Triggered star formation in RCW 120

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1-Introduction

Massive stars ($M \geq 10\ M_\odot$) dominate the dynamical and the chemical evolution of galaxies. However their formation process is not fully understood. It has been shown that the presence of an H II region (region of ionized hydrogen) adjacent to a molecular cloud favours the formation of massive stars (Dobashi et al. 2001). Several processes can trigger star formation at the borders of H II regions (Elmegreen 1998). Among them the 'collect and collapse' process is particularly interesting as it allows the formation of massive molecular fragments and thus, possibly, of massive objects, out of an initially homogeneous medium. We present here a multi-wavelength study of RCW 120, a Galactic H II region candidate for this process.

Fig.1: Spitzer-IRAC 8-µm image from the GLIMPSE survey (in red) superimposed on a SuperCOSMOS Hα image (turquoise) of RCW 120.

2-Presentation of RCW 120

RCW 120 is an optical H II region of about 2.6 pc (E-W) x 3.8 pc (N-S), located at 1.3 kpc (Russeil 2003) in the direction close to that of the Galactic centre (l=348°.249, b=0°.469). The exciting star is an O8V (Georgelin & Georgelin 1970). Fig. 1 shows that the ionized gas is surrounded by a ring of dust emitting at 8 µm. This dust is formed of PAH (polycyclic aromatic hydrocarbon) molecules, which are destroyed in the ionized region. We note the circular form of the H II region, and its high degree of symmetry.

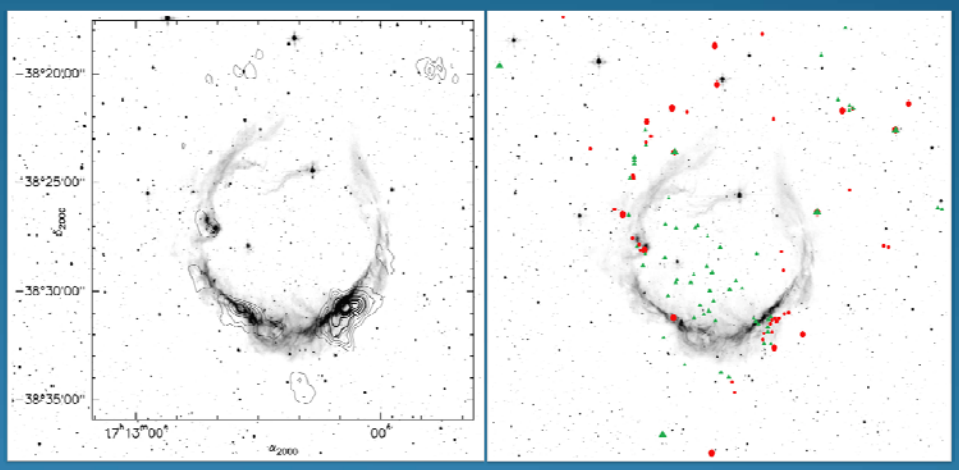

Fig.2: *Left*: Millimetre continuum emission (contours) superimposed on the GLIMPSE 5.8 µm image of RCW 120. *Right*: Spatial distribution of detected YSOs in the direction of RCW 120. Red symbols are for Class I objects, and green ones for Class II objects.

3-Collect & collapse

During the expansion of an H II region, neutral material accumulates between the ionization front and the shock front. This layer may become gravitationally unstable and collapse, leading to the formation of massive fragments. This is the « collect and collapse » process.

The cold dust continuum emission observed at 1.2 mm (fig. 2) shows the presence of a layer of collected material surrounding the ionized gas. This layer is fragmented and the fragments are massive (up to 500 $M_\odot$).

4-Stellar formation and distant triggering?

No massive stars, but some intermediate- to low-mass young stellar objects (YSOs), possibly associated with RCW 120, have been identified using the Spitzer-GLIMPSE observations between 3.6 µm and 8.0 µm and the 2MASS Survey in the near IR (*JHK* bands). These objects present an infrared excess due to heated dust either in an envelope or a disc. YSOs are mostly concentrated in the direction of condensations (fig. 2, right). But many lie far from the ionization front. Their statistics suggest that most of them are probably associated with RCW 120. The problem is to understand what process can trigger star formation so far from the ionization front. Fig. 3 show an unsharp-masked image of RCW 120 at 8 µm which suggests a leaky ionization front. These structures indicate that the UV radiation can penetrate far inside the surrounding photodissociation region.

5-Comparison with models

The density of the initial medium in which RCW 120 expands, based on 1.2 mm emission, is estimated to be ~ 1500 atoms cm^{-3}. The model of Hosokawa and Inutsuka (2005) allows one to derive some physical parameters of RCW 120. Fig. 4 show the results of this simulation. The radius of RCW 120, 1.67 kpc, is reached at t=0.4 Myr. The collected layer then has a mass ~ 1000 $M_\odot$. It has been gravitationally unstable for the last 0.1 Myr, hence compatible with the observation of a fragmented shell.

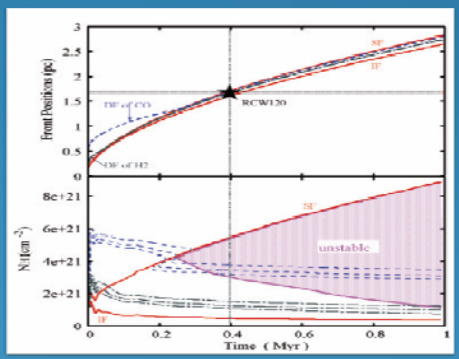

Fig.4: *Top*: time evolution of the positions of the various fronts (IF, SF, dissociation fronts of the H_2 and CO molecules). *Bottom*: time evolution of the column density of various components. The shaded region corresponds to $t \geq (G\rho)^{-1/2}$ and indicates that gravitational fragmentation is expected. The contours represent the position where the fractions of molecular gas X_{H_2} (dashed contours) and X_{CO} (dot-dashed contours) = 0.2, 0.5 and 0.8.

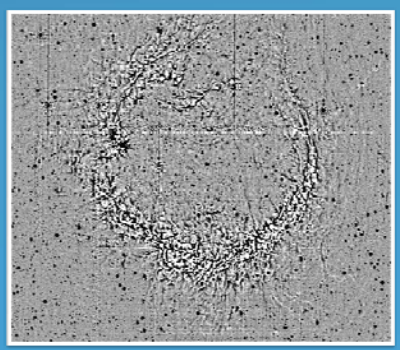

Fig.3: Unsharp-masked image of RCW 120 at 8 µm. It shows low brightness PAH emission features extending far from the ionization front.

6-Futur Herschel GT observations

Four Galactic H II regions (Sh 104, RCW 79, RCW 82 and RCW 120) will be observed with PACS and SPIRE. Imaging and spectroscopy will be performed with both instruments with the aims of:

1. Obtaining a complete census of the YSOs observed towards those regions and analyzing their properties (spectral energy distribution, mass and luminosity)
2. Deriving the physical conditions towards the associated photodissociation regions using PACS and SPIRE spectroscopy (from 55 to 670 microns) and PDR models
3. Studying the gas and dust properties and evolution going from the ionized region to the cold condensations

7-Conclusion

We have shown that 'collect and collapse' has occurred around RCW 120, forming a fragmented shell of gas around the H II region. RCW 120 appears to be an active site of stellar formation. However no massive YSO has been detected. If any are present they must be searched for at longer wavelengths, in the direction of the most massive fragment. Herschel will make such an observation possible.

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