

Source; IRAS 16293-2422 of the Herschel/CHESS program.

These high-J lines are from Herschel:HIFI. I've put them in this document so that the plots and numbers can be presented together in an easily-referenced fashion.

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[With width and position fixed to H13CN parameters:](#)

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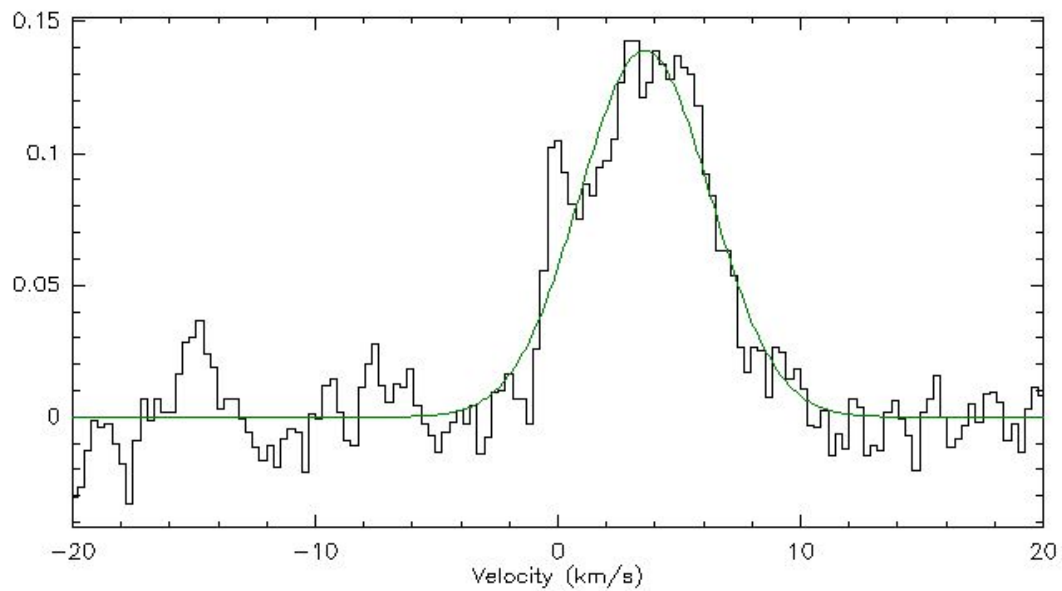
[Appendix: analysis commands](#)

H¹³CN 6-5

It's in band 1a. Freq 517.970 GHz.

Line	Area	Position	Width	Tpeak
1	0.93418	(0.026)	3.588 (0.087)	6.320 (0.191) 0.13887

1;1 iras16293-24 DECON SSB HIF-00-W--1A 0:01-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: +0.7 +4.1
Unknown tau: 0.000 Tsys: 0. Time: 5.0 min El: 0.0
N: 161006 I0: 76971.0 V0: 0.000 Dv: -0.2894 LSR
FO: 517970.000 Df: 0.5000 Fi: N/A

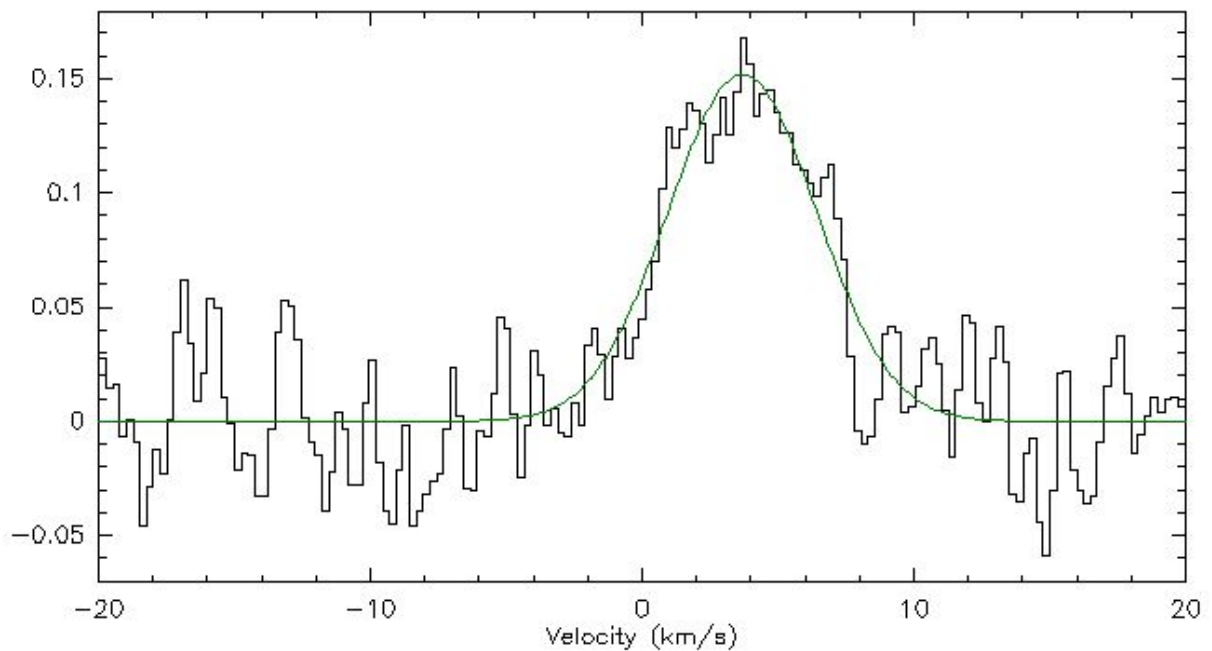


H¹³CN 7-6

It's in Band 1b. 604.268 GHz.

