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RCW98: a dust enshrouded HII region

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Abstract. RCW 98 is an HII region with an active star formation in its immediate neighbourhood. At least three early-type stars ionize it and it contains the bright rimmed cloud. Our observations of this region in the optical regime shows that RCW 98 is a complex and dynamical region. We have created a simple model of the dust distribution in this object, but it is not fully consistent with the optical observations. We also study the effects of ionizing stars on the dust.

Keywords. ISM: bubbles, ISM: individual (RCW 98)

1. Introduction

RCW 98 is an HII region inside the infrared bubble S73 (Churchwell *et al.* 2006) with another smaller infrared bubble S74 inside. There are three known early type stars in the region (Pinheiro, *et al.* 2010): LSS 3423 (O9.5V star, considered to be the main ionizing star), ALS19480 (O9.5V star, with a high extinction) and 2MASS J15554264-5439018 (B2.5V star). RCW 98 contains a bright rimmed cloud SFO75: Sugitani & Ogura (1994), Urquhart *et al.* (2009). It is a place of the active star formation; see e.g. Sharma *et al.* (2016) and Urquhart *et al.* (2009); with many potential young stellar objects. Inside the molecular cloud an ATLASGAL clump AGAL327.568-00.852, Csengeri *et al.* (2014), is located.

All three main stars of RCW 98 are listed in the Gaia DR2 catalogue (Gaia Collaboration (2018): LSS 3423 = DR2 5884682031137168768, ALS19480 = DR2 5884681069064466176, 2MASS J15554264-5439018 = DR2 5884681275222918272. Their parallaxes are 0.165 *mas*, 0.355 *mas* and 0.388 *mas*, respective distances (Bailer-Jones *et al.* 2018) are 4.2 *kpc* (lower limit: 3.0 *kpc*, upper limit: 6.4 *kpc*), 2.6 *kpc* (lower limit: 2.3 *kpc*, upper limit: 3.2 *kpc*) and 2.4 *kpc* (lower limit: 2.2 *kpc*, upper limit: 2.7 *kpc*). Distances around 2.5 *kpc* are in agreement with previous distance estimates, the Gaia distance of the brightest star LSS 3423 is very different. Since LSS 3423 is a binary, its Gaia DR2 distance is probably incorrect.

2. HII region and the dust

We observed several selected points inside RCW 98 by the spectrograph FEROS at the 2.2m MPG/ESO telescope (ESO programs 097.A-9039(C) and 099.A-9039(C)). Radial velocities of the HII gas (the $H\alpha$ line) agree with measured radial velocities of the molecular cloud, they lie in the interval $v_{lsr} \in (-44, -35)$ kms^{-1}. $H\alpha$ and $[NII6584]$ line profiles are shown in Fig. 1 (right) for two of the measured points. The location $P1$ lies further away from the star forming activities and is connected to the smoother S73 bubble. The location $P2$ lies inside the small infrared bubble S74, which is directly connected to the cloud. Line profiles are different from each other, $P1$ is simple while $P2$

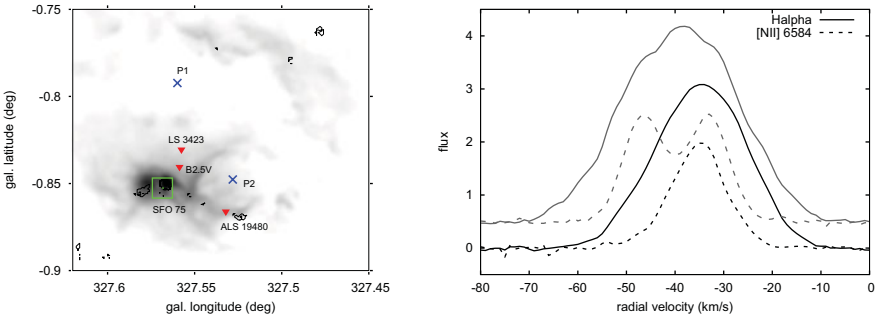

Figure 1. Left: the far-infrared image of RCW98 (Herschel, PACS blue) with superimposed contours of the calculated optical thickness. Triangles are early-type stars in the region, square is the position of the bright rimmed cloud SFO75, crosses denote positions of measurements shown in the right panel. Right: $H\alpha$ and $[NII6584]$ emission from two positions inside the HII region: $P1$ (darker lines) and $P2$ (lighter lines). $P2$ values are artificially shifted upwards by 0.5.

is more complex with a shape, which can be explained by the presence of two denser ionised walls surrounding the more rarefied (ionised) gas, with the velocity separation of these walls 14 kms^{-1}. Using this velocity separation as twice the expansion velocity we can calculate the kinematic age of the structure (Weaver *et al.* 1977; Ehlerová & Palouš 2018): $t_{kin} \simeq 0.7\ Myr$.

Using HERSCHEL observations of this region (all 5 filters) we have calculated the temperature and optical thickness of the emitting dust. The average temperature of the dust in the studied region is 28 K with the minimum value of 17 K and the maximum value 42 K. However, the model of one-temperature component is probably too simplistic for this complex region. Only the star ALS19480 was found to lie in the dust filament, surrounded by a local increase in the temperature. Other two stars, including the brightest LSS 3423, have no visible effect on their surrounding in our calculated maps of temperature and optical thickness. Moreover, we were not able to construct a reasonable picture, which would explain both the dust and ionized gas properties.

Acknowledgements

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