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Analysis of EC1 Observations

10.1 Summary

A summary of observations and detected line intensities, T_{R}^* , can be found in Figs. 8.11, 8.12, 8.13 and Table 10.1. Analysis of observations of EC1 followed the same methods as outlined in chapter 9 (the relevant sections are shown in parenthesis). Beam deconvolution (9.1) of observed line intensities was calculated with a *fwhp* source size, θ_{s} , of $70 \times 70 \text{ arcsec}^2$, based on my ^{13}CO map of EC1 (Fig. 8.9). Beam deconvolved intensities, T_{mb} , are listed in Table 10.1. Compared to EC2, I have detected fewer molecules in EC1; apart from CO there is only HCO^+ , with CS and SO, but at a lower S/N. Using ammonia as a thermometer (9.2) I estimated the temperature (9.3) of EC1 from the 3σ upper limit of T_{mb} for NH_3 at positions P and R, giving $T_{\text{rot}} = 24 - 28 \text{ K}$. However, given the uncertainty in the 3σ upper limit, and for consistency with my EC2 estimates, I have chosen to use an excitation temperature of 20 K in the calculation of column densities and molecular abundances relative to HCO^+ (9.5). In the absence of any LVG models, and again for consistency with my EC2 calculations, I have assumed a density of $n(\text{H}_2) = 1.2 \times 10^4 \text{ cm}^{-3}$, with a column density of $N(\text{H}_2) = 7.4 \times 10^{22} \text{ cm}^{-2}$ in determining molecular abundances relative to H_2 . Table 10.2 lists the derived column densities and abundances relative to HCO^+ and H_2 .

10: ANALYSIS OF EC1 OBSERVATIONS

Table 10.1: Summary of observations and detections toward EC1 positions P, T, S, R, with T_R^* beam deconvolved to yield T_{mb} intensities (see sections 8.4 and 10.1).

Molecule	Transition	Freq. (GHz)	Telescope	T_R^*	rms_R^* (K)	T_{mb}	rms_{mb} (K)
CO	1-0	115.271	OSO 20m	4.450	0.499	5.423	0.608
¹³ CO	1-0	110.201	OSO 20m	0.904	0.111	1.120	0.138
CS	2-1	97.981	OSO 20m	0.120	0.062	0.156	0.081
H ₂ CO	1 _{1,0} -1 _{1,1}	4.830	MPIfR 100m	—	0.010	—	0.060
NH ₃	1,1	23.694	MPIfR 100m	—	—	—	0.079
NH ₃	2,2	23.723	MPIfR 100m	—	—	—	0.033
H ₂ O	6-5	22.235	MPIfR 100m	—	0.107	—	0.142
CO	1-0	115.271	ARO 12m	2.650	0.109	4.259	0.175
¹³ CO	1-0	110.201	ARO 12m	0.442	0.045	0.736	0.075
C ¹⁸ O	1-0	109.782	ARO 12m	—	0.024	—	0.040
CS	2-1	97.981	ARO 12m	0.088	0.032	0.162	0.059
SO	3 ₂ -2 ₁	99.300	ARO 12m	0.054	0.016	0.098	0.029
HCO ⁺	1-0	89.189	ARO 12m	0.074	0.011	0.149	0.022
DCO ⁺	1-0	72.039	ARO 12m	—	0.008	—	0.020
HCN	1-0	88.632	ARO 12m	—	0.011	—	0.022
HNC	1-0	90.664	ARO 12m	—	0.020	—	0.040
CN	1-0	113.491	ARO 12m	—	0.052	—	0.085
C ₂ H	1-0	87.317	ARO 12m	—	0.020	—	0.041
CH ₃ OH	2-1	96.741	ARO 12m	—	0.019	—	0.035
N ₂ H ⁺	1-0	93.174	ARO 12m	—	0.018	—	0.035
CO	1-0	115.271	ARO 12m	2.567	0.088	4.125	0.141
¹³ CO	1-0	110.201	ARO 12m	0.339	0.039	0.564	0.065
C ¹⁸ O	1-0	109.782	ARO 12m	0.044	0.012	0.073	0.020
CS	2-1	97.981	ARO 12m	0.088	0.015	0.162	0.028
SO	3 ₂ - 2 ₁	99.300	ARO 12m	—	0.017	—	0.031
HCO ⁺	1-0	89.189	ARO 12m	0.046	0.007	0.093	0.014
DCO ⁺	1-0	72.039	ARO 12m	—	0.009	—	0.023
HCN	1-0	88.632	ARO 12m	—	0.012	—	0.024
DCN	1-0	72.415	ARO 12m	—	0.007	—	0.018
CO	1-0	115.271	OSO 20m	5.723	0.409	6.974	0.498
¹³ CO	1-0	110.201	OSO 20m	1.453	0.234	1.800	0.290
C ¹⁸ O	1-0	109.782	OSO 20m	0.096	0.060	0.119	0.074
CS	2-1	97.981	OSO 20m	0.103	0.029	0.134	0.038
SO	3 ₂ - 2 ₁	99.300	OSO 20m	0.171	0.043	0.221	0.056
HCO ⁺	1-0	89.189	OSO 20m	0.138	0.028	0.188	0.038
HCS ⁺	2-1	85.348	OSO 20m	—	0.026	—	0.036
CN	1-0	113.491	OSO 20m	—	0.048	—	0.059
C ₂ H	1-0	87.317	OSO 20m	—	0.050	—	0.069
CH ₃ OH	2-1	96.741	OSO 20m	—	0.029	—	0.038
H ₂ CO	1 _{1,0} -1 _{1,1}	4.830	MPIfR 100m	—	0.010	—	0.060
NH ₃	1,1	23.694	MPIfR 100m	—	—	—	0.067
NH ₃	2,2	23.723	MPIfR 100m	—	—	—	0.034
H ₂ O	6-5	22.235	MPIfR 100m	—	0.150	—	0.198

