Line Imaging of Orion-KL at 230GHz with SMA and IRAM 30m Telescope

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Summary

Combing observational data from the Submillimiter Array (SMA) and IRAM 30m telescope, we get the chemical structures of Orion-KL with the spatial resolution of 4″. Particularly, the spectrum (Fig.4) allow us to derive the column densities (Tab.2), and the spatial distribution among species vary significantly (Fig.3). One interesting molecule among is the glycolaldehyde (CH_2OHCHO), which can be as a biologically processes indicator. Different transition levels are firstly found in Orion-KL (Fig.5 & Tab.1).

Data

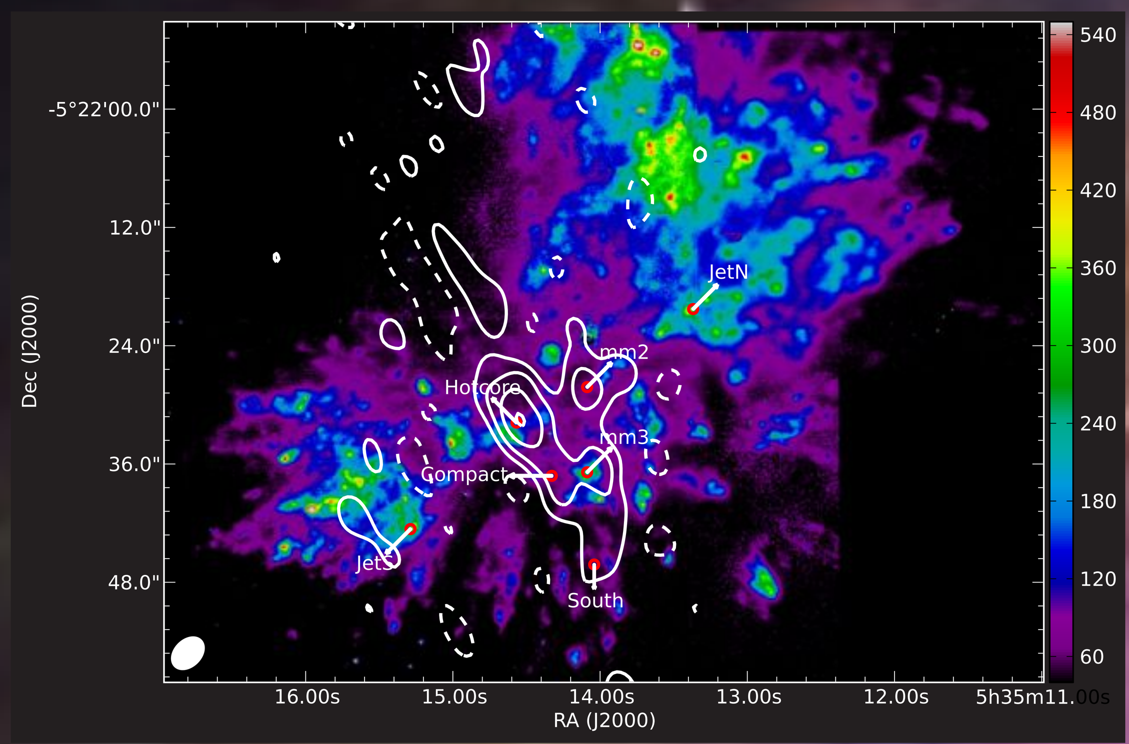

Fig.1 .The color scale presents the shocked H_2 emission[3], and the contours show the SMA 230GHz continuum emission at 3σ, 6σ and 15σ levels (dashed contours show negative features due to missing flux). Red circles mark the peaks of hot core, compact ridge, mm2, mm3, the southern region, northern and southern parts of the jet.

