

## The Detection of Dust Gap-ring Structure in the Outer Region of the CR Cha Protoplanetary Disk

\*Seongjoong Kim<sup>1</sup>, Takayuki Muto<sup>2</sup>, Hideko Nomura<sup>3,1</sup>, Sanemichi Takahashi<sup>3,4</sup>, Takashi Tsukagoshi<sup>3</sup>, Seokho Lee<sup>3</sup>, Ruobing Dong<sup>5</sup>, Yasuhiro Hasegawa<sup>6</sup>, Jun Hashimoto<sup>7</sup>, Kazuhiro Kanagawa<sup>8</sup>, Akimasa Kataoka<sup>3</sup>, Mihoko Konishi<sup>9</sup>, Hanyu Baobab Liu<sup>10</sup>, Munetake Momose<sup>11</sup>, Sitko Michael<sup>12</sup>, Kengo Tomida<sup>13</sup>

1. Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2. Division of Liberal Arts, Kogakuin University, 1-24-2 Nishi-Shinjuku, Shinjuku-ku, Tokyo 163-8677, Japan, 3. National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan, 4. Department of Applied Physics, Kogakuin University, 1-24-2 Nishi-Shinjuku, Shinjuku-ku, Tokyo, 163-8677, Japan, 5. Department of Physics & Astronomy, University of Victoria, Victoria, BC V8P 1A1, Canada, 6. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA, 7. Astrobiology Center, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan, 8. Research Center for the Early Universe, Graduate School of Science, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, 9. Faculty of Science and Technology, Oita University, 700 Dannoharu, Oita 870-1192, Japan, 10. Academia Sinica Institute of Astronomy and Astrophysics, P.O. Box 23-141, Taipei 10617, Taiwan, 11. College of Science, Ibaraki University, 2-1-1 Bunkyo, Mito, Ibaraki 310-8512, Japan, 12. Department of Physics, University of Cincinnati, Cincinnati, OH 45221, USA, 13. Department of Earth and Space Science, Osaka University, Toyonaka, Osaka 560-0043, Japan

We observe the dust continuum at 225 GHz and CO isotopologue ( $^{12}\text{CO}$ ,  $^{13}\text{CO}$ , and  $\text{C}^{18}\text{O}$ )  $J=2-1$  emission lines toward the CR Cha protoplanetary disk using the Atacama Large Millimeter/submillimeter Array. The dust continuum image shows a dust gap-ring structure in the outer region of the dust disk. A faint dust ring is also detected around 120 au beyond the dust gap. The CO isotopologue lines indicate that the gas disk is more extended than the dust disk. The peak brightness temperature of the  $^{13}\text{CO}$  line shows a small bump around 130 au, while  $^{12}\text{CO}$  lines do not. We investigate two possible mechanisms for reproducing the observed dust gap-ring structure and a gas temperature bump. First, the observed gap structure can be opened by a Jupiter-mass planet using the relation between the planet mass and the gap depth and width. Meanwhile, the radiative transfer calculations based on the observed dust surface density profile show that the observed dust ring could be formed by dust accumulation at the gas temperature bump, that is, the gas pressure bump produced beyond the outer edge of the dust disk.

Keywords: Observational Astronomy, Protoplanetary disks