The four sections of the above table refer to the positions P, T, S and R respectively.

Table 10.2: Summary of densities and abundances toward EC1 positions P, T, S, R, estimated for an excitation temperature of 20 K (see section 10.1).

Molecule	Transition	ΔV (km s ⁻¹)	$\Delta \nu$ (km s ⁻¹)	N (cm ⁻²)	X/HCO ⁺	X/H ₂
CO	1-0	2.30 ± 0.15	0.260	1.46 ± 0.19 × 10 ¹⁶	29129	2.0 × 10 ⁻⁷
¹³ CO	1-0	1.48 ± 0.13	0.272	2.09 ± 0.32 × 10 ¹⁵	4185	2.8 × 10 ⁻⁸
CS	2-1	1.09 ± 0.38	0.306	9.70 ± 6.04 × 10 ¹¹	1.94	1.3 × 10 ⁻¹¹
H ₂ CO	1 _{1,0} -1 _{1,1}	—	0.606	<2.01 × 10 ¹³	<40	<2.7 × 10 ⁻¹⁰
NH ₃	1,1	—	0.490	<7.67 × 10 ¹²	<15	<1.0 × 10 ⁻¹⁰
NH ₃	2,2	—	0.490			
H ₂ O	6-5	—	0.527	<4.97 × 10 ¹³	<99	<6.7 × 10 ⁻¹⁰
CO	1-0	2.66 ± 0.09	0.650	1.32 ± 0.07 × 10 ¹⁶	26458	1.8 × 10 ⁻⁷
¹³ CO	1-0	1.84 ± 0.18	0.680	1.71 ± 0.24 × 10 ¹⁵	3417	2.3 × 10 ⁻⁸
C ¹⁸ O	1-0	—	0.273	<1.22 × 10 ¹⁴	<245	<1.7 × 10 ⁻⁹
CS	2-1	1.40 ± 0.63	0.765	1.29 ± 0.75 × 10 ¹²	2.58	1.7 × 10 ⁻¹¹
SO	3 ₂ -2 ₁	2.55 ± 0.70	0.755	4.02 ± 1.62 × 10 ¹²	8.04	5.4 × 10 ⁻¹¹
HCO ⁺	1-0	2.22 ± 0.37	0.840	5.00 ± 1.12 × 10 ¹¹	1.00	6.8 × 10 ⁻¹²
DCO ⁺	1-0	—	1.040	<2.13 × 10 ¹¹	<0.43	<2.9 × 10 ⁻¹²
HCN	1-0	—	0.338	<1.56 × 10 ¹¹	<0.31	<2.1 × 10 ⁻¹²
HNC	1-0	—	0.331	<2.52 × 10 ¹¹	<0.50	<3.4 × 10 ⁻¹²
CN	1-0	—	0.264	<3.14 × 10 ¹²	<6.28	<4.2 × 10 ⁻¹¹
C ₂ H	1-0	—	0.343	<9.93 × 10 ¹²	<19.9	<1.3 × 10 ⁻¹⁰
CH ₃ OH	2-1	—	0.310	<7.01 × 10 ¹¹	<1.40	<9.5 × 10 ⁻¹²
N ₂ H ⁺	1-0	—	0.322	<1.67 × 10 ¹¹	<0.33	<2.3 × 10 ⁻¹²