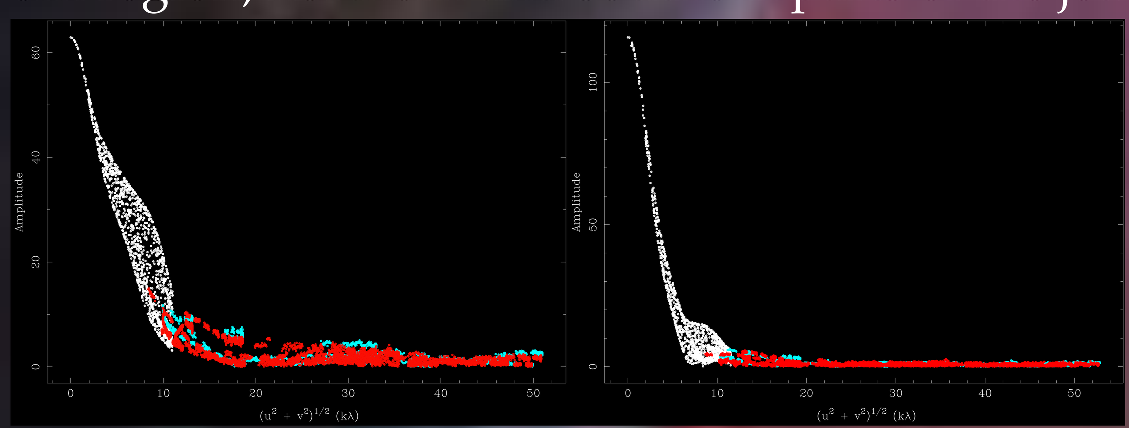

Fig.2 . UVPLOT shows successfully combination of the interferometer and single dish data:

- Interferometer can disentangle chemical components at high spatial resolution;
- Single dish can compensate the "missing short data" problem from the interferometer, thus obtain the total flux density.

References

[1] S.Y., Feng, H.Beuther, Line Imaging of Orion-KL at 230GHz with SMA and IRAM 30m (*in prep.*)

[2] Larralde, R., Robertson, M.P., & Miller, S. L., 1995, Proc. Natl. Acad. Sci., 92, 8158

[3] Nissen, H.D, Gustasson, M., Lemaire, J.L., et.al, 2007, A&A, 466,949

Acknowledge

We acknowledge the financial support by LASSIE FP7 Marie Curie Initial Training Network (ITN).

