

# Planetary-Nebulae/Stars-Clusters associations

Danilo González Díaz<sup>1</sup>

Christian Moni Bidin<sup>2</sup>

<sup>1</sup> Instituto de Física, Universidad de Antioquia, Medellín, Colombia

<sup>2</sup> Instituto de Astronomía, Universidad Católica del Norte, Antofagasta, Chile.

**Synopsis** We have assessed the membership of the Planetary Nebula (PN) NGC 2452 in Open Cluster (OC) NGC 2453 via radial velocity on intermediate-resolution spectra. This pair PN/OC has shown to be hard because the line of sight in which they lie are highly contaminated for field stars belonging to Puppis OB associations and Perseus Arm. Additional deep UBVR photometry and data of the Gaia Second Data Release (DR2) were acquired to establish more accurately the fundamental parameters of the cluster as distance, proper motion, reddening and age. We conclude finally that NGC 2452 is not a member of NGC 2453, but a most likely member of the Galaxy Arm.

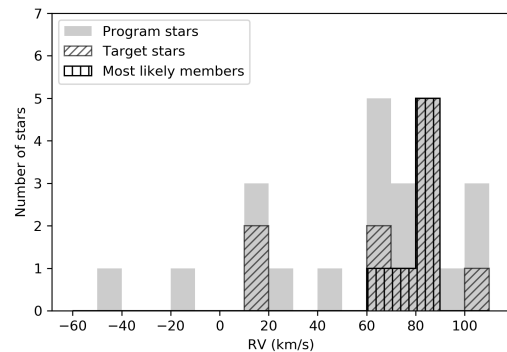
To date, several hundred Galactic PNe are known, but the distances to individual PNe are difficult to establish. Determining real associations between open clusters (OCs) and PNe can provide an accuracy distance as well as important constraints for their fundamental properties. Unfortunately, the number of Galactic PNe that are members of star clusters is quite small. Nowadays, just four association PN/OC have been confirmed.

The cluster membership of the PNe offers a reliable scenario to determine luminosity, age, physical size, luminosity and mass of the central star, among others. Star cluster poses solid spectroscopic observations and deep multi-band photometry may yield distance uncertainties less than 10%. Once the membership is establishing, the PNe inherit the cluster properties.

In this work, we present the first of a series of works aimed to assess membership among some PNe lying in the line of sight of OCs. More specifically, we have assessed the discussed membership of the PN NGC 2452 in OC NGC 2453. Possible membership on this pair have been debated it by many authors (see for instance, Mallik et. al. 1995 [1], Majaess et. al. 2007 [2], Moni et. al. 2014 [3]). Nevertheless, results have not been conclusive. The line of sight in which they lie are highly contaminated for field stars belonging to Puppis OB associations and Perseus arm.

We have adopted the methodology followed by Moni et. al. 2014 [3] to assess the membership of NGC 2452 in NGC 2453 via radial velocity on intermediate-resolution spectra. Radial velocity distribution of the program stars is shown in Fig. 1. Possible cluster stars were selected as Targets, but in the observation run some additional stars fell in the slit. By cross-matching ra-

dial velocities with distances and proper motions drawn from Gaia Second Data Release (DR2), we identified the most likely cluster members. Fig. 1 shows that radial velocity of the cluster fall among 80-90 km·s<sup>-1</sup>, disagreeing with that for the PN of 62 ± 2 km·s<sup>-1</sup>. Additional deep UBVR photometry were acquired to establish more accurately the fundamental parameters of the cluster. We obtained cluster distance of  $d \sim 4.7$  kpc, reddening of  $E_{(B-V)} \sim 0.42$  mag and age of  $\sim 40$ -50 Myr. We conclude finally that NGC 2452 is not a member of NGC 2453, but a most likely member of the Galaxy Arm.



**Figure 1.** Radial velocity distribution of the stars observed in NGC 2453.

## References

- [1] Mallik, D. C. V., Sagar, R., Pati, A. K. 1995, A&AS, 114, 537.
- [2] Majaess, D. J., Turner, D. G., Lane, D. J. 2007, PASP, 119, 1349
- [3] Bidin et. al. 2014. A&A 561, A119 . [0004-6361 201220802](https://doi.org/10.1051/0004-6361/201220802)

<sup>1</sup>E-mail: [danilo.gonzalez@udea.edu.co](mailto:danilo.gonzalez@udea.edu.co)

<sup>2</sup>E-mail: [cmoni@ucn.cl](mailto:cmoni@ucn.cl)