Line	Area	Position	Width	Tpeak
1	1.0378	(0.051)	3.688 (0.155)	6.425 (0.368) 0.15175

1;1 iras16293-24 DECON SSB HIF-00-W--1B O:02-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: +0.4 +4.0
Unknown tau: 0.000 Tsys: 0. Time: 5.7 min El: 0.0
N: 163944 IQ: 99558.0 VQ: 0.000 Dv: -0.2481 LSR
FQ: 604268.000 Df: 0.5000 Fi: N/A

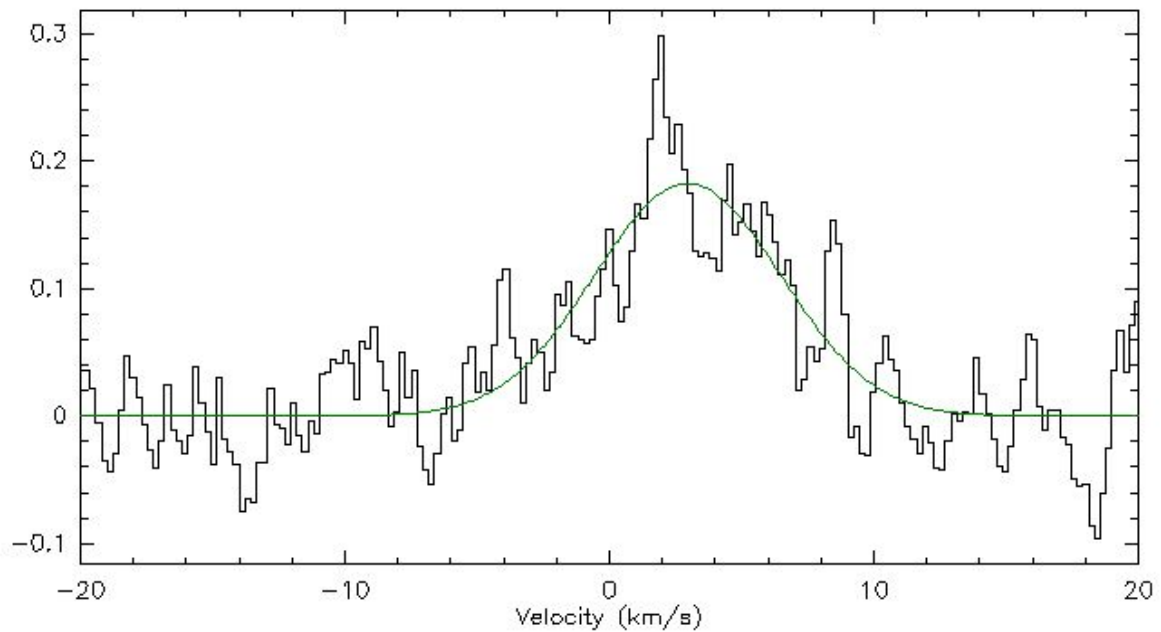


H¹³CN 8-7

It's in band 2a. 690.552 GHz.

Line	Area	Position	Width	Tpeak
1	1.6022	(0.076)	2.960 (0.189)	8.243 (0.466) 0.18260

1;1 iras16293-24 DECON SSB HIF-00-W--2A O:18-FEB-2011 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: -2.1 +3.5
Unknown tau: 0.000 Tsys: 0. Time: 4.5 min El: 0.0
N: 199908 I0: 129115. V0: 0.000 Dv: -0.2171 LSR
F0: 690552.000 Df: 0.5000 Fi: N/A

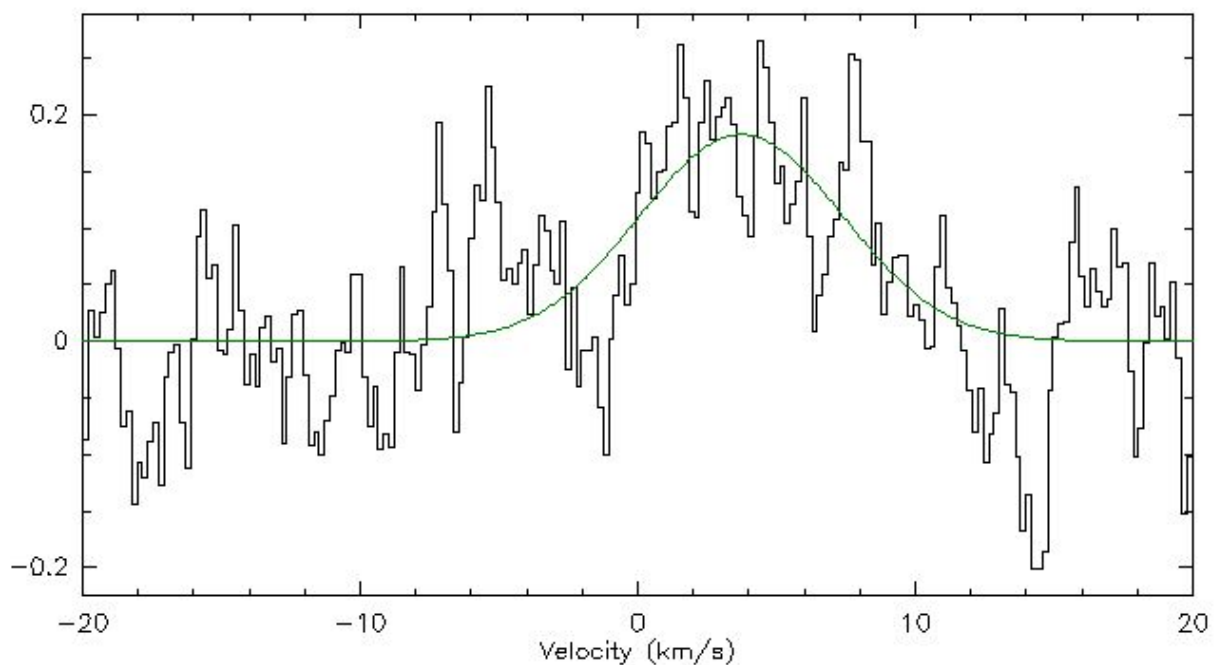


H¹³CN 9–8

It's in Band 2b. 776.820 GHz.