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Results

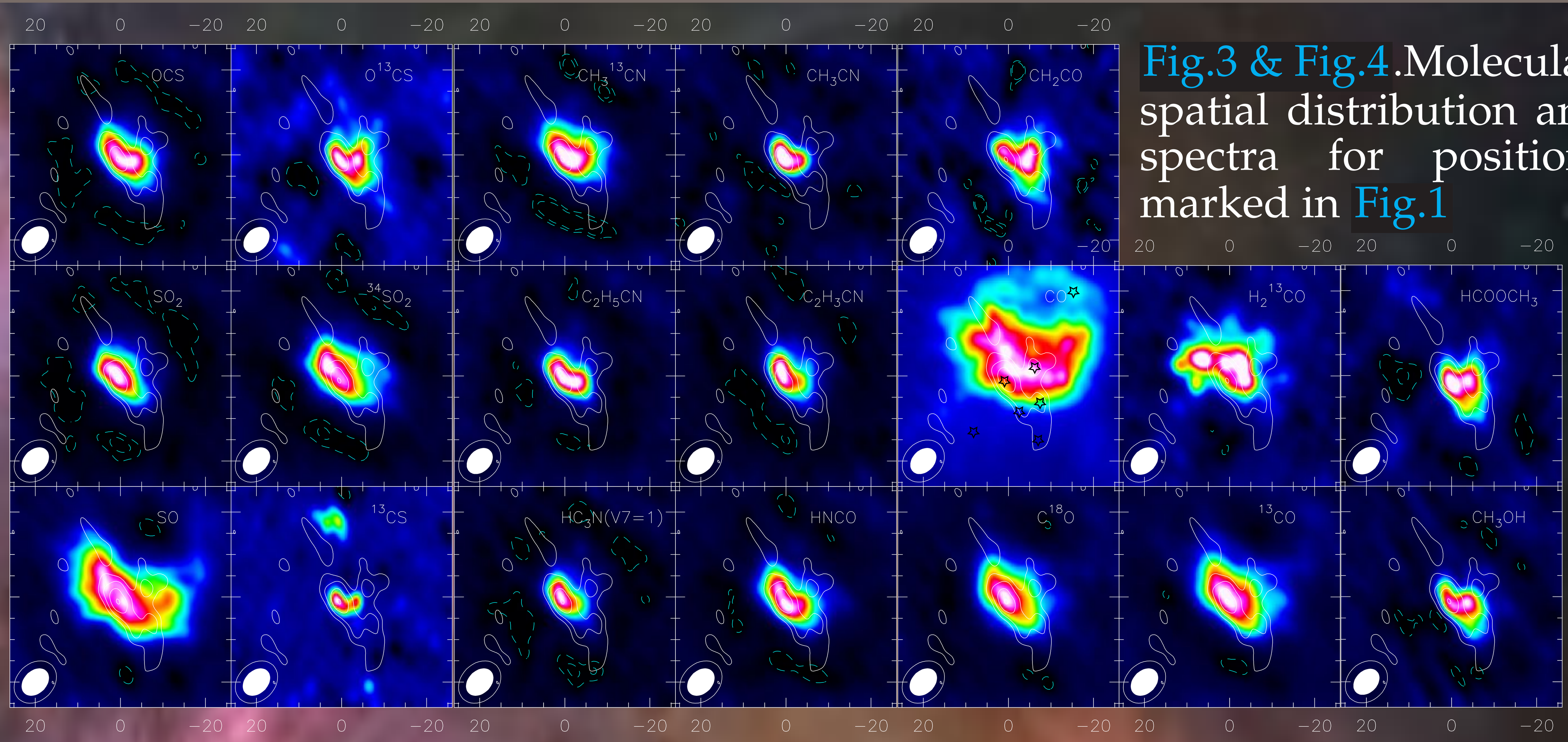

Fig.3 & Fig.4.Molecular spatial distribution and spectra for positions marked in Fig.1

