Characterization of the star-forming region G327.3-0.6

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Continuum Emission

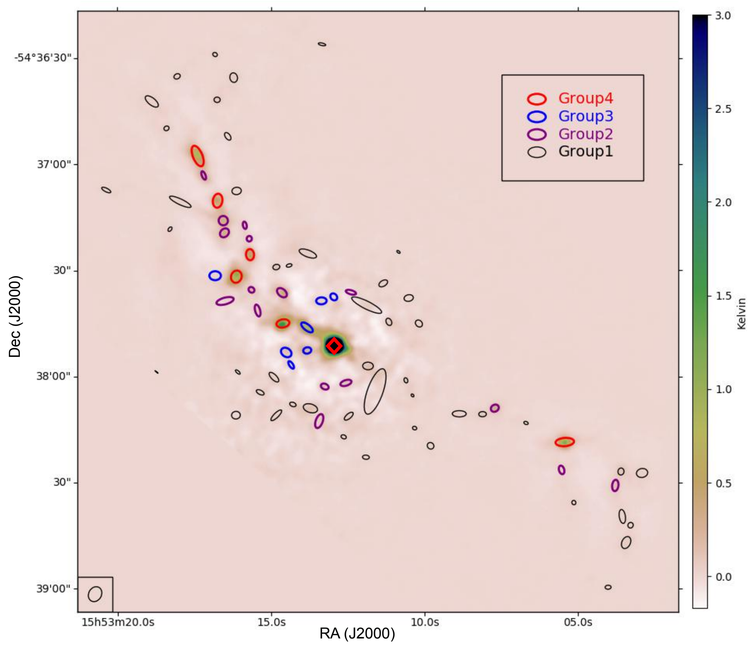

Figure 1: Continuum image of 218.5 GHz observed by ALMA. 78 cores selected by SExtractor (Benedikt 2018, Bachelor thesis) are shown in ellipse and the hot core is marked by a red diamond.

Hot Core Spectra Analysis

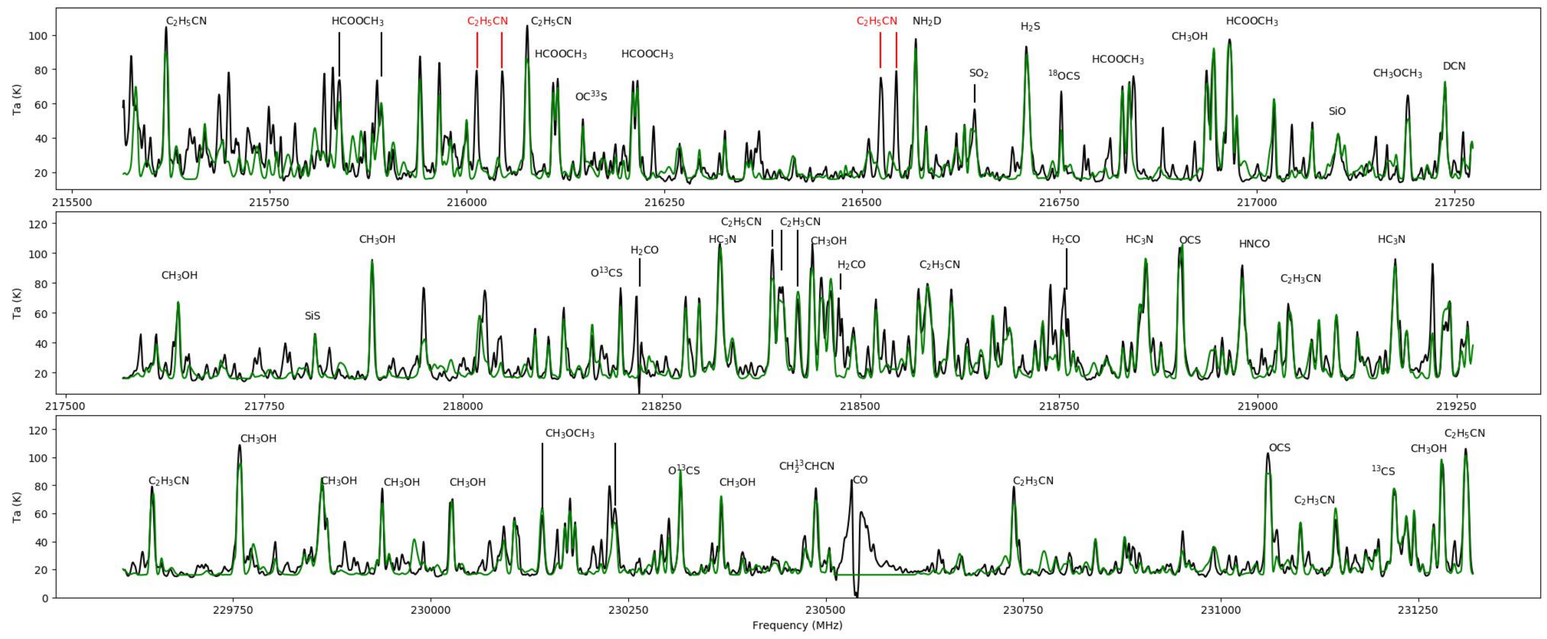

Figure 2: The spectra of the peak pixel in the hot core are shown in black and the fitting results by green. 25 molecules and their isotopologues were fitted together by eXtended CASA Line Analysis Software Suite (XCLASS). CO and H_2CO were skipped because of artificial absorption from interferometer. C_2H_5CN lines marked in red are vibrational states not included in all the molecular database.

