*Massive Stars Near and Far*
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# Infrared studies of the massive stellar population at the Galactic Center and the inner disk

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**Abstract.** We present results from our ongoing infrared spectroscopic studies of the massive stellar content at the Center of the Milky Way (GC) and across the obscured Galactic disk. Together with the full characterization of these clusters, we seek to obtain a present day metallicity 2-D map of the inner Galaxy and characterize the influence on the bar in the chemical evolution. We will also constrain the clusters IMFs, infer the presence of possible top-heavy recent star formation histories and test massive star formation channels: clusters vs isolation.

**Keywords.** stars: early-type, (Galaxy:) open clusters and associations: general, Galaxy: center, Galaxy: abundances

## 1. Program description

Massive stars in young massive clusters are ideal tracers of the present day metallicity of the Galactic region where they are located. Since $\alpha$-element and Fe enrichment follows different routes and timescales, measuring the $\alpha$ vs Fe ratio constrains the past star formation history. The infrared allows us to peer through the strong extinction veil towards the inner regions of the galactic disk and hence characterize these clusters. We have shown (Najarro et al. 2004, 2009) that quantitative NIR spectroscopy of high-mass stars using CMFGEN (Hillier & Miller 1998) provides estimates of both absolute abundances and abundance ratios. LBVs and B-hypergiants yield Fe and $\alpha$-element (Mg, Si) estimates, direct oxygen abundances are obtained from O-supergiants, while indirect oxygen estimates and direct Si values are extracted from WNh stars. Our program has obtained near-infrared moderate-resolution (R 3000-5000) spectroscopic observations of several massive clusters distributed across the inner Galactic disk and the Galactic Center (Arches, Quintuplet and isolated stars) using GNIRS and NIFS at GEMINI, ISAAC, SINFONI and KMOS at VLT and EMIR at GTC.

## 2. Preliminary results

**Arches cluster:** a deep spectroscopic survey (Clark et al. 2019) has revealed the presence of O9.5V stars and an apparent turn-off at O4-5V. Using our modeled stellar

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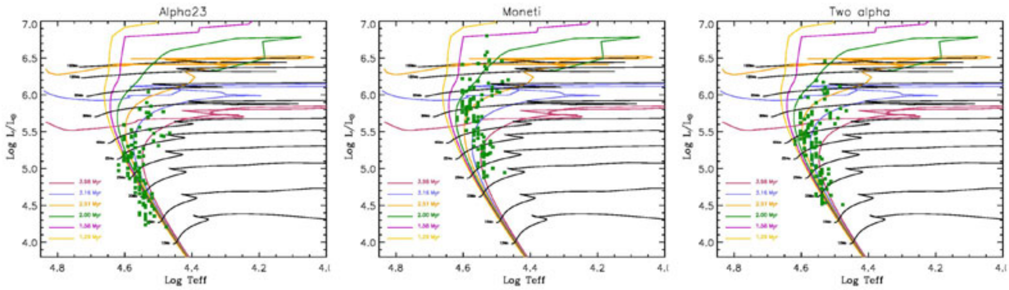


**Figure 1.** Testing the extinction towards the Arches. Recent ($\alpha \sim 2.3$,**left**) and previous (Cardelli, **center**)) extinction laws severely underestimate/overestimate the luminosities for the Arches main sequence stars. A two-$\alpha$ law yields better results (**right**).

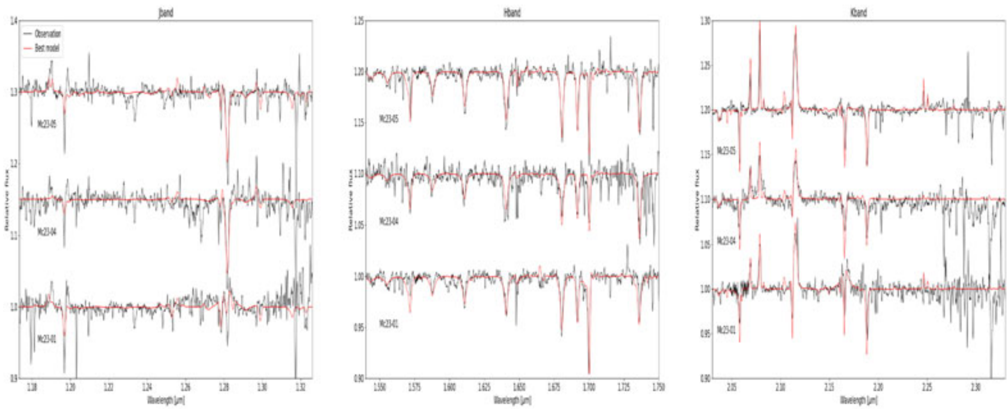

**Figure 2.** Fits to stars in Mercer23 in the J- (**left**), H- (**center**), and K-bands (**right**).

properties and placing the objects in the HR-diagram we may test the validity of the extinction law. Current best value, $\alpha$=2.3, from Red Clump stars (Nogueras-Lara et al. 2019) severely underestimates the resulting luminosities for the Arches main sequence stars. We find a degeneracy that is solved by means of a two-$\alpha$ law (see Fig. 1).

**Galactic disk:** following the strategy presented in previous studies (Najarro et al. 2004, 2009), we are currently analyzing the stellar population of other Galactic disk clusters. As an example, we show in Fig. 4 model fits to a selection of objects in Mercer 23 observed in the J, H and K bands with EMIR/VLT. Preliminary results indicate that, as for the GC population and Mercer 81, this cluster is characterized by an enhanced oxygen abundance. So far, most of the inner disk clusters show $\alpha$-enhancement and only Mercer 30, placed at a galacto-centric distance of 11 kpc is consistent with solar abundances. Whether the bar is able to create an effective mixing and a flattened gradient in the chemical enrichment within the inner regions of the disk needs to be further investigated.

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