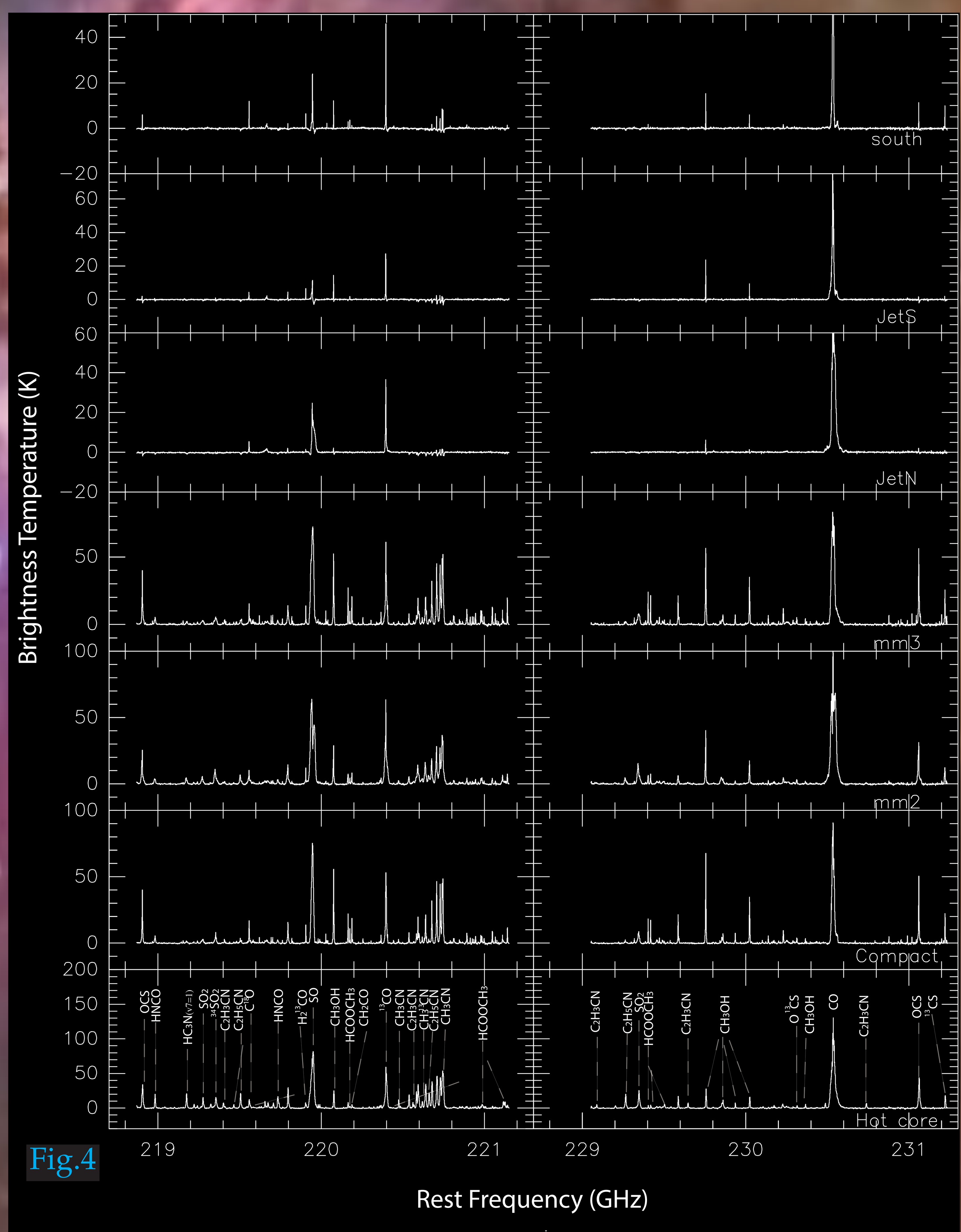

Fig.4

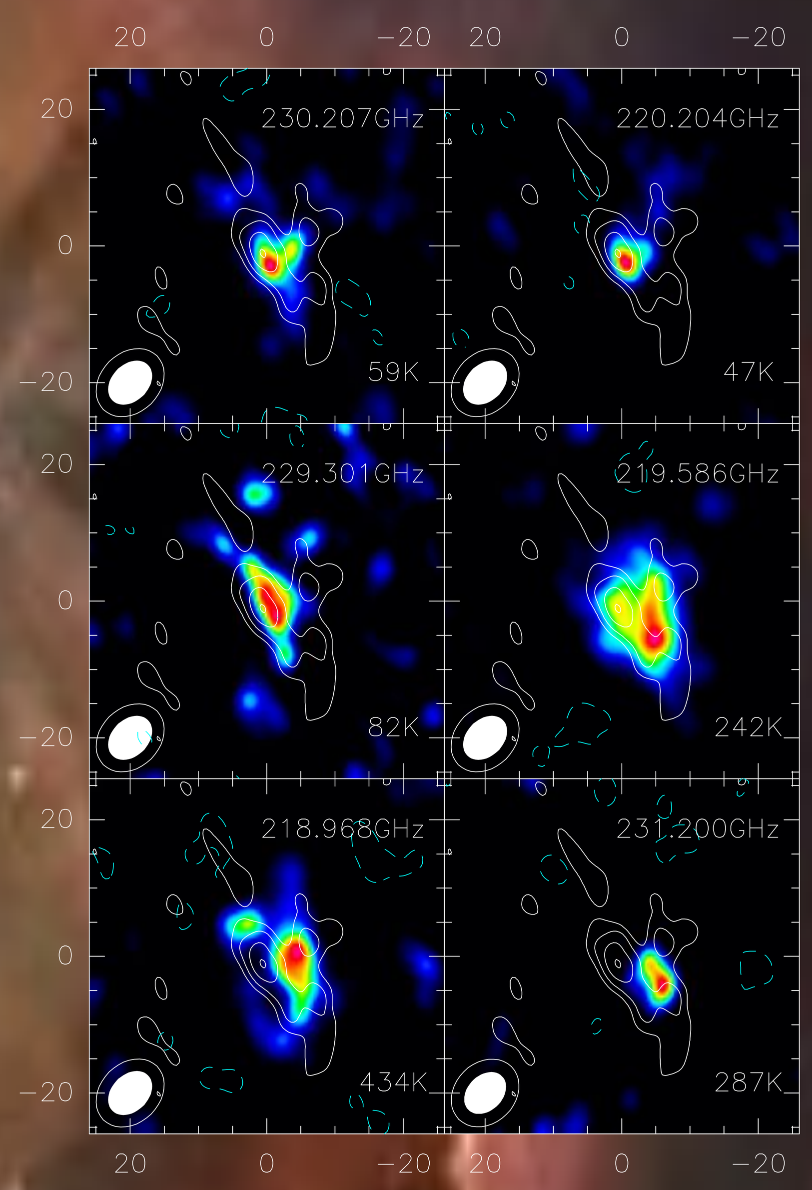

Fig.5 & Tab.1 .Transition levels of CH_2OHCHO detected in 230GHz band.

Transition	Frequency (GHz)	E_u (K)
$36_{10,27} \rightarrow 36_{9,28}$	218.968	434
$19_{15,4} \rightarrow 18_{15,3}$	219.586	242
$11_{4,7} \rightarrow 10_{3,8}$	220.204	47
$15_{5,10} \rightarrow 15_{2,13}$	229.301	82
$12_{5,7} \rightarrow 12_{2,10}$	230.207	59
$28_{10,19} \rightarrow 28_{9,20}$	231.200	287

Glycolaldehyde (CH_2OHCHO) is the simplest sugar, also the first intermediate product in the formose reaction. Under early Earth conditions, it begins with formaldehyde (H_2CO), and leads to the (catalyzed) formation of sugars, ultimately ribose, and the backbone of RNA[2].

Calculation

Column density calculated under the assumption of Local Thermodynamic Equilibrium, in Log_{10}/cm^2

Species	Hotcore	mm2	mm3	Compact	South	JetN	JetS
