S07a High-resolution imaging of sub-millimeter water masers in the nuclear region of Circinus Galaxy with ALMA

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The recent results of imaging sub-millimeter water masers in the transitions of 183 and 321 GHz towards the active nucleus of Circinus Galaxy using ALMA are presented. Prior to this talk, the nature and partly resolved structure of the 321 GHz maser at 0.3 arcsec angular resolution with ALMA in the galaxy were presented (Japan Astronomical Society Spring Meeting, Hagiwara et al., 2022, S20a; Hagiwara et al. 2021, ApJ, 923, 251). As a result of the analysis of new data observed at the resolution of 0.022 arcsec, corresponding to ∼0.46 pc, the 321 GHz water maser exhibits nearly symmetrically Doppler-shifted velocity features with respect to the systemic velocity of the galaxy. Since the velocity range of the 321 GHz maser emission largely overlaps that of the 22 GHz maser, it is likely that the both masers are originated from the same region in the galaxy. Similarly, the 183 GHz maser exhibits Doppler-shifted velocity features. Based on the velocity gradient of the 183 GHz maser observed at ∼ 0.045 arcsec resolution (∼ 0.9 pc), we estimated a dynamical mass at center of the galaxy, which is comparable with the mass including stars and gas inside a radius of 140 pc (3.2×10^8 $M_\odot$). The sub-millimeter water masers in the Circinus Galaxy could make possible the detailed study of the dynamics of a region within ∼0.1 pc from a central engine and accurate mass measurement of a super massive black hole through sub-millimeter VLBI observations.