



New red giant star in the *Kepler* open cluster NGC 6819



ARTICLE INFO

Keywords:

Open cluster
Membership
Red giants

ABSTRACT

A recent study indicated that 39 red giant stars showing solar-like oscillations were discovered in the field of *Kepler* open cluster NGC 6819. The study was based on photometric distance estimates of 27 stars out of the 39. Using photometric method alone may not be adequate to confirm the membership of these stars. The stars were not previously known in literature to belong to the open cluster NGC 6819. In this study, *Kepler* data was used to study the membership of the 27 stars. A plot of apparent magnitude as a function of the large frequency separation, supplemented with the proper motion and radial velocity values from literature revealed KIC 5112840 to lie on the same plane with the well known members of the cluster. Echelle diagram was constructed, and the median gravity-mode period spacings (ΔP) calculated for KIC 5112840. A value of $\Delta P = 66.3$ s was obtained, thus placing the red giant star KIC 5112840 on the Red Giant Branch stage of evolution. Our evolutionary status result using the approach in this paper is in agreement with what is in the available literature.

1. Introduction

Red-giant stars show rich spectra of solar-like oscillation excited and intrinsically damped by turbulence in the outer layers of the convective envelopes (Chaplin and Miglio, 2013). This near-surface convection triggers solar-like oscillations of stars characterized by variations in amplitude, frequencies and mode lifetimes.

Balona et al. (2013) studied stars in the *Kepler* open cluster NGC 6819 and discovered by independent visual inspection of the periodogram and light curves 39 candidate solar-like stars not previously mentioned in the literature (their table 3). They estimated the distance moduli for 27 individual candidate solar-like pulsators by using a fixed reddening $E(B-V) = 0.15$ and compared the distribution with that of the stars with known solar-like pulsators in *Kepler* open cluster NGC 6819. However, the fact that the distance moduli of some of the candidate solar-like oscillators agree well with that of the cluster members, one can also presume that mass motions in the atmosphere of red giants may change their radial velocity and thus change the membership criterion (Balona et al., 2013).

Cluster membership is crucial to draw meaningful conclusions from the analysis of stars in a cluster. Star clusters share common properties (distance, age, proper motions and radial velocities). The study of these properties in a group of stars allows us to evaluate their cluster membership.

Stello et al. (2011) found that stars located in cluster NGC 6819 lie on a straight line on K mag versus large frequency separation ($\Delta\nu$) diagram. The advantage of using K mag versus $\Delta\nu$ is that it provides a direct observational way of comparing the candidate red giants with the known members of the clusters. $\Delta\nu$ is not affected by reddening and K mag is used as a relative distance proxy. This is an alternative way of distinguishing between cluster stars and field stars.

The *Kepler* mission has been helpful in the study of solar-like oscillations in Red Giant (RG) stars. NGC 6819 is one of the four open clusters in the *Kepler* field of view. It is located in the galactic plane, with Right Ascension of 19 hr 39 min 36 s and Declination of $+40^\circ 04'$. It has an age of 2.5 Gyr (Basu et al., 2011) and super-solar metallicity of $[Fe/H] = +0.09 \pm 0.03$ (Bragaglia et al., 2001) and reddening of 0.15. The cluster has an average mass of $1.68 \pm 0.03 M_\odot$ (Basu et al., 2011; Corsaro et al., 2012) and distance modulus of 12.20 ± 0.06 mag (Balona et al., 2013). The cluster average radial velocity is 2.34 ± 0.05 km s $^{-1}$ (Hole et al., 2009). It consists of several eclipsing binaries, stars with solar-like oscillations, three γ Dor variables, blue stragglers, rotational variable stars and seven δ Scuti stars (Christensen-Dalsgaard et al., 2007; García et al., 2011; Balona et al., 2013).

In this paper we use Sloan *griz* photometry of the stars from the *Kepler* Input Catalogue - KIC and time-series photometry from the *Kepler* public archives to study the field of the open cluster NGC 6819, the data are available at the Mikulski Archive for Space Telescopes (MAST)¹. In particular, we study the 27 candidate red giant (RG) stars showing solar-like oscillations in NGC 6819 which Balona et al. (2013) identified by visual inspection of light curves and periodogram in which they were able to estimate the distance moduli. The aim is to (i) distinguish between the members and non-members using magnitude versus $\Delta\nu$ method, (ii) study the evolutionary stages of the member stars by determining whether they are RGB or RGC based on the magnitude versus $\Delta\nu$ analysis.

¹ <http://archive.stsci.edu/kepler/>