SO	17.0	16.9	16.7	16.7	15.3	16.0	15.0
^{13}CS	15.1	14.7	14.5	14.7	13.5	12.8	<12.6
$^{34}SO_2$	16.7	16.4	16.0	16.1	<14.3	<14.2	<14.4
$O^{13}CS$	15.7	15.5	15.6	15.6	14.4	14.9	<14.5
CH_3CN	16.8	16.2	16.3	16.1	<16.2	<16.3	<16.4
$CH_3^{13}CN$	15.7	15.0	14.8	15.0	<13.4	<13.8	<13.9
C_2H_3CN	16.0	15.5	15.2	15.1	<14.2	14.3	14.4
C_2H_5CN	16.4	15.8	15.5	15.4	<14.7	<14.8	<14.7
HNCO	16.2	15.6	15.4	15.5	<13.5	<14.4	<14.1
$HC_3N(v7=1)$	15.5	15.1	15.2	14.5	<15.4	<15.3	<15.1
$C^{18}O$	17.6	17.4	16.9	17.2	16.4	16.5	16.2
^{13}CO	18.5	18.2	18.0	18.1	17.2	17.4	17.2
$H_2{}^{13}CO$	15.5	15.0	14.8	15.1	14.1	13.7	14.2
CH_2CO	15.6	15.2	15.3	15.4	14.4	13.7	14.1
CH_3OH	17.3	17.1	17.1	17.3	15.8	15.6	16.1
$HCOOCH_3$	17.0	16.8	16.8	16.9	15.4	<15.0	<15.2

Only the rare species are listed when multiple isotopologues are detected, uncertainty comes from the optical depth.

Tab.2. Columns correspond to the star-marked places in Fig.1.