Herschel Galactic Cold Cloud Core Analysis

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Abstract. We have compiled a sample of 106 lesser-known cores from the Herschel Galactic Cold Cloud Cores Key Program (Juvela, M. et al. 2007). Based on the assumption, that these represent the crowd of the cold cores in the galaxy well, we have started a deep individual investigation, beginning with a ground-based follow-up and molecular line measurement at IRAM 30m telescope. We present the methods and calculated values of the most important parameters on a selected source: the G130.38+11.25 molecular cloud, which is part of the L1340.

Keywords. ISM: clouds — dust, extinction — ISM: molecules

During the observation at IRAM 30m telescope in 2011 April 7, a 3’x3’ map was taken of the source using OTF/fsw mode. Three different line-transitions were observed simultaneously: \(^{13}\)CO(1-0), \(^{13}\)CO(2-1) and C\(^{18}\)O(1-0), using the VESPA autocorrelation spectrometer with a velocity resolution of 0.0266 kms\(^{-1}\) (100 GHz) and 0.0531 kms\(^{-1}\) (220 GHz). The integration time was 3.918s. Pointing accuracy is \(\sim 2\)”. The radius of the densest part of the cloud is determined with two independent methods: first (M1), fitting a 2D Gaussian surface to the 250\(\mu\)m SPIRE map; second (M2), applying Larson’s law to the CO velocity dispersion (\(\sigma_{1D}\)). Table 1 summarizes the results of the calculations. Both methods identify two cores, with a good agreement in the radius (R). The \(^{13}\)CO column density and H\(_2\) density is calculated from the molecular line spectra, again, using two different method. The first is a classical calculation assuming local thermal equilibrium (LTE). In the second method, we use a non-LTE excitation and radiative transfer code, called RADEX (Van der Tak et al. 2007). We find a big difference in the results of the two methods. For the dust temperature, we apply the Herschel SPIRE maps (SED fitting). Finally, we determine the virial-mass, using the equation: \(M = 3.9R_{1D}^2G^{-1}\) (see Roman-Duval et al. 1995), and we estimate the core-mass, assuming a simple spherical geometry with \(\rho \sim R^{-1.5}\) using \(n(H_2)\) calculated previously. The most important parameters of a molecular cloud are determined using different estimations and methods, leading us to a better model of such small cold cores.

References

Table 1. Parameter table for G130.38+11.25 molecular cloud cores

<table>
<thead>
<tr>
<th>Properties</th>
<th>CORE 1</th>
<th>CORE 2</th>
<th>Properties</th>
<th>CORE 1</th>
<th>CORE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Coordinate RA</td>
<td>2:32:28.4</td>
<td>2:32:26.3</td>
<td>M1 n(H(_2)) [10(^3) cm(^{-3})]</td>
<td>10.2 ± 0.9</td>
<td>15.6 ± 2.0</td>
</tr>
<tr>
<td>Central Coordinate DEC</td>
<td>+72:38:38.6</td>
<td>+72:40:19.9</td>
<td>M2 n(H(_2)) [10(^3) cm(^{-3})]</td>
<td>9.7 ± 2.2</td>
<td>6.1 ± 0.9</td>
</tr>
<tr>
<td>M1 R [pc]</td>
<td>0.052</td>
<td>0.036</td>
<td>(T_{dust}) [K]</td>
<td>11.95</td>
<td>12.33</td>
</tr>
<tr>
<td>M2 R [pc]</td>
<td>0.053</td>
<td>0.047</td>
<td>Virial Mass [M(_\odot)]</td>
<td>1.5 ± 0.2</td>
<td>0.94 ± 0.11</td>
</tr>
<tr>
<td>M1 N(^{13})CO [10(^{15}) cm(^{-2})]</td>
<td>5.6 ± 0.2</td>
<td>7.5 ± 0.2</td>
<td>M1 Core-mass [M(_\odot)]</td>
<td>2.6 ± 1.4</td>
<td>1.43 ± 0.94</td>
</tr>
<tr>
<td>M2 N(^{13})CO [10(^{15}) cm(^{-2})]</td>
<td>7.8 ± 0.3</td>
<td>11.1 ± 1.6</td>
<td>M2 Core-mass [M(_\odot)]</td>
<td>2.5 ± 1.3</td>
<td>0.58 ± 0.38</td>
</tr>
</tbody>
</table>

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