)[a] placed Sgr B2 130 pc in front of Sgr A* which would put it outside of the CMZ. Both Kruijssen et al. (2015) and Ridley et al. (2017) also placed Sgr B2 in front of Sgr A*. On the other hand Molinari et al (2011)[b] placed Sgr B2 about 70 pc behind Sgr A* based on their dust continuum measurements.

Recent observations of infrared lines of H_3^+ and CO [c] and the conclusion from the analysis of their velocity profiles that diffuse gas in the CMZ is expanding radially at a velocity of 150 km s^{-1} with the front of the expansion 150 pc from Sgr A* provides a useful tool for determining the location of Sgr B2 within the CMZ. Although currently there is no known infrared star usable for observations of H_3^+ toward Sgr B2, the star ι, 2M17470898-2829561, 16.6 pc to the west of the center of Sgr B2, is sufficiently close that it probes much of the same gas; the similarity of the velocity profile of the H_3^+ spectrum toward ι observed at the Gemini South Observatory and of H_2O^+ [d] by Herschel Observatory toward Sgr B2 attest to this. Using the velocity profiles of infrared absorption lines of H_3^+ toward the star ι and far infrared absorption lines of H_2O^+, both of which molecular ions reside in diffuse clouds, we conclude that Sgr B2 is behind Sgr A* by at least 70 pc.

[a] Reid, M. J., Menten, K. M., Zheng, X. W., Bunthaler, A. & Xu, Y. 2009, ApJ, 105, 7548

[b] Molinari, S., Bally, J., Noriega-Crespo, A. et al. 2011, ApJ, 735, L33

[c] Oka, T. & Geballe, T. R. 2020, ApJ, 902, 9

[d] Schilke, P., Comito, C. Müller, H. S. P., et al. 2010, A&A, 521, L11