A SURVEY of SYMBIOTIC STARS in the SMC

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Abstract

Symbiotic systems (SySts) are interacting binary systems with high matter transference rate, and because of that they are among the most prominent candidates for type Ia supernova (SN Ia) progenitors. In order to verify the consistency of this hypothesis a census of SySts of a specific galaxy is needed.

So far, only 8 SySts have been found in the Small Magellanic Cloud (SMC), although based on the Magrini et al. (2003) estimation of the expected number of SySts in the Local Group dwarf galaxies, the SMC would host at least 465 SySts – 0.5% of the total number of RGB plus AGB stars in whole galaxy, 93,000 (Dobbie et al. 2014).

This work aims to find new SySts in the SMC using two methods. i) Conducting a narrow-band O VI Raman scattered line imaging survey (6825Å) of a crowded central region of the SMC (11 fields of 6.8x6.8 arcmin² were observed with FORS2@VLT. And ii) Through a narrow (*Hα*) plus broad-band (*r'* and *i'*) imaging survey, carried out using Goodman@SOAR, of an outer region of the SMC (44 fields of 7.2x7.2 arcmin² each were already observed).

Methods

Raman Line Imaging - According to Schmid & Schild (1994) at least 50% of the Galactic SySts exhibit the OVI Raman scattered line at 6825Å (Fig. 1). Recently, Mikolajewska et al. (2014) showed that 55% of the new SySts in the M31 have this line. Regarding the SMC, all the 8 known SySts show the Raman line (100% of the sample).

Our method is based on the simple narrow-band O VI Raman scattered line imaging. The advance of this method is that larger areas can be observed with a relatively short time exposures.

By imaging with on- and off-band filters, the subtraction of the off-band continuum emission allow us to get a rough estimation of the OVI Raman line flux. This is so, because we observed one known SySt (SMC 3) for which the OVI Raman flux is found in the literature. The main criteria for accepting a source as a OVI Raman line emitter was $\Delta mag = mag_{OVI} - mag_{con} > 0.15$.

2MASS photometric data were found for 7 out of 18 SySt candidates – the 18 strong OVI Raman emitters – and their colour indices were found to be similar to those of the known SySts of the SMC (Fig. 4).

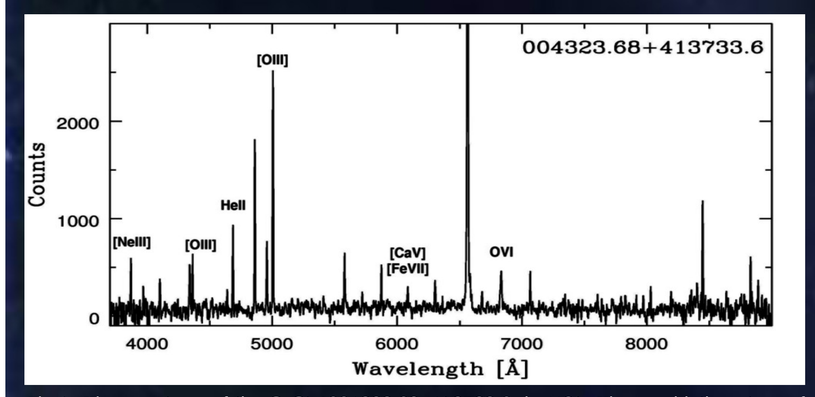

Fig 1. The spectrum of the SySt J004323.68+413733.6, in M31. The symbiotic nature of this object was confirmed due to the presence of the broad OVI Raman scattered line at 6825Å (Mikołajewska et al. 2014).

Narrow plus Broad-Band Imaging - This method is based on the IPHAS photometric colours (*r'* - *Hα* vs *r'* - *i'* – Fig. 2), which selects and discriminates in regions all the sources contained in this survey with strong *Hα* emission: SySts, planetary nebulae (PNe), T-Tauri stars, compact H II regions, Be stars (Be-S), among others.

