Evidence of Cloud-Cloud Collision in S235 Complex

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1. Background
2. Collision evidence in S235
3. Summary
4. Future work
Basic scenario of cloud-cloud collision introduced by Habe & Ohta (1992)

1. Background

Credit: Torii et al. 2015
Examples of collision

Table 1. Comparisons between the cloud-cloud collision regions.

<table>
<thead>
<tr>
<th>Name</th>
<th>cloud mass</th>
<th>column density</th>
<th>relative velocity</th>
<th>complementary</th>
<th>bridge</th>
<th>cluster</th>
<th>number of</th>
<th>reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCW 38</td>
<td>(20, 3)</td>
<td>(10, 1)</td>
<td>12</td>
<td>no</td>
<td>yes</td>
<td>~0.1</td>
<td>~20</td>
<td>[1]</td>
</tr>
<tr>
<td>NGC 3603</td>
<td>(70, 10)</td>
<td>(10, 10)</td>
<td>15</td>
<td>no</td>
<td>yes</td>
<td>~2</td>
<td>~30</td>
<td>[2]</td>
</tr>
<tr>
<td>Westerlund 2</td>
<td>(90, 80)</td>
<td>(20, 2)</td>
<td>16</td>
<td>yes</td>
<td>yes</td>
<td>~2</td>
<td>~4</td>
<td>[3, 4]</td>
</tr>
<tr>
<td>DBS2003 179</td>
<td>(200, 200)</td>
<td>(8, 5)</td>
<td>20</td>
<td>yes</td>
<td>no</td>
<td>&lt;1</td>
<td>&gt;10</td>
<td>[5]</td>
</tr>
<tr>
<td>ONC (M 42)</td>
<td>(20, 3)</td>
<td>(20, 1)</td>
<td>~7</td>
<td>yes</td>
<td>no</td>
<td>&lt;1</td>
<td>~10</td>
<td>[6]</td>
</tr>
<tr>
<td>ONC (M 43)</td>
<td>(0.3, 0.2)</td>
<td>(6, 2)</td>
<td>~7</td>
<td>yes</td>
<td>yes</td>
<td>~0.2</td>
<td>1</td>
<td>[7]</td>
</tr>
<tr>
<td>RCW 120</td>
<td>(50, 4)</td>
<td>(3, 0.8)</td>
<td>20</td>
<td>no</td>
<td>yes</td>
<td>~0.6</td>
<td>1</td>
<td>[8]</td>
</tr>
<tr>
<td>N159W-South</td>
<td>(9, 6)</td>
<td>(10, 10)</td>
<td>~8</td>
<td>no</td>
<td>no</td>
<td>&lt;0.2</td>
<td>1</td>
<td>[9]</td>
</tr>
<tr>
<td>N159E-Papillon</td>
<td>(5, 7, 8)</td>
<td>(4, 4, 6)</td>
<td>~9</td>
<td>yes</td>
<td>yes</td>
<td>~0.3</td>
<td>1</td>
<td>[10]</td>
</tr>
<tr>
<td>M 20</td>
<td>(1, 1)</td>
<td>(1, 1)</td>
<td>7.5</td>
<td>yes</td>
<td>yes</td>
<td>~1</td>
<td>0</td>
<td>[11]</td>
</tr>
<tr>
<td>L 1188</td>
<td>(1.2, 2.7)</td>
<td>(1.1, 2)</td>
<td>~2</td>
<td>no</td>
<td>yes</td>
<td>~1</td>
<td>1</td>
<td>This work</td>
</tr>
<tr>
<td>S 235</td>
<td>(10, 10)</td>
<td>(3, 3)</td>
<td>5</td>
<td>yes</td>
<td>yes</td>
<td>~1</td>
<td>1</td>
<td>This work</td>
</tr>
</tbody>
</table>

2~20 km/s

Super star clusters

Typical HII regions

Low- or intermediate star formation
Color composite image of S235 complex.

Red: IRAC 8 μm  
Green: IRAC 5.8 μm  
Blue: IRAC 3.6 μm
CO, $^{13}$CO, C$^{18}$O (1-0) are from PMO-14m

2. Collision Evidence in S235

Evidence 1: 5 km/s velocity separation.

Evidence 2: velocity bridge features
Evidence 3: colliding interface: velocity dispersion greater than 2 km/s
Evidence 4: complementary distribution in different wavelengths

- Grayscale: Spitzer 8 μm
- Grayscale: IPHAS Hα
- Grayscale: CGPS 1420 MHz

Traced ionized gas

Cavity
3. Summary

- 1. **5 km/s velocity separation** of blue-shifted and red-shifted cloud shows the colliding motion of S235-main and S235-AB.

- 2. **The velocity bridge features** connecting the two clouds indicate current colliding process.

- 3. **The colliding interface** can be traced by complementary morphology, large velocity gradients and high velocity dispersion of two clouds.

- 4. **The complementary distribution** between the two clouds and ionized gas support physical interaction between them.
4. Future work

- Propose JCMT CO 3-2 observations toward S235.
  mapping size: 30’ x 25’
  goal: probe the excitation condition and density properties of the colliding interface with LVG analysis.

- Star formation triggered by cloud-cloud collision.

![Graph and map showing star formation and cloud collision analysis.](image)