CO	1-0	2.28 ± 0.07	0.650	1.10 ± 0.05 × 10 ¹⁶	33243	1.5 × 10 ⁻⁷
¹³ CO	1-0	2.27 ± 0.25	0.680	1.62 ± 0.26 × 10 ¹⁵	4892	2.2 × 10 ⁻⁸
C ¹⁸ O	1-0	1.07 ± 0.45	0.683	9.98 ± 5.00 × 10 ¹³	302	1.3 × 10 ⁻⁹
CS	2-1	0.93 ± 0.15	0.306	8.57 ± 2.01 × 10 ¹¹	2.60	1.2 × 10 ⁻¹¹
SO	3 ₂ -2 ₁	—	0.755	<1.98 × 10 ¹²	<6.01	<2.7 × 10 ⁻¹¹
HCO ⁺	1-0	2.36 ± 0.37	0.840	3.30 ± 0.72 × 10 ¹¹	1.00	4.5 × 10 ⁻¹²
DCO ⁺	1-0	—	1.040	<2.40 × 10 ¹¹	<0.73	<3.2 × 10 ⁻¹²
HCN	1-0	—	0.846	<2.69 × 10 ¹¹	<0.82	<3.6 × 10 ⁻¹²
DCN	1-0	—	1.035	<3.14 × 10 ¹¹	<0.95	<4.2 × 10 ⁻¹²
CO	1-0	2.07 ± 0.09	0.260	1.69 ± 0.14 × 10 ¹⁶	72218	2.3 × 10 ⁻⁷
¹³ CO	1-0	1.07 ± 0.18	0.272	2.43 ± 0.57 × 10 ¹⁵	10417	3.3 × 10 ⁻⁸
C ¹⁸ O	1-0	6.01 ± 1.22	0.273	9.09 ± 5.98 × 10 ¹⁴	3897	1.2 × 10 ⁻⁸
CS	2-1	0.92 ± 0.25	0.306	7.03 ± 2.75 × 10 ¹¹	3.01	9.5 × 10 ⁻¹²
SO	3 ₂ -2 ₁	0.76 ± 0.18	0.302	2.70 ± 0.93 × 10 ¹²	11.6	3.6 × 10 ⁻¹¹
HCO ⁺	1-0	0.82 ± 0.16	0.336	2.33 ± 0.66 × 10 ¹¹	1.00	3.2 × 10 ⁻¹²
HCS ⁺	2-1	—	0.351	<7.89 × 10 ¹¹	<3.38	<1.1 × 10 ⁻¹¹
CN	1-0	—	0.264	<2.18 × 10 ¹²	<9.35	<2.9 × 10 ⁻¹¹
C ₂ H	1-0	—	0.343	<1.67 × 10 ¹³	<71.4	<2.2 × 10 ⁻¹⁰
CH ₃ OH	2-1	—	0.310	<7.52 × 10 ¹¹	<3.23	<1.0 × 10 ⁻¹¹
H ₂ CO	1 _{1,0} -1 _{1,1}	—	0.606	<2.01 × 10 ¹³	<86	<2.7 × 10 ⁻¹⁰
NH ₃	1,1	—	0.490	<6.44 × 10 ¹²	<27.6	<8.7 × 10 ⁻¹¹
NH ₃	2,2	—	0.490			
H ₂ O	6-5	—	0.527	<6.97 × 10 ¹³	<299	<9.4 × 10 ⁻¹⁰

The four sections of the above table refer to the positions P, T, S and R respectively.