Velocity Distribution

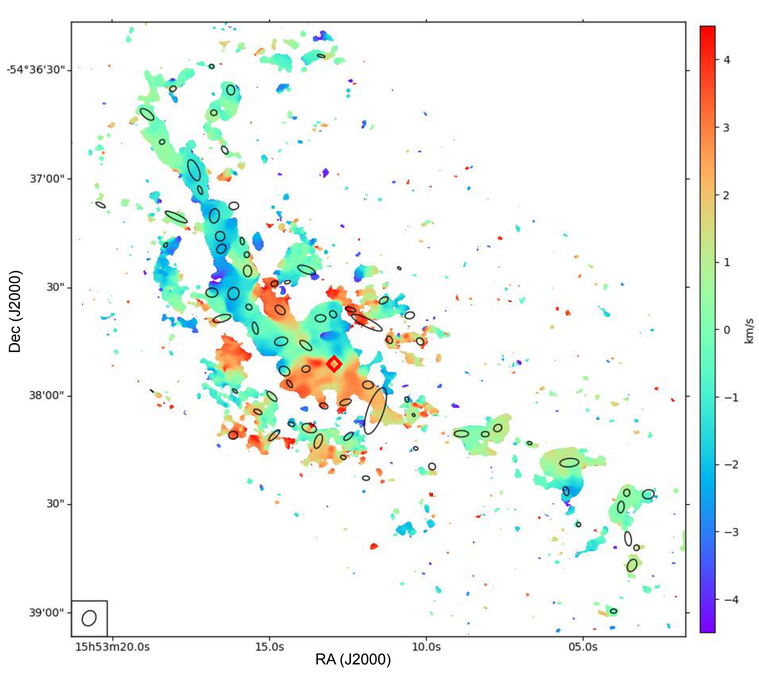

Figure 3: Central velocity distribution of DCN. A large scale velocity gradient is shown, indicating possible global infall from the filament to the hot core. DCN is extended, hence excluded from PCA.

Principle Component Analysis (PCA)