After selecting S(stellar) and D(dust) SySt candidates, Rodríguez-Flores et al. 2014 also used a second colour-colour diagram, this one based on 2MASS colours (*J- H* vs *H-Ks* – Fig. 2b), in order to eliminate as many as possible PNe that were contaminating the SySt sample if only the first criterion of selection is applied.

So far 19 SySts have been spectroscopically confirmed through the combined criteria using IPHAS colours and 2MASS colours (Rodriguez-Flores et al. 2014), in a region of the Galactic plane in which only 11 SySts were known previously.

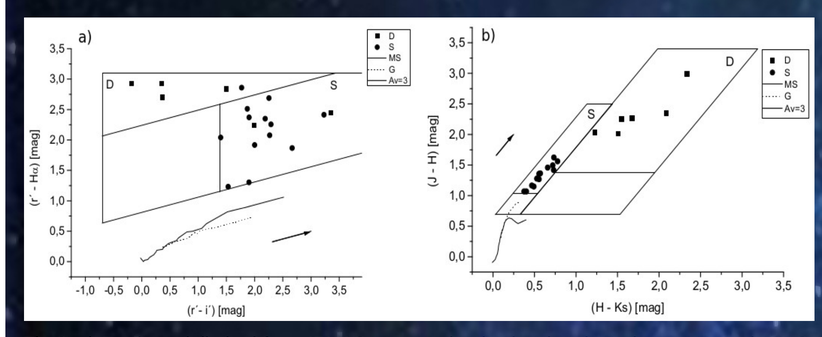

Fig 2. a) Regions delimited from IPHAS survey, clearly showing the colour ranges where S- and D-type SySts are found. 2.b) Regions delimited using 2MASS colours, which can help in separating SySts from other objects (Rodríguez-Flores et al. 2014).

Preliminary Results

i) Fig.3 highlights the source locations, on the Hα image of the SMC, we found with the OVI Raman line imaging method (yellow circles). 18 strong OVI Raman scattered line emitters were identified in the observed area of the SMC.

ii) Seven out of the 18 sources have 2MASS data which allow us to locate them in the J-H vs H-Ks diagram. Our candidate SySts and the known SySts in the SMC share the same locus in the 2MASS CCD, whereas the Galactic IPHAS SySts are systematically redder (Fig.4).

Iii) The SySt detection by the Raman line imaging method proves to be the most robust one until now to search for SySts, since the presence of the Raman scattering lines is an almost clear-cut proof of the presence of a symbiotic star.

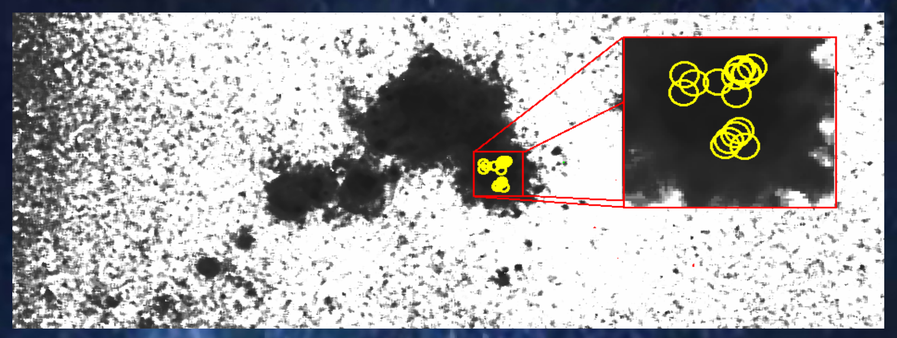

Fig 3. *Hα* image of the SMC (12.5 x 5.1 degree²), The yellow circles portray the position of the 18 candidate SySts we found using the narrow-band OVI Raman imaging method.

