

GAIA AND *KEPLER* OBSERVATIONS OF
NEW GENERAL CATALOGUE 6811

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Declaration

I, Atino Doris Eggo, declare that the work presented in this dissertation is my own and has not been presented to this institution or any other institution for any award. I confirm that where I have quoted from the works of other authors, the source is always acknowledged. With the exception of such quotations, this dissertation is my original work.

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Dedication

To my beloved Daughters Theresa, Mercy, Laetitia, and **Anna (RIP)**

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Abstract

In this study, the National Aeronautics and Space Administration (NASA) *Kepler* space-craft high-precision data, and *Gaia* astrometric data were used to identify new members of New General Catalogue, NGC 6811 open cluster. These new members would be used to re-define and estimate the properties of the open cluster. The new cluster members were classified in the Hertzsprung Russell (HR) diagram. Delta (δ) Scuti stars were identified from the HR diagram. A binarity study conducted on the δ Scuti stars identified were used to re-define and estimate the cluster properties of NGC 6811. Five new single member δ Scuti were identified as Kepler Input Catalogue KIC 9716483, KIC 9716528, KIC 9716615, KIC 9716843 and KIC 9594935. New members were combined with the well-known members to estimate mean distance modulus as 10.42 pc, $\log\text{Age} = 0.103$ and metallicity = 0.0152 dex. This work was limited to *Gaia* second Data release (DR2) magnitudes as well as the stars that have known parallax and proper motion values only. A comparison of parallax and proper motion of *Gaia* DR2 with the most recently released *Gaia* Early Data Release 3 (EDR3) was made and shows different values. This implies that the two sets of data should be used independently.

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Abbreviations

AfAS	African Astronomical Society.
DR1	Data Release 1.
DR2	Data Release 2.
EDR3	Early Data Release 3.
ESA	European Space Agency.
G	Gravitational constant.
HR	Hertzsprung Russell.
KIC	Kepler Input Catalogue.
NASA	National Aeronautics and Space Administration.
RGB	Red Giant Branch
RGC	Red Giant Clump.
TESS	Transiting Exoplanet Survey Satellite.

Astrophysical Constants

Light year (ly)	=	9.460×10^{15} m
Parsec (pc)	=	3.085×10^{16} m
Solar mass (M_{\odot})	=	1.988×10^{30} kg
Solar luminosity (L_{\odot})	=	3.839×10^{26} W

Symbols

L_{\odot}	=	Solar luminosity.
M_{\odot}	=	Solar mass.
ξ_t	=	Microturbulent velocity.
m_{\odot}	=	Solar metallicity.
$[M/H]$	=	metallicity.
T_{eff}	=	Effective temperature.
$v \sin i$	=	Projectional rotational velocity.
$\log g$	=	Surface gravity.
V_r	=	Radial velocity.
pc	=	Parsec.

Chapter 1

INTRODUCTION

1.1 Background

The *Gaia* mission launched in 2013 measures positions in right ascension and declination, trigonometric parallaxes, proper motions, and photometry of million of stars, provides an average parallax error up to 0.04 mas for sources of magnitude, $G \leq 15$ mag and around 0.7 mas for sources of magnitude, $G = 20$ mag. The *Gaia* second Data Release (DR2) provides proper motions of more than 1.3 billion sources with uncertainties up to 0.06 mas yr^{-1} for the sources having $G \leq 15$ mag, 0.2 mas yr^{-1} for $G = 17$ mag and 1.2 mas yr^{-1} for sources up to magnitude, $G = 20$ mag (Gaia et al., 2018).

The National Aeronautics and Space Administration (NASA) spacecraft *Kepler* provides photometric time-series of un-precedented quality for solar-type and red-giant stars (Gilliland et al., 2010). The asteroseismic analysis of these data has led to remarkable results as reviewed by Chaplin and Miglio (2013).

The asteroseismic analysis allowed for determination of the evolutionary stage of evolved stars, period spacings of mixed oscillation modes, separate hydrogen-shell-burning and helium-core-burning red giants (Bedding et al., 2011; Mosser et al., 2011; Stello et al., 2013).

The New General Catalogue, NGC 6811, is one of the four open clusters located in the *Kepler* field of view of the NASA Space Telescope *Kepler* (Borucki et al., 2003) and (Gilliland et al., 2010), where others are NGC 6819, NGC 6791 and NGC 6866. Among its members there are several known pulsating A-F stars of the δ Scuti, γ Doradus, and hybrid type, which made this cluster a very interesting

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