Line	Area	Position	Width	Tpeak
1	1.6728	(0.159)	3.728 (0.408)	8.603 (0.989) 0.18268

1;1 iras16293-24 DECON SSB HIF-00-W--2B O:19-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: -1.2 +2.4
Unknown tau: 0.000 Tsys: 0. Time: 5.7 min El: 0.0
N: 173733 I0: 125628. V0: 0.000 Dv: -0.1930 LSR
F0: 776820.000 Df: 0.5000 Fi: N/A

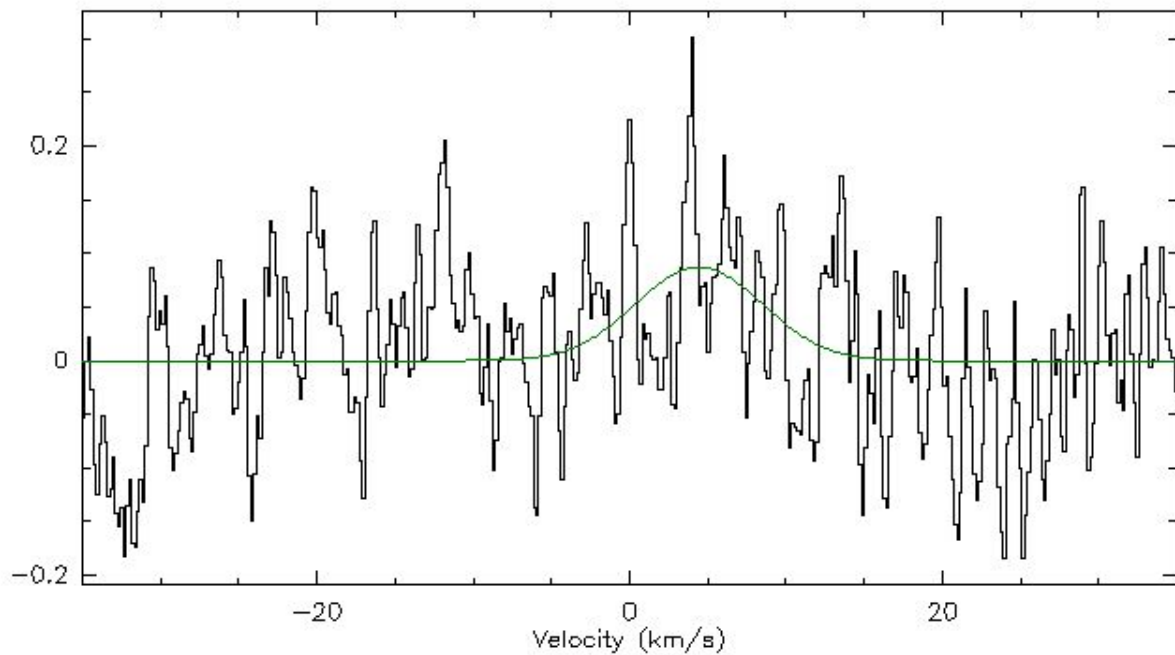


H¹³CN 10-9

It's in Band 3b. 863.071 GHz.

Line	Area	Position	Width	Tpeak
1	0.88238	(0.161)	4.430 (0.824)	9.495 (2.243) 8.72988E-02

1;1 iras16293-24 DECON SSB HIF-00-W--3B O:19-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: -1.8 +3.2
Unknown tau: 0.000 Tsys: 0. Time: 4.5 min El: 0.0
N: 205817 I0: 10111.0 V0: 0.000 Dv: -0.1737 LSR
F0: 863071.000 Df: 0.5000 Fi: N/A