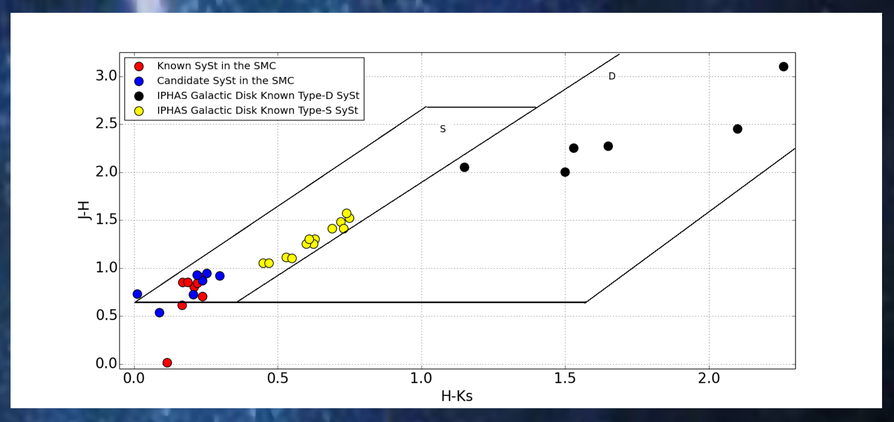

Fig 4. 2MASS colour–colour diagram of SySts. The yellow and black circles represent the 19 SySts found by IPHAS survey at the Galactic disk. The two regions enclosed by the black lines define the regions of the S- and D-type SySts (Rodríguez-Flores et al. 2014). The red and blue circles correspond to the known SySts in the SMC, and our sources for which 2MASS data are available, respectively.

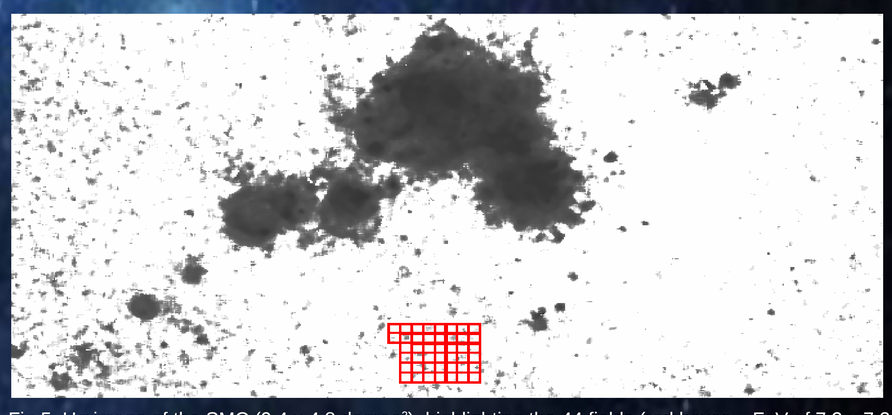

Fig 5. H*α* image of the SMC (9.4 x 4.8 degree²), highlighting the 44 fields (red boxes – FoV of 7.2 x 7.2 arcmin² each) in an outer area of the SMC that were imaged by Goodman@SOAR. Images were taken with *Hα, r'* and *i'* filters. The narrow plus broad-band imaging method will be applied to these fields for discriminating SySts from other objects.