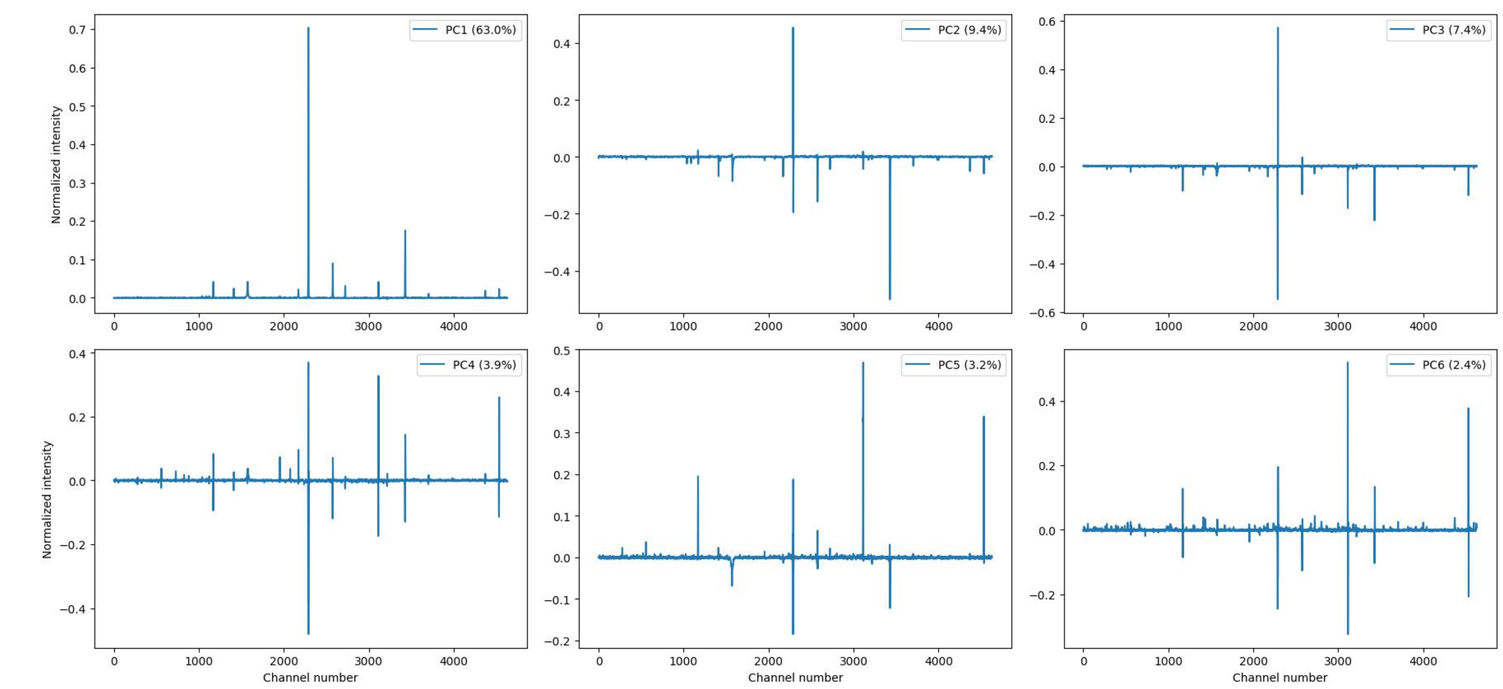

Figure 4: PCA eigenvectors and percentage of eigenvalues. The first three components count ~ 80% and the first six ~ 90%. Hence 6 principle components are adopted for further classification. Steps: Get average spectra of each region except the hot core; Smooth to the same resolution, delete unnecessary channels, and align the spectra; Normalize each spectrum by sum and then do PCA.

Classification and Chemical evolution

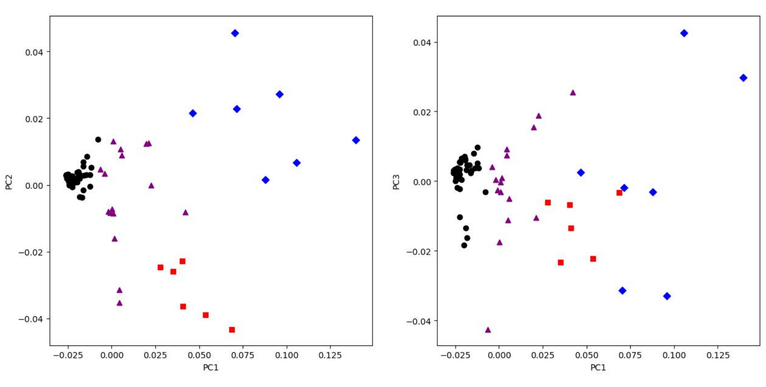

Figure 5: Clustering algorithm KMeans is applied to classify the cores. Different groups are clearly distinguished when being plotted on principle component axis, assuming four groups exists.

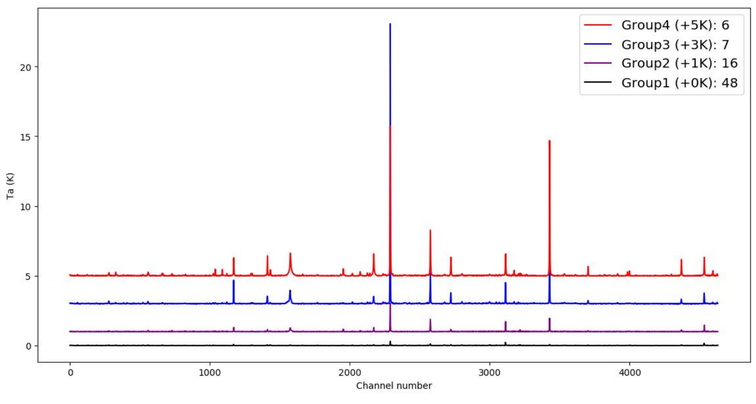

Figure 6: Average spectra of each classified group, and the number of cores in each group is shown in the legend. A gradient of peak intensity and line number is seen. The spatial distribution of groups is colored in Fig.1, showing that group 4 is the bright cores on the main filament, group 2 and 3 are also on the filament but weaker, group 1 is weak cores and usually off the filament.

Group	1	2	3	4
Universal molecule	CH_3OH	CH_3OH	CH_3OH	CH_3OH
	H2S	H2S	H2S	H2S
	OCS	OCS	OCS	OCS
	SiO	SiO	SiO	SiO
Rare molecule		CH_3OCHO	CH_3OCHO	CH_3OCHO
		HC_3N	HC_3N	HC_3N
			NH_2D	NH_2D
Warm core molecule			HNCO	HNCO
			C_2H_5CN	C_2H_5CN
				CH_3OCH_3
				CH_3CHO
Tex(K)	30.8	39.4	94.4	182.0
N(cm^{-2})	$7.6{\cdot}10^{14}$	$1.9{\cdot}10^{15}$	$1.0{\cdot}10^{16}$	$1.3{\cdot}10^{16}$

Table 1: Typical molecules in each group show a chemical evolution. Average temperature and column density are derived from methanol lines.

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