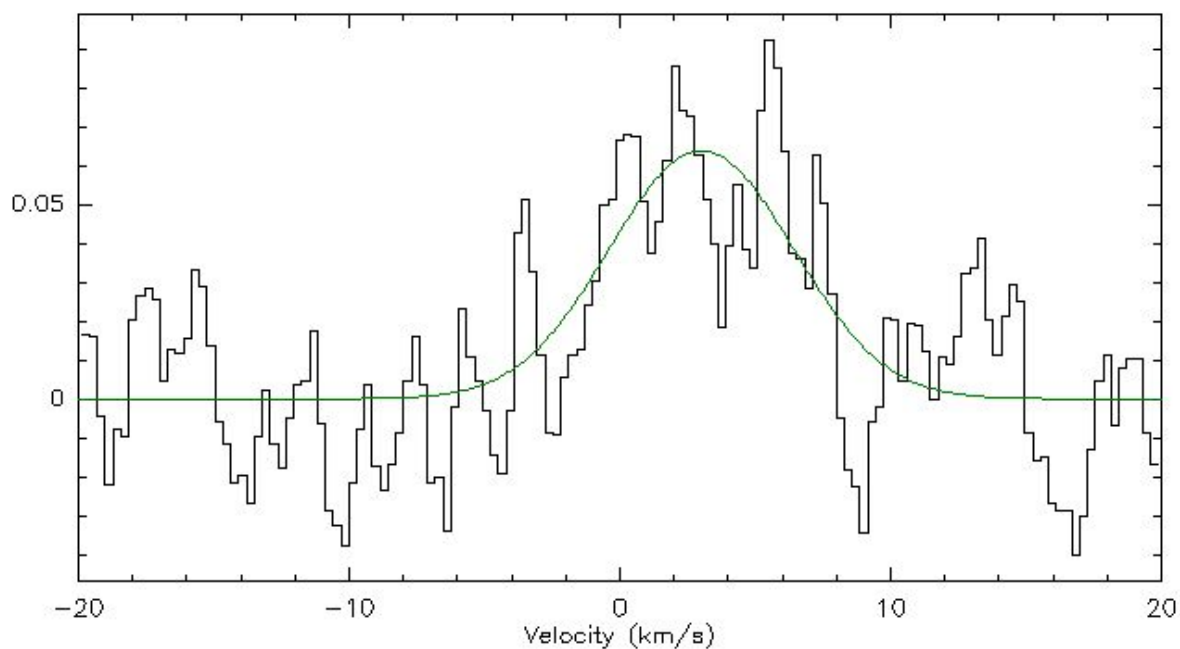


HC¹⁵N 6-5

It's in Band 1a. 516.261 GHz

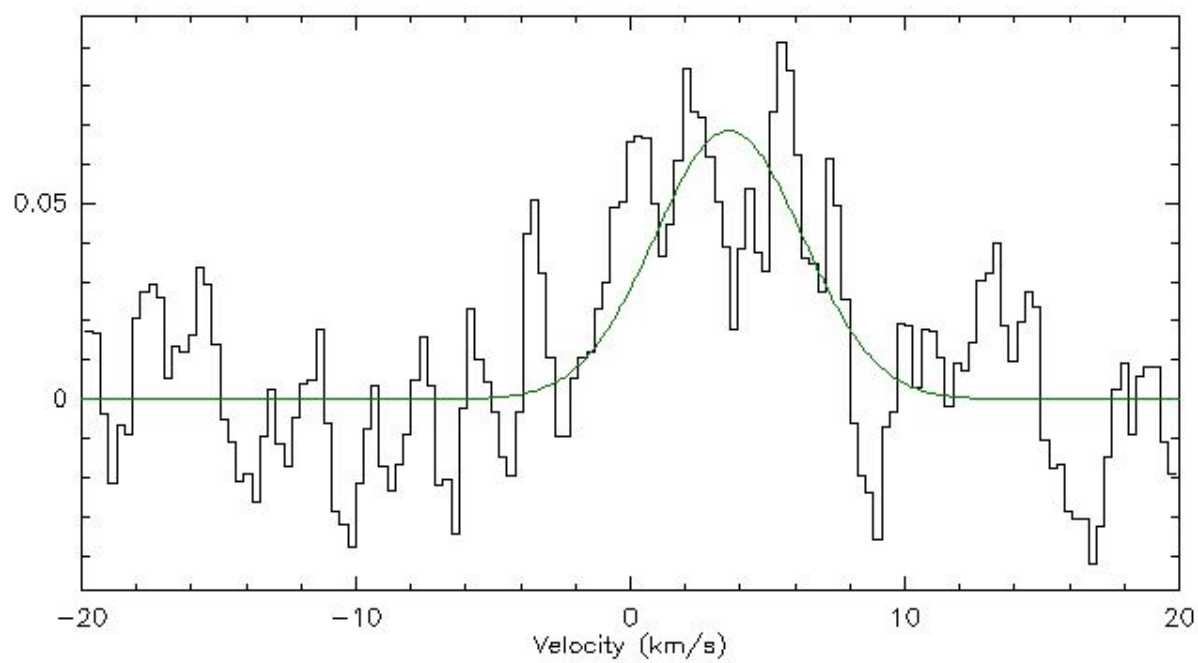
Line	Area	Position	Width	Tpeak
1	0.54126	(0.043)	3.010 (0.316)	7.957 (0.706) 6.39061E-02

1;1 iras16293-24 DECON SSB HIF-00-W--1A 0:01-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: +0.7 +4.1
Unknown tau: 0.000 Tsys: 0. Time: 5.0 min El: 0.0
N: 161006 I0: 73553.0 V0: 0.000 Dv: -0.2903 LSR
F0: 516261.000 Df: 0.5000 Fi: N/A



With width and position fixed to H13CN parameters:

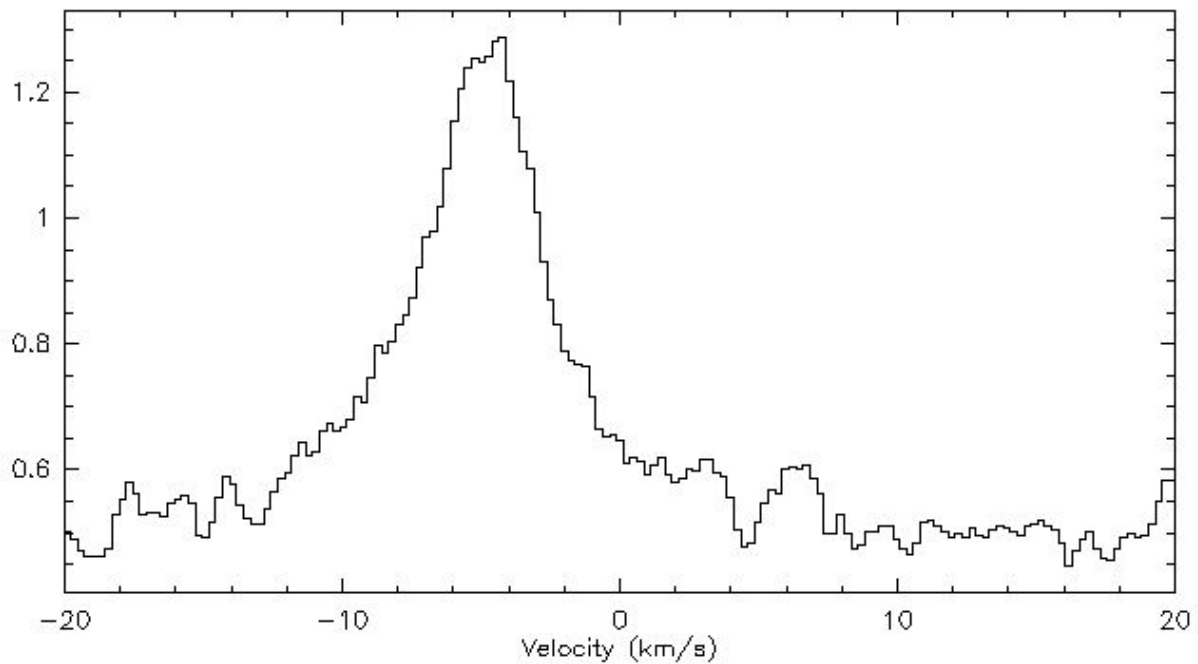
Line	Area	Position	Width	Tpeak
1	0.46173	(0.033)	3.588 (0.000)	6.320 (0.000) 6.86343E-02



