THE Gaia-ESO SURVEY: THE DOUBLE OPEN CLUSTER NGC 2451

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1. Introduction

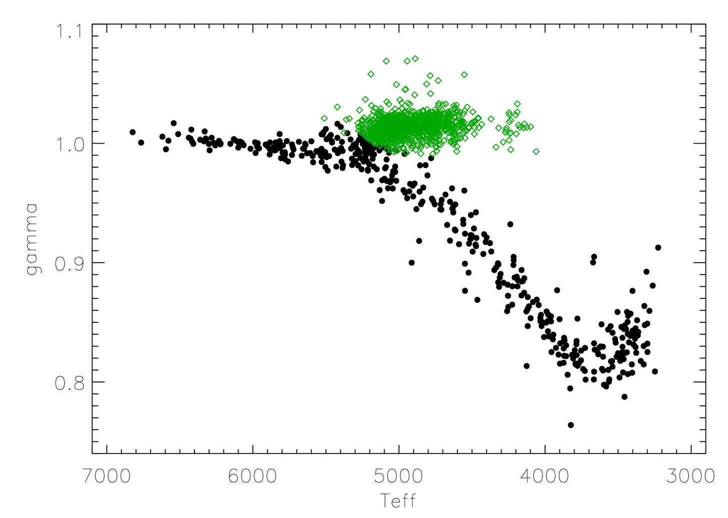
NGC 2451 is a double cluster composed of two open clusters of similar age located at different distances along the same line of sight (Röser & Bastian 1994; Platais et al. 1996): NGC 2451 A, the closer one, lies at d $\sim$ 180 – 200 pc, and has a very low reddening E(B – V) = 0.01 mag, while the background cluster NGC 2451 B is located at d $\sim$ 370 pc, with E(B – V) = 0.05 mag (Carrier et al. 1999; Hünsch et al. 2003). Hünsch et al. (2003) estimated ages of $\sim$ 50 – 80 Myr for NGC 2451 A and $\sim$ 50 Myr for NGC 2451 B.

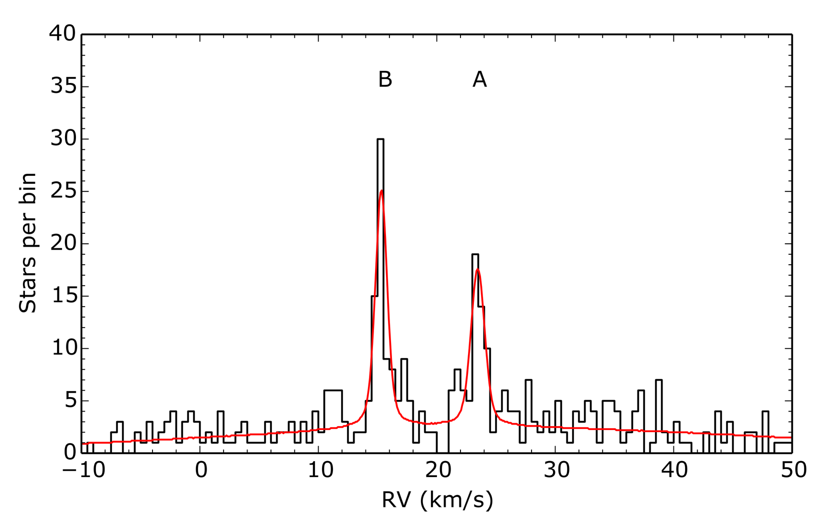
The two clusters have been observed as part of the Gaia-ESO Spectroscopic Survey (GES), which is providing precise radial velocities (RVs), stellar parameters and chemical abundances for all components of the Milky Way, including $\sim$ 80 open clusters of different ages. Spectra for a total of 1657 stars were obtained in December 2013 and January 2014 with the Giraffe HR15N and UVES U580 and U520 setups; results presented here are from the fourth internal data release (iDR4). Three of the GES fields centered on cluster B were observed in X-rays in April 2013, for $\sim$ 70 ks each, using the EPIC cameras onboard XMM-Newton (PI E. Franciosini).

In this poster we present preliminary results on the membership analysis, lithium depletion patterns and X-ray activity of the two clusters.

2. Membership selection

Gravity: we used the γ index, defined by Damiani et al. (2014) for HR15N spectra, as a function of T_{eff}, and/or log g < 3.5 dex, to identify and discard 1156 contaminating giants (green diamonds in the figure below), leaving 532 candidates.

