NGC 6811 is one of the four open clusters in the field of view of the Kepler space mission. Among its members there are several known pulsating A-F stars of the Delta Scuti, Gamma Doradus, and hybrid type, which makes this cluster a very interesting object to study its pulsational content. During the summers of 2013 and 2014 we performed an extensive observational campaign using the 1.5 m telescope at the Sierra Nevada Observatory and multicolour photometry. New pulsating variables candidates were detected in this work. We fulfilled a frequency analysis for the known variables, with very good agreement with previous results, by using multicolour photometry. The frequencies found in this work are members of the cluster except ID17. We also found one new δ Scuti and one γ Doradus variables. The frequencies found in this work are consistent with δ Scuti and γ Doradus pulsators. In this work we found 2 new variables, one δ Scuti and one γ Doradus. We achieved very good precision, being able to detect pulsations with amplitudes as low as 0.7 mmag. In every case we verified that the amplitudes in the different filters follow the relation $A_v > A_b > A_y$, which is characteristic of δ Scuti and γ Doradus pulsators (Rodríguez 2005).

In figure 3 we can see that all the 5 δ Scuti variables found are inside the instability strip determined by Rodríguez and Breger (2001) as expected. The γ Doradus does not fall between the limits of the instability strip determined by Handler & Shobbrook (2002), although is not uncommon to find γ Dor variables beyond the red edge of this instability strip as can be seen in Uytterhoeven et al. (2011). According to the membership probabilities determined by Sanders (2011), all the variables found in this work are members of the cluster except ID17. In table 2 we show the frequency analysis of the 5 δ Scuti and γ Doradus variables. The frequencies found in this work are in good agreement with previous ground-based studies as Luo et al. (2009) and Kepler based studies as Uytterhoeven et al. (2011) and Rodríguez et al. (2016). We detected all the previously known 5 δ Scuti stars discovered using ground based observations and all the known 5 δ Scuti discovered using Kepler data, this is the first time that these are detected from the ground and have light curves in multicolour photometry. We also found to new variables: one δ Scuti and one γ Dor (ID17). We achieved very good precision, being able to detect pulsations with amplitudes as low as 0.7 mmag. In every case we verified that the amplitudes in the different filters follow the relation $A_v > A_b > A_y$, which is characteristic of δ Scuti and γ Doradus pulsators (Rodríguez 2005).

In figure 4 we present an example of a δ Scuti light curve (ID17) in three different filters (v, b, and y). The decrease in amplitude from the v to the y filter can be visually appreciated.

Table 2. Frequency analysis of the 5 δ Scuti and γ Dor variables found in this work.

5. Conclusions
- We have determined an age of 600 Myrs, a reddening of E(b−y) = 0.06 and a distance module of 10.45 magnitude for NGC 6811.
- We obtained the physical parameters of the cluster stars using Strömgren-Crawford photometry with good agreement with the ones found by Huber et al. (2014).
- In this work we found 16 δ Scuti  and one γ Dor (ID16) variables stars. Twelve 5 δ Scuti stars were previously known from ground-based observations (Luo et al. 2009) and other three were discovered using multicolour photometry performed by Rodríguez et al. (2016).
- All the variable stars found are members of the cluster according to Sanders (1971) except ID17.
- We achieved very good precision; finding variability with amplitudes as low as 0.7 mmag. For every frequency found we verified that the amplitudes in the different filters follow the relation $A_v > A_b > A_y$, which is characteristic of δ Scuti and γ Doradus pulsators (Rodríguez 2005).

References

Figure 1. Image of NGC 6811 taken with the 1.5 m Telescope of the Sierra Nevada Observatory. The FoV is 7x7 arcminutes.

Figure 2. HR diagram for our sample of stars in NGC 6811. The pink solid line is the isochrone of log(t) = 8.75 and solar metallicity from Bressan et al. (2012). The dashed red line denotes the γ Doradus instability strip as can be seen in Handler & Shobbrook (2002). The blue dots are the 5 δ Scuti variables found in this work and the γ Dor is represented as a red star.

Figure 3. δ Scuti Instability strip from Rodríguez and Breger (2001) (Black dashed lines). The dashed red line denotes the γ Doradus instability strip by Handler & Shobbrook (2002). The blue dots are the 5 δ Scuti variables found in this work and the γ Dor is represented as a red star.

Figure 4. Light curves of ID17 in v, b and y filters.

Figure 5. Periodogram of the temporal series of ID17 in the v filter.