HC¹⁵N 7–6

It's in Band 1b, but is badly blended. 602.275 GHz.

1;1 iras16293-24 DECON SSB HIF-00-W--1B O:02-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: +0.4 +4.0
Unknown tau: 0.000 Tsys: 0. Time: 5.7 min El: 0.0
N: 163944 I0: 95572.0 V0: 0.000 Dv: -0.2489 LSR
F0: 602275.000 Df: 0.5000 Fi: N/A

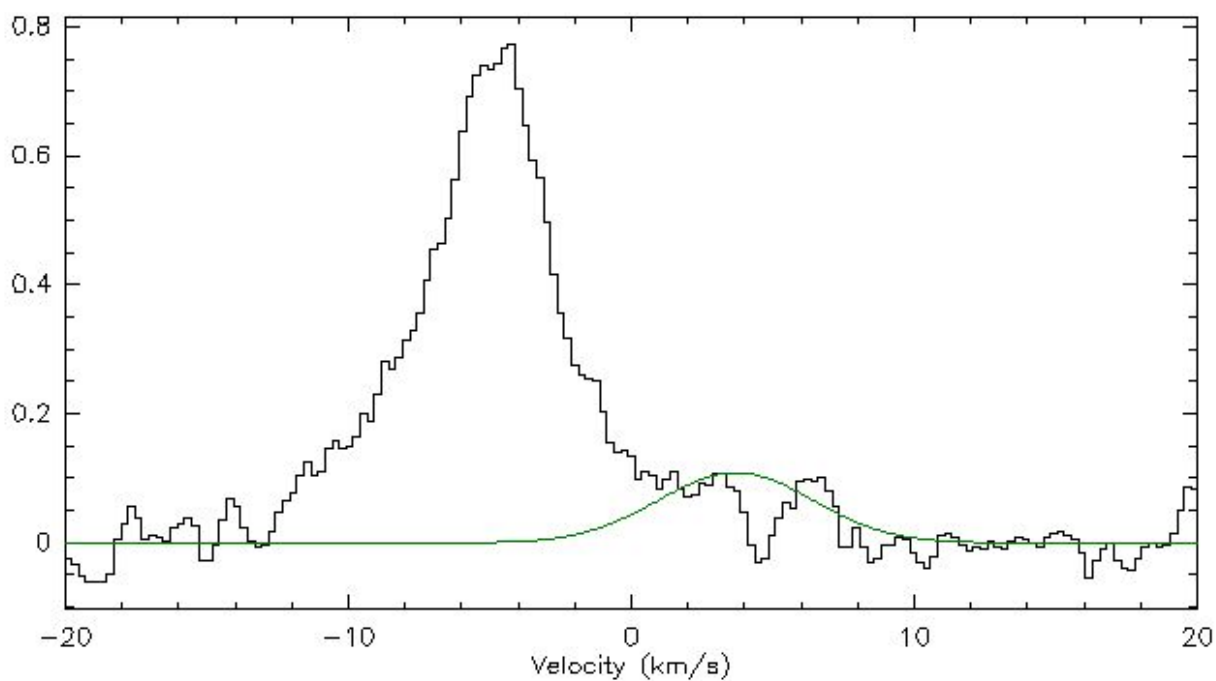


With width and position fixed to H13CN parameters:

Using h13cn parameters, I get the following “optimistic fit”, for what that’s worth:

