The stellar population of ultra-compact H II regions: the case of IRAS 10049-5657

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Abstract: We have performed a near-infrared survey of 45 ‘southern’ UCHIIIs and identified the deeply embedded, ionizing stars using VLTI/ISAAC K-band spectroscopy. The photospheric spectra of these young massive stars allow the secure classification of their photospheric properties. As an example, we discuss the UCHII IRAS10049-5657, which hosts a young cluster of stars. Two of the (possible) cluster members are classified as O4.5 and O6, respectively. With this classification, the cluster ZAMS and distance is calibrated. The cluster consists of several dozen OB stars and likely is a recently formed OB association. Although the cluster is probably very young, the deeply embedded O stars show “normal” photospheric spectra. IRAS 10049-5657 most likely is a compact, instead of an ultra-compact H II region.

Ultra-compact H II regions (UCHIIIs) represent the earliest recognizable stage of massive-star formation. Our observational program is aimed at the direct detection of the photospheric spectrum of the embedded OB-type stars at this early stage of stellar evolution, and at the determination of their stellar parameters. Our ultimate goal is to better understand the formation process of massive stars. UCHII regions are intensively studied at radio and far-infrared wavelengths, which probe the large amounts of gas and dust in which these regions are embedded. UCHII regions are among the brightest 100 µm sources and have specific IR colors (Wood and Churchwell, 1989,ApJS,69,831). The IRAS point source 10049-5659 fulfills these selection criteria; however, the absence of methanol maser emission (Walsh et al. 1997,MNRAS,291,261) might suggest that this UCHII is already somewhat evolved.

Near-infrared images were obtained with ESO's NTT and SOFI, using narrow-band filters in the J and K band. Figure 1 displays a colour composite image of the UCHII 10049-5657; figure 2 shows the (K,J-K) diagram for the stars located inside the region exhibiting Brγ emission. The white symbols represent foreground stars. However, the stars in yellow seem to be embedded in the UCHII and are part of a reddened main sequence, suggesting that they are the members of a young, embedded cluster. Their reddening in J-K ≈ 2.5, which corresponds with a radial velocity of v_r ≈ 18. The brightest of these are candidate O stars for which we obtained VLTI/ISAAC spectra.

The K-band spectra of the two O stars show a “normal” photospheric spectrum. This indicates that the OB stars in IRAS 10049-5657, though young, have clearly passed their phase of formation. This supports our view that 10049-5657, with a spatial extent of about 2 pc, is a compact, instead of an ultra-compact H II region.

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We have performed a near-infrared survey of 45 "southern" UCHIIIs and identified the deeply embedded, ionizing stars using VLTI/ISAAC K-band spectroscopy. The photospheric spectra of these young massive stars allow the secure classification of their photospheric properties. As an example, we discuss the UCHII IRAS10049-5657, which hosts a young cluster of stars. Two of the (possible) cluster members are classified as O4.5 and O6, respectively. With this classification, the cluster ZAMS and distance is calibrated. The cluster consists of several dozen OB stars and likely is a recently formed OB association. Although the cluster is probably very young, the deeply embedded O stars show “normal” photospheric spectra. IRAS 10049-5657 most likely is a compact, instead of an ultra-compact H II region.

We took VLTI/ISAAC spectra for two of these candidate O stars (#59 and #44), which are displayed in Figure 3. The K-band spectra of these objects (yellow) are shown next to spectra of two comparison O stars in Carina (white) for which both the optical and the K-band spectral features are known. Just a few diagnostic lines in the K band allow the definitive classification of O and B stars. The C iv (2.07 µm) and N iii (2.11 µm) lines are characteristic of early O-star spectra (Hanson et al. 1996,ApJS,107,281); the C iv line is only present from spectral type O5 to O8.5, and the N iii disappears for stars with spectral type later than O7. In the late-O and early-B stars, the He i line at 2.113 µm becomes more and more prominent. With these criteria, we have determined the spectral type of these two stars to be O4.5 (44) and O6 (59). The other several dozen stars on the reddened main sequence must be OB-type stars as well, suggesting that we are studying a recently formed OB association.

Figure 1: Colour composite of three narrow-band images of IRAS10049-5656 obtained with NTT/SOFI (Kaper et al. 2001). Colour code: blue J, red Brγ, green H2. Figure 2: Color magnitude (K vs. J-K) of the encircled region of Figure 1. The color code is equal to the color code used in Fig1. The lines represent the position of the ZAMS of OB stars for different visual extinction (A_V).

Figure 3: The K-band spectra of two young O stars embedded in IRAS10049-5659 (yellow), together with two comparison spectra of two O stars in Carina (white) with known optical spectra.