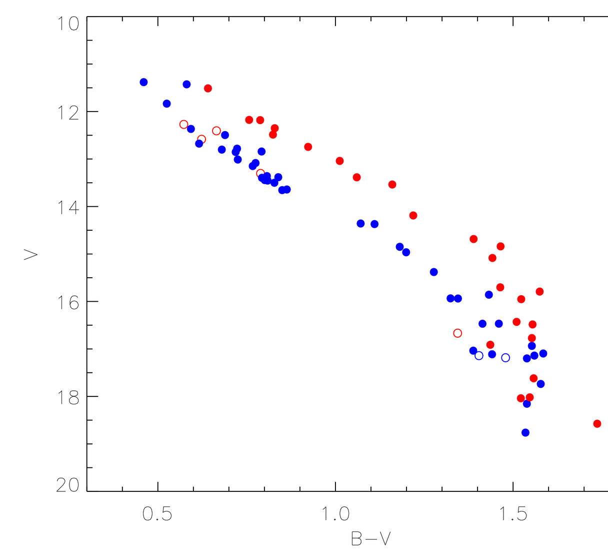


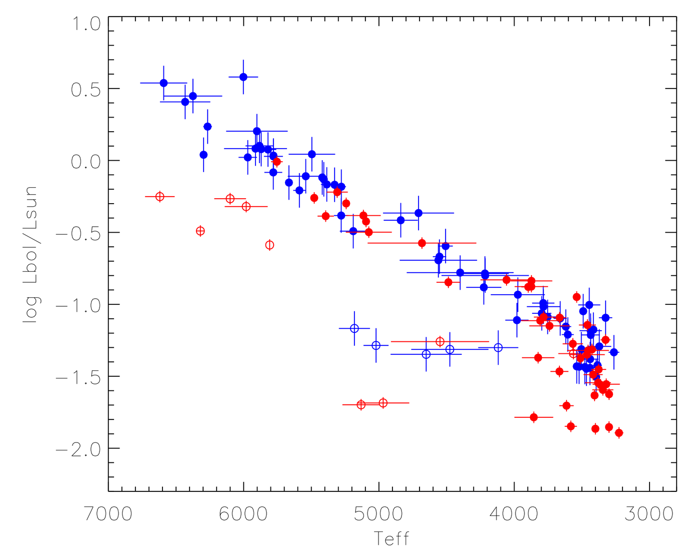


Radial velocities: we fitted the RV distribution using two populations plus the field, taking into account individual errors and binaries. The two populations are well separated, and centered at V_A = 23.46 $\pm$ 0.02 km/s, with σ_A = 0.45 $\pm$ 0.23 km/s, and V_B = 15.31 $\pm$ 0.08 km/s, with σ_B = 0.36 $\pm$ 0.18 km/s, in agreement with Balog et al. (2009).

We selected as members stars with RV membership probability P_A or $P_B \geq 50\%$. This yields 53 members for NGC 2451 A and 70 for NGC 2451 B.

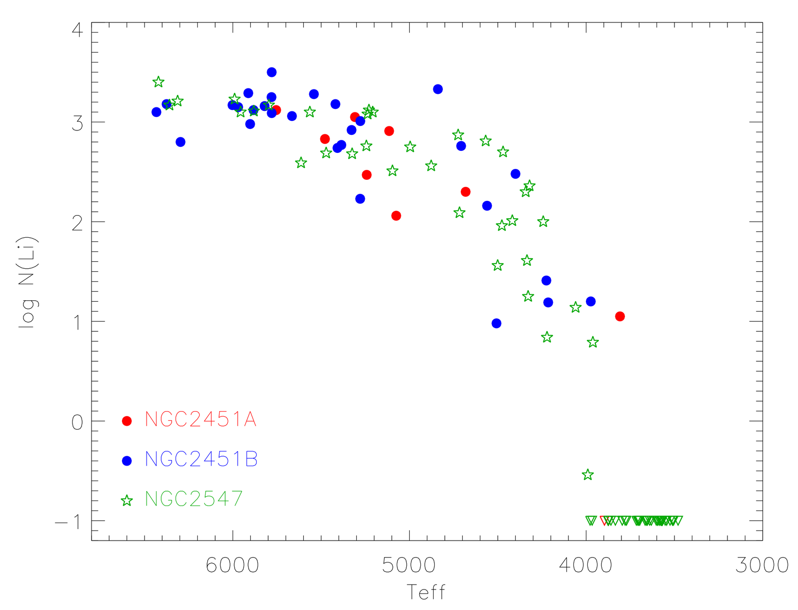
Colour-magnitude (CM) and HR diagrams: as a final check, we plotted the selected stars in the CM and HR diagrams (red for NGC 2451 A, blue for NGC 2451 B). L_{bol} was computed from T_{eff} and the J magnitude using the bolometric corrections by Pecaut & Mamajek (2013). The two sequences can be clearly identified in the CM diagram. In the HR diagram the two sequences overlap, supporting a comparable age for the two clusters.





