Sequential star formation in Cassiopeia

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Goals

Massive stars (M> 9Mo) are usually formed in OB associations, consisting of one or more not very massive open clusters and a halo of scattered young stars. The study of these open clusters can provide clues about how stellar formation proceeds from the parent molecular clouds.

We present first results on a project to understand sequential star formation mechanisms in OB associations. We have chosen associations Cas OB4, Cas OB5 and Cas OB7, close to the Cassiopeia constellation, at l = 110-125 deg. Previous determinations of their distance provided very similar values for them all, and placed them on the Perseus Arm.

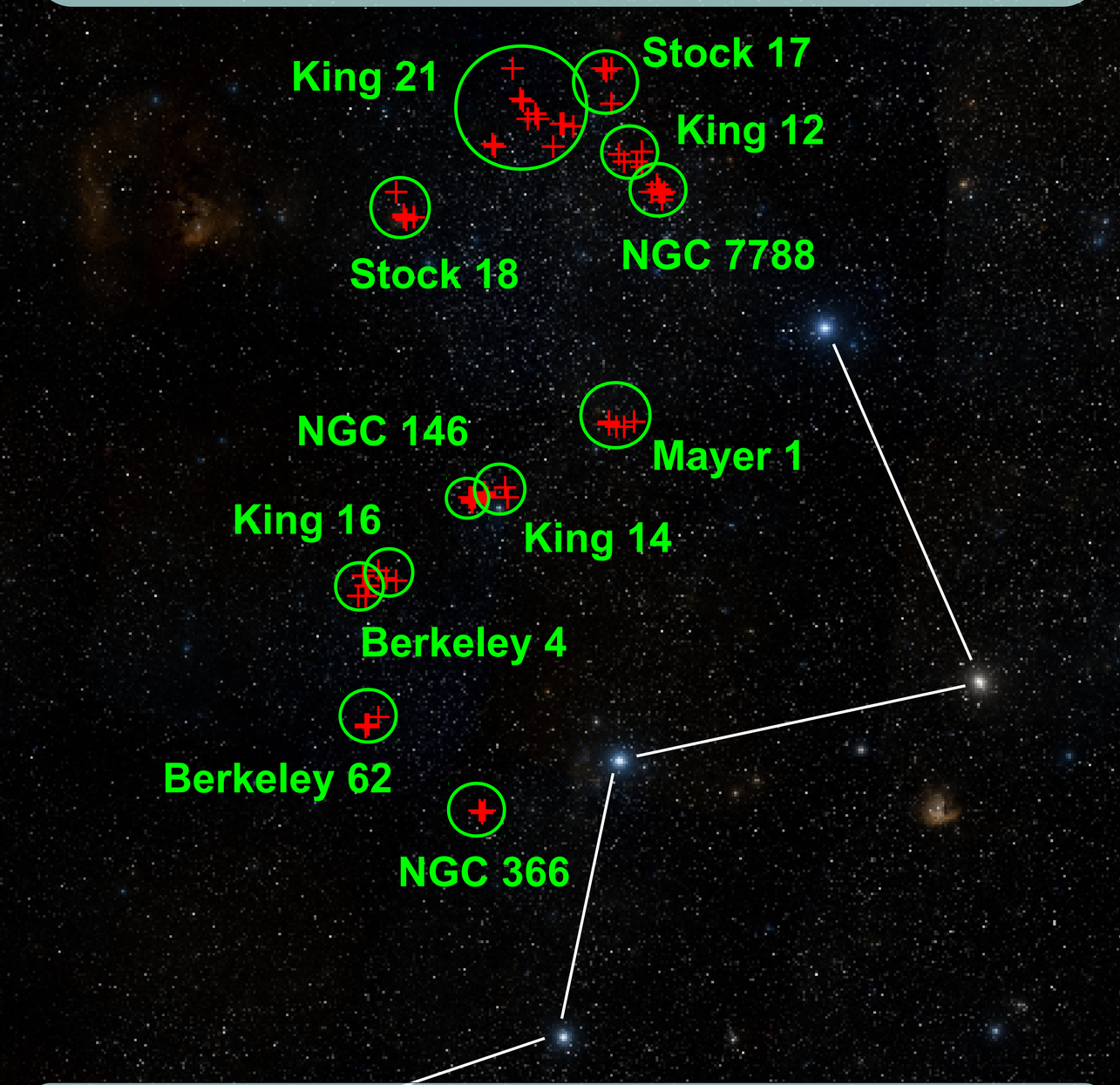
This study aims at improved distance and age determinations using new spectroscopic observations and existing photometry, to decide whether they are separate entities or can be enclosed in a global common OB association and, if associated, check for evidence of induced star formation.

Target selection and observations

Based on existing photometric colors, we chose about 100 stars from 12 different clusters located in associations Cas OB4, Cas OB5 and Cas OB7. The selected targets and host clusters are shown on the background image. The figure illustrates that crowding is not severe.

