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Direct Infall Signatures and Complex Organic Molecules toward an Isolated Embedded Protostar BHR 71

Yao-Lun Yang[1], Neal J. Evans II[1,2,3], Aaron Smith[4], Joel D. Green[5,1], Jes K. Jørgensen[6], Jeong-Eun Lee[7], Tyler L. Bourke[8], John J. Tobin[9] and Susan Terebey[10]

[1]Department of Astronomy, The University of Texas at Austin, USA
email: yaolunyang.astro@gmail.com

[2]Korea Astronomy and Space Science Institute, Korea

[3]Humanitas College, Kyung Hee University, Korea

[4]Department of Physics, Massachusetts Institute of Technology, USA

[5]Space Telescope Science Institute, USA

[6]Centre for Star and Planet Formation, Niels Bohr Institute and Natural History Museum of Denmark, University of Copenhagen, Denmark

[7]Department of Astronomy & Space Science, Kyung Hee University, Korea

[8]SKA Organization, Jodrell Bank Observatory, UK

[9]National Radio Astronomy Observatory, USA

[10]Department of Physics and Astronomy, California State University at Los Angeles, USA

Abstract. Our ALMA observations of HCO^+ and HCN show such redshifted absorption toward an isolated core, BHR 71. Both lines show a similar redshifted absorption profile. We also found emissions of complex organic molecules (COMs) around 345 GHz from a compact region centered on the continuum source, which is barely resolved with a beam of 0.″27, corresponding to ∼50 AU.

Keywords. ISM: kinematics and dynamics, astrochemistry, and stars: formation

1. Introduction

Gas infall transforms dense cores into protostars. While interferometric observations of molecular spectra best probe the gas kinematics at the densest part of the prorotstellar envelope, only a few direct measurements of infall exist to constrain the model of infall. ALMA observations of optically-thick molecular transitions exclusively probe the line-of-sight velocity structure within a pencil beam toward protostars, resulting in a redshifted absorption against the continuum, which is an unambiguous signature of infall (Pineda *et al.* 2012; Evans *et al.* 2015).

Several protostars harbor complex organic molecules (COMs), named as "hot corinos", suggested by Ceccarelli (2004). With the high resolution and sensitivity of ALMA, the emission of COMs not only represents the chemical complexity of the protostars but also probes the dynamics at the disk-forming regions (e.g. Oya *et al.* 2017).

2. Results

In our ALMA Cycle 4 observation of BHR 71 (PI: Y.-L. Yang, 2016.0.00391S), we detect strong redshifted absorption against the continuum from the HCO^+ $J = 4 \rightarrow 3$ and HCN $J = 4 \rightarrow 3$ lines (Figure 1) with a synthetic beam size of 0.″39×0.″27.

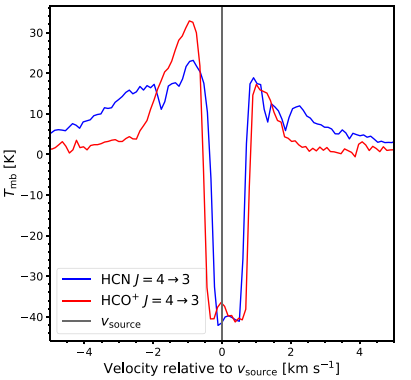

Figure 1. The infall signature detected from the HCO^+ $J = 4 \rightarrow 3$ (blue) and HCN $J = 4 \rightarrow 3$ (red) lines extracted from a $0''.52 \times 0''.39$ ellipse with PA=125°.

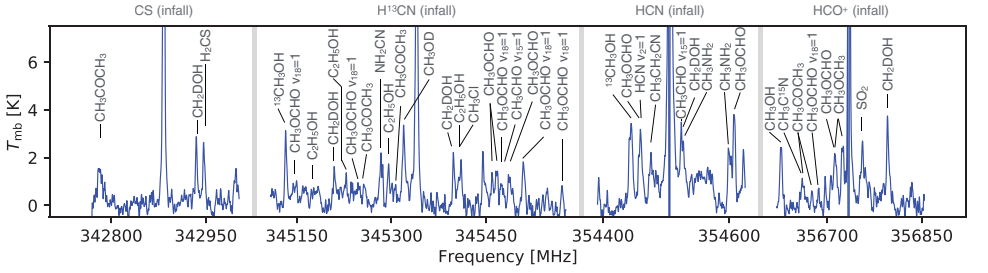

Figure 2. The full ALMA spectra at Band 7, showing numerous weak and narrow emission features identified as the emission of complex organic molecules. The annotated texts show the identified species.

In the same observation, we detect more than 40 weak narrow emission features over the entire ALMA spectra (Figure 2). We identified 14 species of COMs toward the compact center of BHR 71, discovering the "hot corino" nature of BHR 71. The COMs emit from an averaged 90 AU×70 AU region at the center, similar to the size of continuum emission, 100 AU×80 AU, suggesting that the COMs locate at the high temperature (>100 K) region around the central protostar (Yang *et al.* 2017).

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