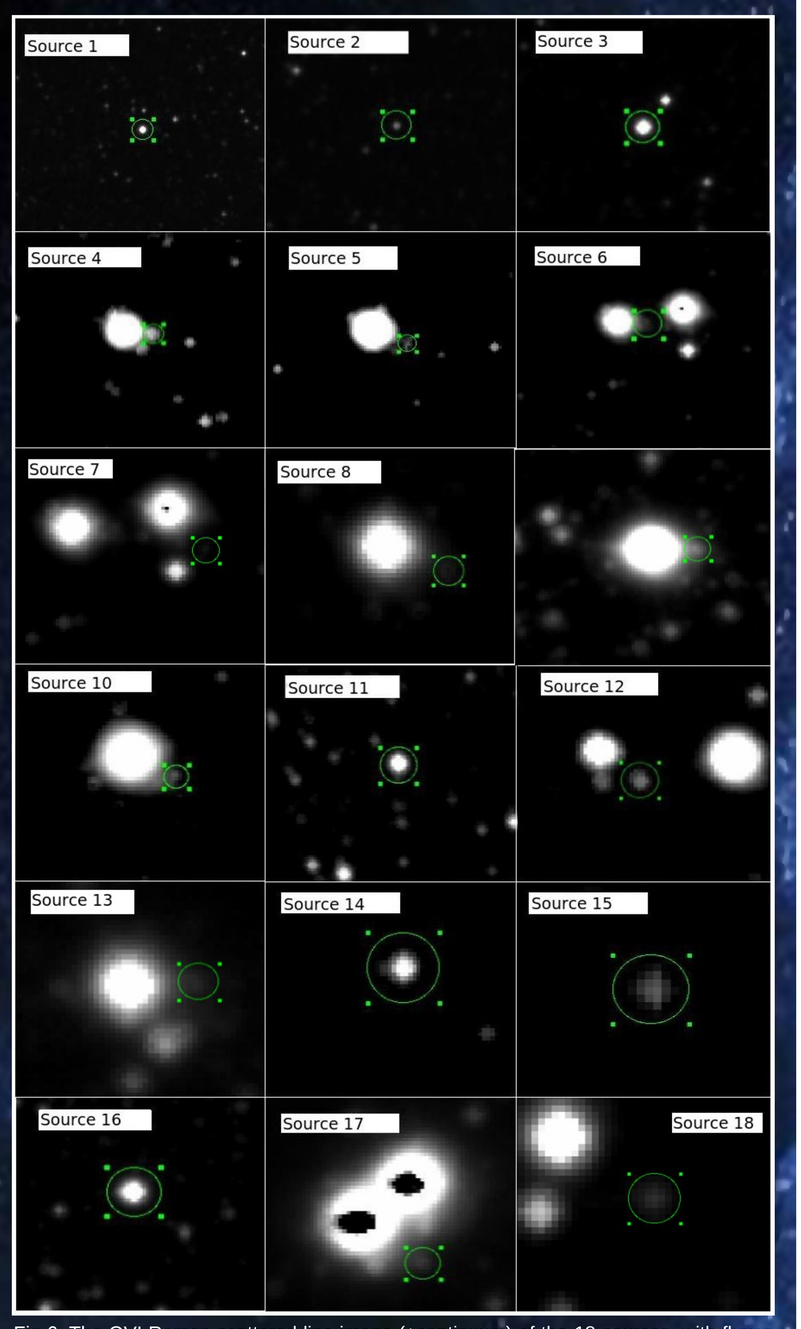

Fig 6. The OVI Raman scattered line image (+continuum) of the 18 sources, with fluxes of ~3×10^{-16} erg cm^{-2} s^{-1} – 1.17×10^{-14} erg cm^{-2} s^{-1}. The SySt candidates are highlighted with green circles. Each box has 15 x 15 arcsec².

Observations

1) In the 96A period, we observed eleven 6.8x6.8 arcmin² fields in a crowded area of the SMC (one of them centered on the known SySt – SMC 3) with the FOcal Reducer and Spectrograph (FORS2) at the Very Large Telescope.
We used two filters centered at 683.2 nm (on-band) and 677.4 nm (off-band), with 3 exposures of 150s.

2) The 2015B period was addressed to use the SOAR Goodman Spectrograph (7.2 x 7.2 arcmin² FoV), an instrument capable of performing spectroscopy and imaging in the optical, which contains the *Hα, i'* and *r'* filters. A total of 44 fields in an outer area of the SMC were imaged (Fig 5), with three exposures of 150s, 12s and 10s, in *Hα r'* and *i'*, respectively. At this moment the SOAR data are being reduced.

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