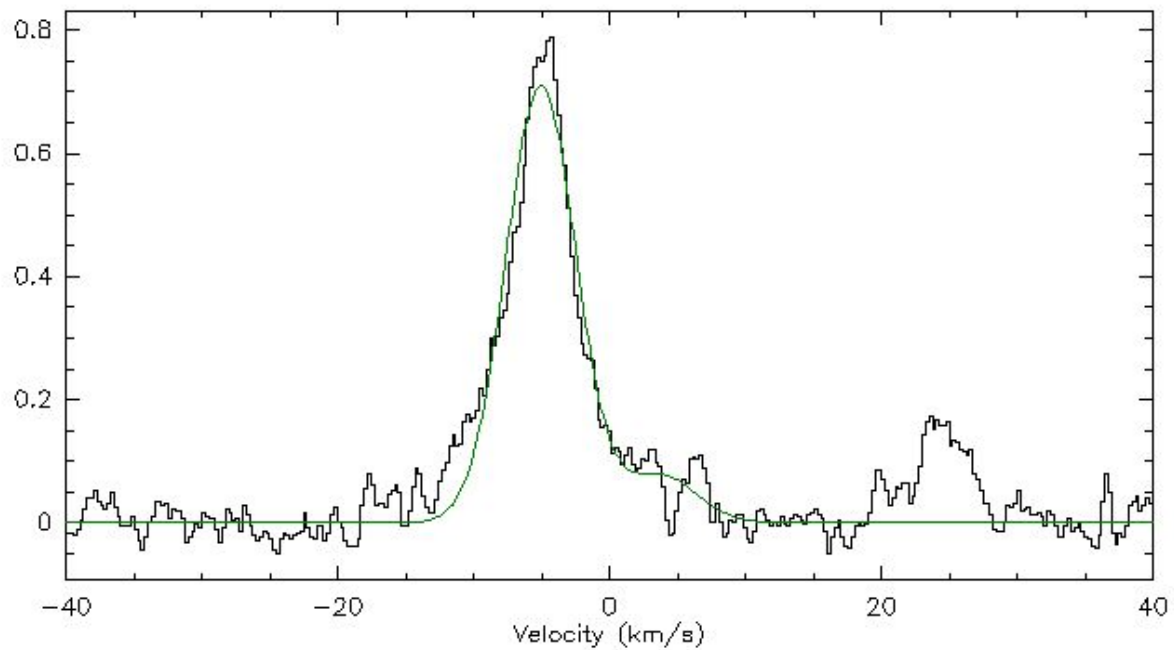
Optimistic fit

Line	Area	Position	Width	Tpeak
1	0.74452	(0.384)	3.688 (0.000)	6.425 (0.000) 0.10886



As a final attempt, here's a 2-component fit where I (a) fit that "big" line with a free-floating Gaussian while simultaneously (b) fitting a line that uses the width and position of the h13cn line as fixed priors:¹

Line	Area	Position	Width	Tpeak
1	0.53067	(0.078)	3.688 (0.000)	6.425 (0.000) 7.75926E-02
2	4.5919	(0.096)	-5.032 (0.058)	6.087 (0.164) 0.70865



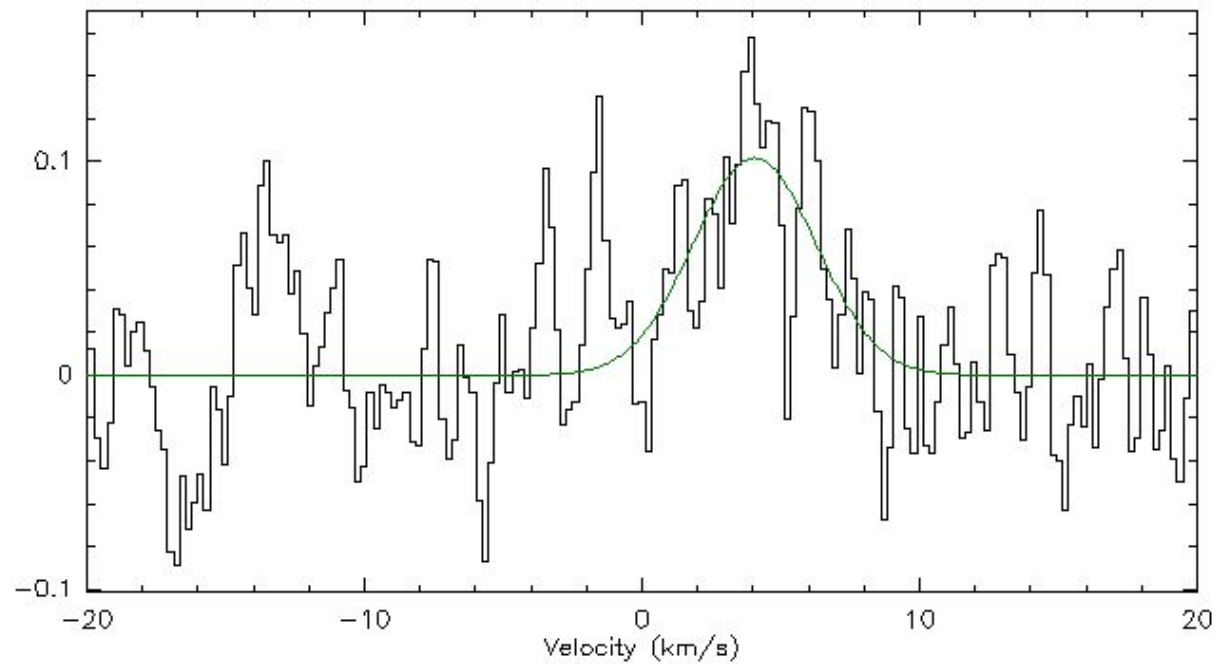
¹ Command: LAS> lines 2 "0 1 1 3.688 1 6.425" "0 1 0 -4.231 0 5.926"