Long-slit spectra were taken with the Intermediate Dispersion Spectrograph at the Isaac Newton Telescope (2.5m), located in La Palma's Observatorio del Roque de los Muchachos. We used grating R632V (blaze 5460Å) with a slit 1.11 arcseconds wide, to obtain a resolution of 0.90 (Å pixel^{-1})

We show some example spectra in Figures 1 and 2. We assigned spectral type and luminosity class to the targets, following the criteria of Sota et al. (2011) [I], Walborn & Fitzpatrick (1990) [II] and Castro (2010) [III]. They are mainly based on the relative strength of the spectral transitions of SiII, SiIII and SiIV, and the comparison of these with MgII and HeI lines.



Future Work

We will use spectral types to estimate the stellar properties of the targets (effective temperatures and gravities) from calibrations. These data, together with existing photometry, will be fed into CHORIZOS [IV] to calculate extinction towards individual targets and intrinsic magnitudes.

Finally, all this information will be used to build the clusters's HR-diagram and provide their most accurate distance and age measurement to date.

The spatial distribution of the clusters and the derived ages will reveal whether there exists an age gradient in the spanned area. If an age gradient is found, it will constitute positive evidence for induced star formation in the region.

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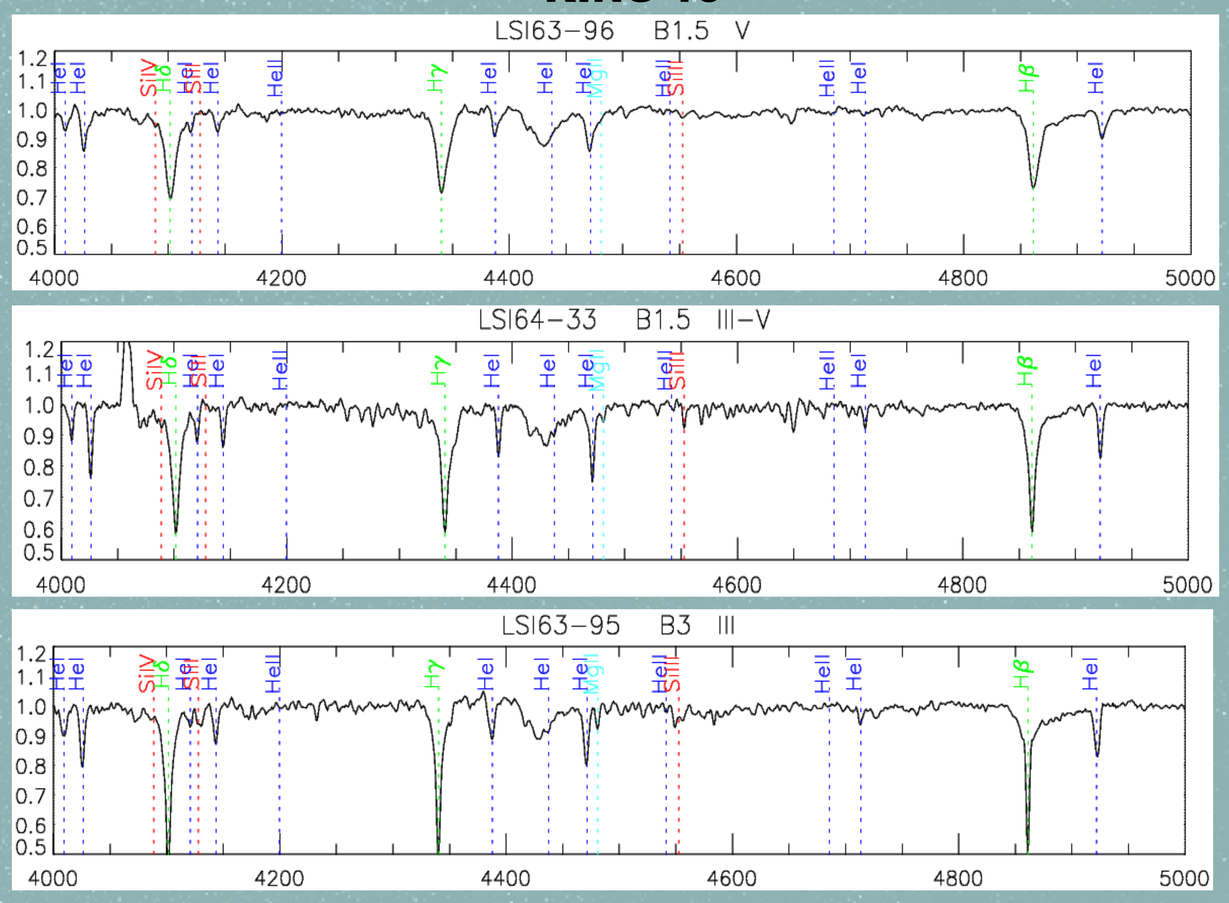

Fig. 1 Early-B stars in cluster King-16.

This figure illustrates the spectral classification process; derived spectral types are provided in the plot.

The spectral lines used for classification are marked with dashed vertical lines. As we move towards later spectral types, the populations of the Si ionization stages vary. Si IV4089 is stronger in the early types while Si II4128 grows stronger in the later types. On intermediate types Si III4552 increases while Si IV4089 decreases, and Si II4128 is still weak.