A few stars deviate significantly from the corresponding cluster sequences and were therefore discarded (open circles in the figures). We further excluded a few objects with Li EW much lower than other stars at similar temperature. The final sample contains 41 and 60 members of NGC 2451 A and B, respectively.

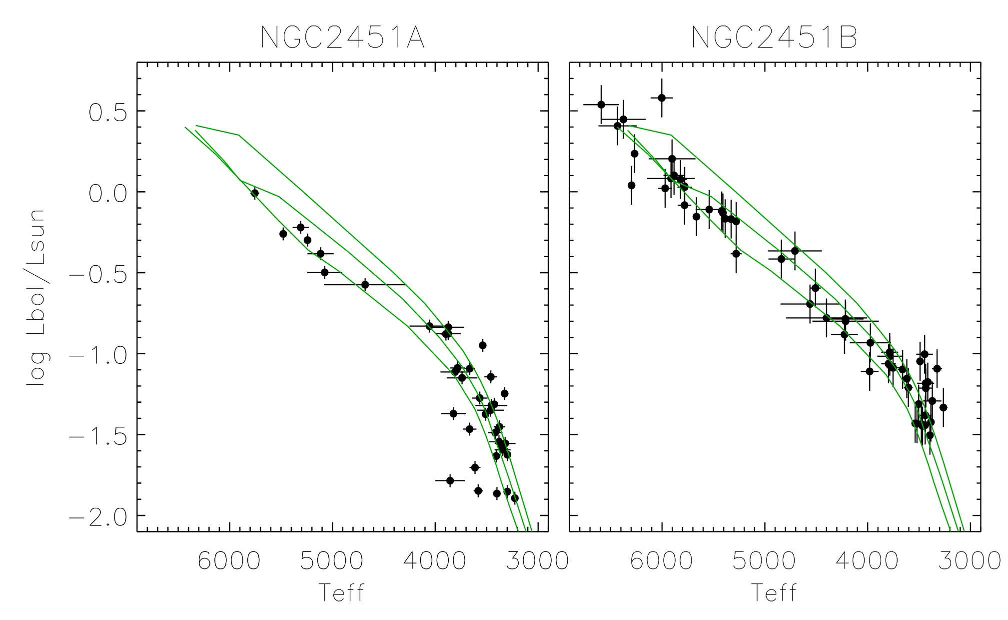
3. Lithium abundances



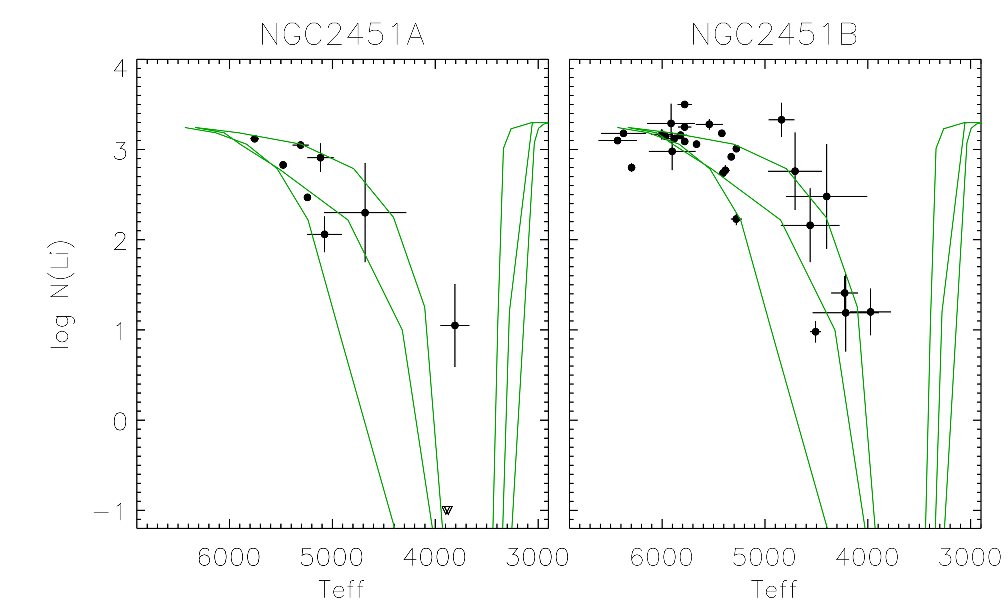
The Li patterns of NGC 2451 A and B do not appear to show any significant difference, although the low number of objects does not allow us to draw a definite conclusion. Both clusters show a spread of up to $\sim$ 1 dex at a given temperature.