HC¹⁵N 8-7

Band 2a, 688.275 GHz

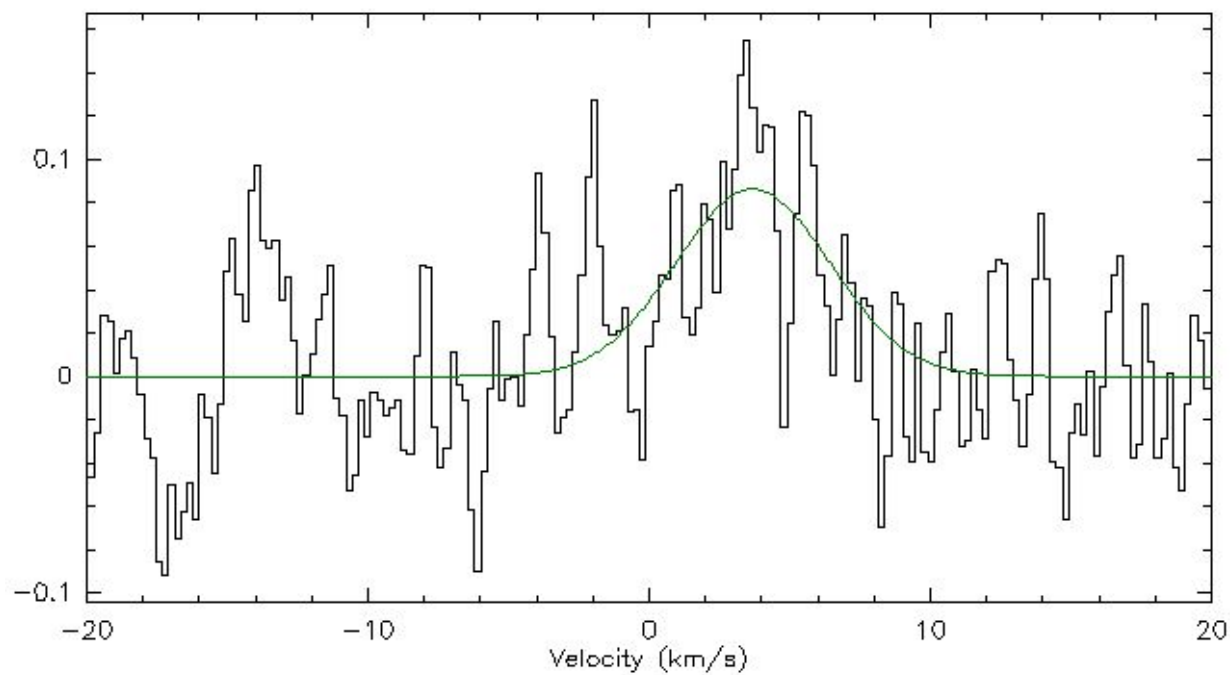
Line	Area	Position	Width	Tpeak
1	0.55974	(0.072)	4.053 (0.317)	5.182 (0.894) 0.10148

1;1 iras16293-24 DECON SSB HIF-00-W--2A O:18-FEB-2011 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: -2.1 +3.5
Unknown tau: 0.000 Tsys: 0. Time: 4.5 min El: 0.0
N: 199908 I0: 124563. V0: 0.000 Dv: -0.2178 LSR
F0: 688276.000 Df: 0.5000 Fi: N/A



With width and position fixed to H13CN parameters:

Line	Area	Position	Width	Tpeak
1	0.59042	(0.060)	3.688 (0.000)	6.425 (0.000) 8.63293E-02



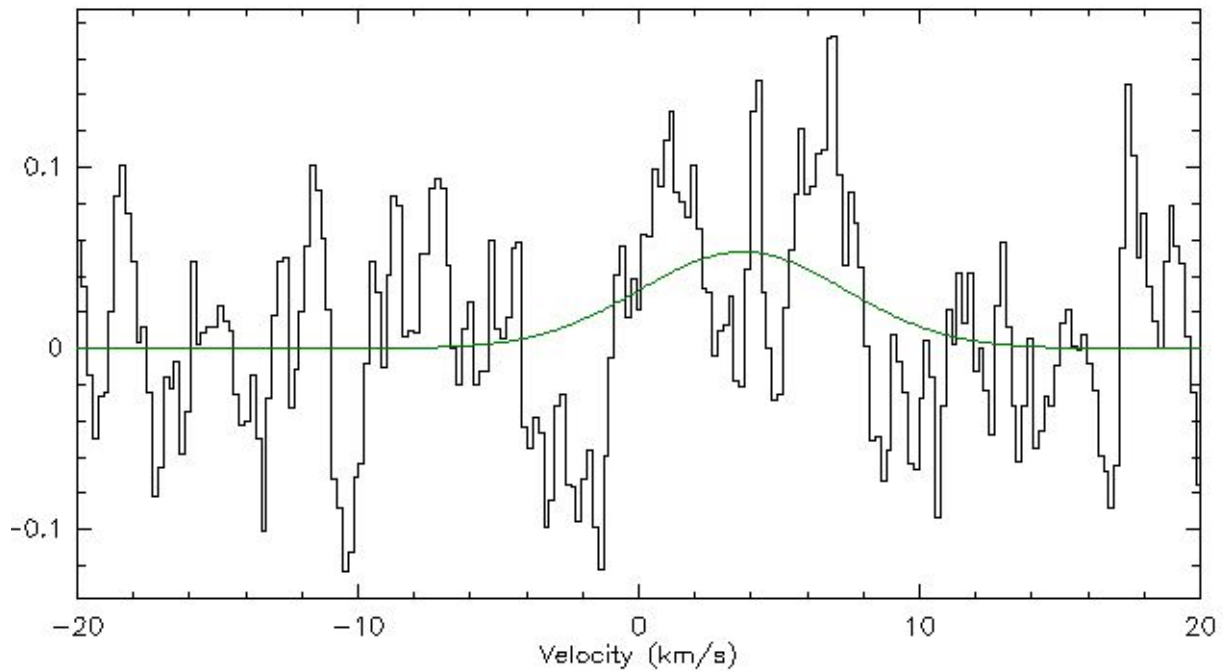
HC¹⁵N 9–8

It's in Band 2b. 774.261 GHz.

