

Abstract

We present a ground-based time-series photometric study of stellar variability in four intermediate-to old-age open clusters—NGC 2192, NGC 2266, NGC 2509, and IC 1369—based on high-cadence Cousins R-band observations obtained with the 0.6 m VASISTHA telescope at the IERCOO observatory. The monitoring campaign comprises more than ~ 34 hr of time-series data, providing sensitivity to short-period variability on timescales of ~ 0.02 –2 days. We identified between 190 and 290 probable members in each cluster using a Gaussian mixture model. Structural parameters were derived from radial density profiles fitted with King models. Fundamental parameters were further constrained using color–magnitude diagram analysis with PARSEC isochrones, yielding ages of ~ 0.3 –1.6 Gyr and distances of ~ 2.5 –3.9 kpc. From the time-series photometry, we identify four new variable stars and seven previously uncharacterized periodic variables, including δ Scuti and γ Doradus pulsators, as well as rotational variables. The detected variables exhibit periods between ~ 0.12 and 0.90 days, with R-band amplitudes ranging from 0.01 to 0.20 mag. Periods were determined using Lomb–Scargle analysis of calibrated light curves. For a subset of variables, spectral energy distribution fitting was performed to derive effective temperatures (~ 4300 –10,000 K), radii (~ 1.3 –46 $R_{\odot}$), and luminosities (~ 2 –100 $L_{\odot}$), enabling reliable placement on the Hertzsprung–Russell diagram. We present PHOEBE light-curve modelling of the W UMa-type eclipsing binary Gaia DR3 2164531610149292288 in IC 1369, deriving its physical parameters and providing the first detailed characterization beyond its previously reported variability. These results demonstrate that combining dense-cadence ground-based observations with Gaia astrometry provides a reliable approach for identifying and characterizing variable stars in open clusters.