The Li patterns appear also to be very similar to that of NGC 2547 (35 Myr), suggesting that NGC 2451 A and B should not have a significantly older age.

4. Comparison with models



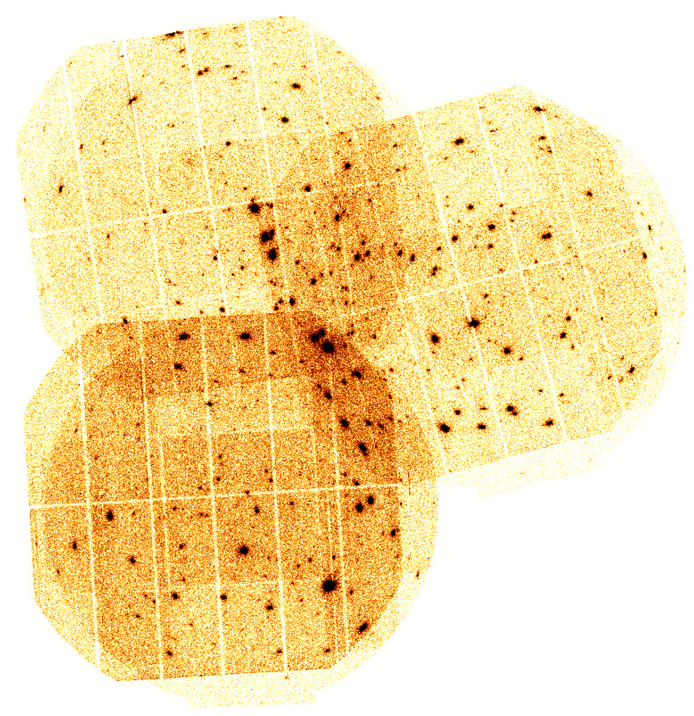
The comparison of the HR diagrams with the 20, 30 and 50 Myr isochrones of Baraffe et al. (2015) suggests an age of $\sim$ 50 Myr for NGC 2451 A and between 30 and 50 Myr for NGC 2451 B.



However, the Li vs T_{eff} diagrams seem to indicate a lower age, expecially for NGC 2451 B, where most of the points are consistent with the 20 – 30 Myr isochrones.

5. XMM-Newton observations

Source detection was performed using the PWXDETECT code developed in Palermo, yielding a total of 364 X-ray sources. Of these, 203 have a 2MASS counterpart.

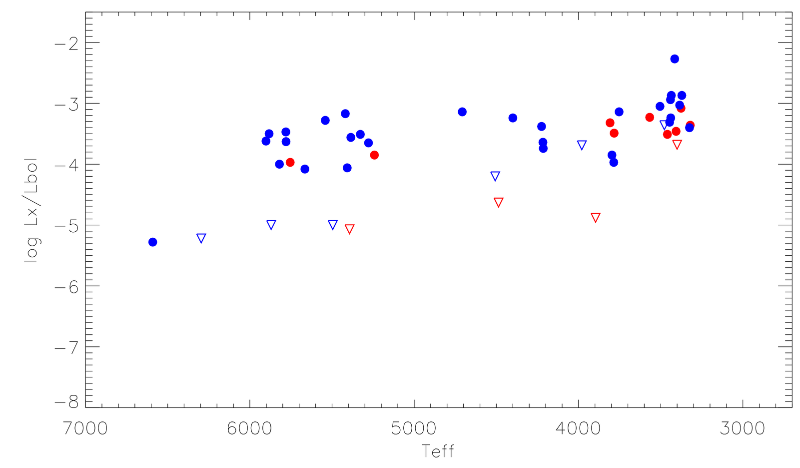


The XMM fields contain 13 members of NGC 2451 A and 37 of NGC 2451 B. Of these, 9 and 31 were detected, respectively. For the undetected members, we computed 3σ upper limits.

Additional 42 sources are identified with previously known probable members not observed by the GES, including the bright K2.5 I-II supergiant c Pup (member of NGC 2451 B).

X-ray luminosities for the GES members were derived from the count rates assuming a thermal plasma at T = 1 keV.

There is no significant difference in the X-ray luminosities of the two clusters. All late-type stars show a saturated level of emission, around a median value $\log L_X/L_{bol} \sim -3.5$, consistently with what generally observed in young clusters. A few undetected objects with upper limits $\sim$ 1 dex lower than detections at similar temperature are likely to be nonmembers.



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