The above figure also shows that the Mg II4481 line varies with spectral type, and it is stronger towards the late B-types.

The spectrum of LSI 63-95 shows wide Si II4128 and HeI lines, abnormal Si III4552 and slight mismatches in wavelength. It could be a binary star, but present data is insufficient to be determinant.

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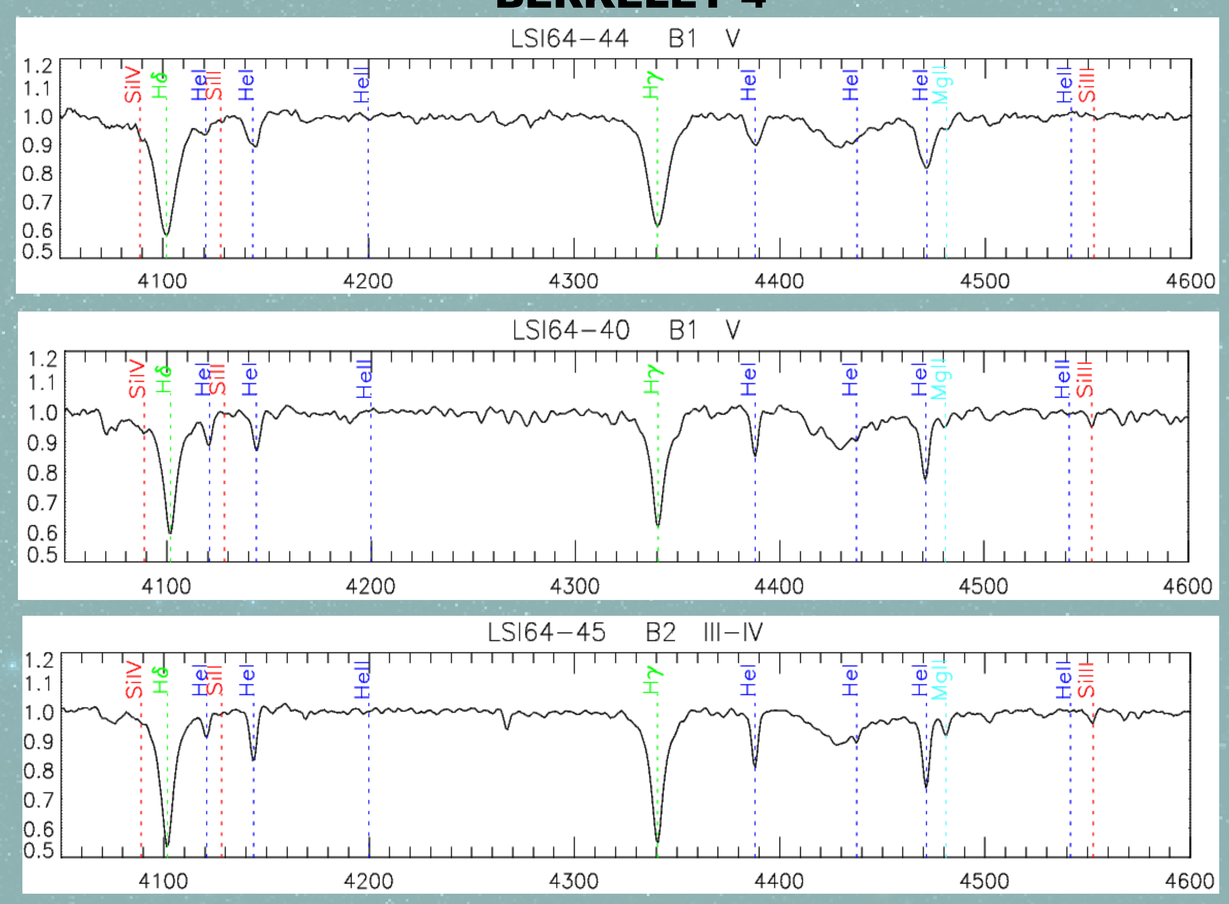

Fig. 2 The Si ionization balance in Berkeley-4

Zoom into the region containing the main Si lines used for spectral classification.

Note that the spectrum of LSI 64-44 shows very weak lines of both SiII 4128 and HeII 4200, which is inconsistent with all the classification criteria. Slight mismatches between the observed and laboratory wavelengths of spectral lines, and the double-peaked distribution of photons in a transversal cut of the raw spectrum, hint that the star may be a binary or a blend.

The SiII 4128 line is almost vanished in the spectrum of LSI 64-45, but the remaining diagnostics (absent SiIV 4089 and the strength of MgII 4481 and CII 4267) indicate a B2 type.

References

[I] Sota et al. 2011, AJS, 193, 24

[II] Nolan R. Walborn and Edward Fitzpatrick. 1990, PASP, 102, 379

[III] Castro N., 2010, PhD thesis, Universidad de La Laguna

[IV] Maíz-Apellániz, J. 2004, PASP, 116, 859

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