I had to fix the width and position (using exactly the values derived from the h13cn 9-8 fit) to get a not-obviously-spurious fit here:

Line	Area	Position	Width	Tpeak
1	0.48881	(0.082)	3.700 (0.000)	8.600 (0.000) 5.33964E-02

1;1 iras16293-24 DECON SSB HIF-00-W--2B O:19-MAR-2010 R:25-OCT-2016
RA: 16:32:22.75 DEC: -24:28:34.2 Eq 2000.0 Rad. 0.0° Offs: -1.2 +2.4
Unknown tau: 0.000 Tsys: 0. Time: 5.7 min El: 0.0
N: 173733 I0: 120510. V0: 0.000 Dv: -0.1936 LSR
F0: 774261.000 Df: 0.5000 Fi: N/A



Appendix: analysis commands

The following is a literal copy-paste of one of my line-fitting sessions, to give an example. The window selection ("set win") and line boundary selection ("lines 1") include an interactive step.

```
LAS> file in 3b-combined.hifi
I-CONVERT, File is [Native]
I-INPUT, 3b-combined.hifi successfully opened
LAS> find
I-FIND, 1 observation found
LAS> get first
I-GET, Observation 1; Vers 1 Scan 1
LAS> set mode x auto
LAS> set unit v v
LAS> plot
LAS> mod freq 863071
LAS> set mode x -20 +20
LAS> plot
LAS> set mode x -35 +35
LAS> plot
LAS> set win
  WINDOW #1 (low) : -.7
  WINDOW #1 (up ) : 12.2
LAS> base
I-POLYNO, degree: 1 rms: 7.807E-02 area: 0.669      v0: 3.995      width: 0.000
LAS> plot
LAS> method gauss
I-METHOD, GAUSS      selected
LAS> lines 1
  Using the cursor, type / to keep last values
    any other key to set a line boundary
    Setting line 1
LAS> mini
I-MIDGAUSS, Input Parameters: Area Position Fwhm
I-MIDGAUSS, 0.710      3.99  2.21
I-SIMPLX, Minimization has converged
I-FITGAUSS, RMS of Residuals : Base = 7.89E-02 Line = 7.34E-02
I-HESSE, Second derivative matrix inverted
I-MIGRAD, Minimization has converged
I-FITGAUSS, RMS of Residuals : Base = 7.81E-02 Line = 7.55E-02
I-FITGAUSS, Number of calls:      65
```


Observation 1 RMS of Residuals : Base = 7.81E-02 Line = 7.55E-02

Fit results

Line	Area	Position	Width	Tpeak
1	0.88238	(0.161)	4.430 (0.824)	9.495 (2.243) 8.72988E-02

LAS> visu
LAS> exit

Addendum:

Sometimes, when fitting the lines you need to fix one or two parameters (usually width and/or position) when the S/N is low and you have strong priors on these parameters. Use "help lines" to get something helpful, and here's an example:

LAS> lines 1 "0 1 1 3.7 1 8.6"

which allows the temperature to float, but fixes the position at 3.7 and the width at 8.6.

Addendum 2:

If you want to do 2 lines this way, it would look like this:

LAS> lines 2 "0 1 1 3.688 1 6.425" "0 1 1 -4.231 1 5.926"

Appendix: Lines from Caux et al. 2011

There are H¹³CN and HC¹⁵N (and DCN) lines below ~400 GHz in [Caux et al. 2011](#).

Let's copy and paste some content from [Table 4](#).

TAG	Species & Transition (MHz)	Frequency (K)	Eup s-1	Aij (km s-1)	Vo (km s-1)	δVo (K)	FWHM (K km s-1)	δFWHM	Int	δInt	Flux	δFlux	Comments
27501	HCN (1-0)	88631.60	4.25	2.41E-05	4.46	0.33	9.50	0.79	1.765	0.127	21.71	2.39	hf structure
27501	HCN (3-2)	265886.43	25.52	8.36E-04	3.00	0.22	5.94	0.51	2.812	0.209	35.12	5.97	
27501	HCN (4-3)	354505.48	42.54	2.05E-03	3.25	0.26	5.73	0.60	3.637	0.331	40.65	7.32	self abs
28002	H13CN (12-01)	86340.18	4.14	2.22E-05	3.88	0.09	2.91	0.25	0.284	0.009	1.04	0.12	hf structure
28002	H13CN (11-01)	86338.77	4.14	2.22E-05	3.84	0.06	2.87	0.17	0.191	0.005	0.75	0.09	hf structure
28002	H13CN (10-01)	86342.27	4.14	2.22E-05	3.81	0.13	2.46	0.33	0.079	0.008	0.25	0.03	hf structure
28002	H13CN (3-2)	259011.82	24.86	6.48E-04	3.32	0.58	6.63	2.62	0.600	0.080	8.16	1.39	
28002	H13CN (4-3)	345339.76	41.44	1.90E-03	4.00	0.09	5.39	0.23	0.664	0.022	6.90	1.24	
28509	DCN (2-1)	144828.00	10.43	1.27E-04	4.16	0.21	4.24	0.56	0.635	0.062	3.88	0.66	
28509	DCN (3-2)	217238.54	20.85	4.57E-04	3.36	0.07	4.54	0.19	0.440	0.013	3.49	0.59	
28509	DCN (5-4)	362045.75	52.13	2.25E-03	3.38	0.06	3.48	0.24	0.570	0.015	3.90	0.70	odd profile
28003	HC15N (1-0)	86054.96	4.13	2.20E-05	4.03	0.18	3.51	0.43	0.114	0.012	0.51	0.06	
28003	HC15N (2-1)	172107.96	12.39	2.11E-04	3.29	0.16	5.37	0.41	0.228	0.014	1.88	0.32	
28003	HC15N (3-2)	258157.10	24.78	7.65E-04	3.70	0.07	6.81	0.21	0.186	0.003	2.57	0.45	
28003	HC15N (4-3)	344200.32	41.30	1.88E-03	3.39	0.36	6.38	0.99	0.122	0.012	1.49	0.27	