

# STRÖMGREN PHOTOMETRY AND SEARCH FOR SHORT PERIOD VARIABLES IN THE OPEN CLUSTERS NGC 6910 AND NGC 6913

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**ABSTRACT.** Analysis of the absolute  $uvby - \beta$  photometry of the Open Clusters *NGC 6910* and *NGC 6913* show well-defined peaks that clearly define the accumulation of stars. Differential photometry of five stars in the direction of each cluster determines that at least two stars in each cluster are variables. For *NGC 6910* both belong to the cluster and are  $\delta$  Scuti stars and for *NGC 6913* two short period variables one does not belong to the cluster and it might be a  $\delta$  Scuti star. The other one is a B type star and it belongs to the cluster.

**Key words:**  $\delta$  Scuti, variable stars, open clusters, photometry; stars: individual: H01, H05, H09, H10.

## 1. Introduction

Since Strömgren  $uvby - \beta$  photometry provides unique opportunities for determining both cluster membership and physical characteristics of observed stars, several bright stars in the direction of the clusters, as well as several standard stars, were observed in order to transform their photometric values into the standard system. Simultaneously, differential photometry of a few stars within the instability strip limits was carried out for detection of new short period variables.

## 2. The Open Cluster NCG 6910.

Due to its youth, this cluster has been a subject of numerous studies, the last one of which, Delgado & Alfaro (2000), provides us with an excellent review. They report the following values for this cluster:

$$\begin{aligned} E(B - V) &= 1.02 \pm 0.13, \\ V_0 - M_V &= 11.2 \pm 0.2 \text{ and} \\ \text{age} &= (6.53) \times 10^6 \text{ yr.} \end{aligned}$$

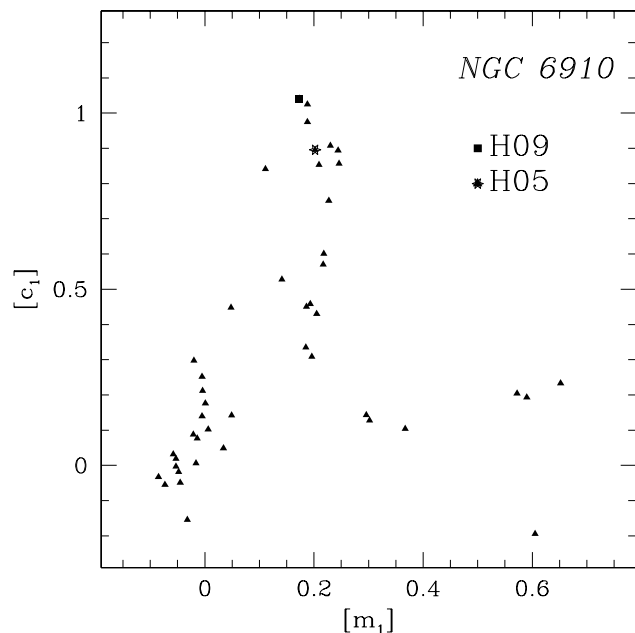


Figure 1: Diagram  $[m_1]vs[c_1]$

We carried out observations of a few stars in the  $uvby - \beta$  system that complemented those of Crawford, Barnes and Hill (1977) in 35 stars, 10 of which were in common with CBH and 13 were observed by them but not by us, constituting a total sample of 48 stars. Their unreddened indexes  $[m_1] - [c_1]$  which establish their spectral class as early *A* are also shown in Fig. 1.

## 3. The Open Cluster NCG 6913

This cluster (M29, 20h, 23m; +38.32 (2000), is located in the *Cygnus OB1* Association. A fine recent com-

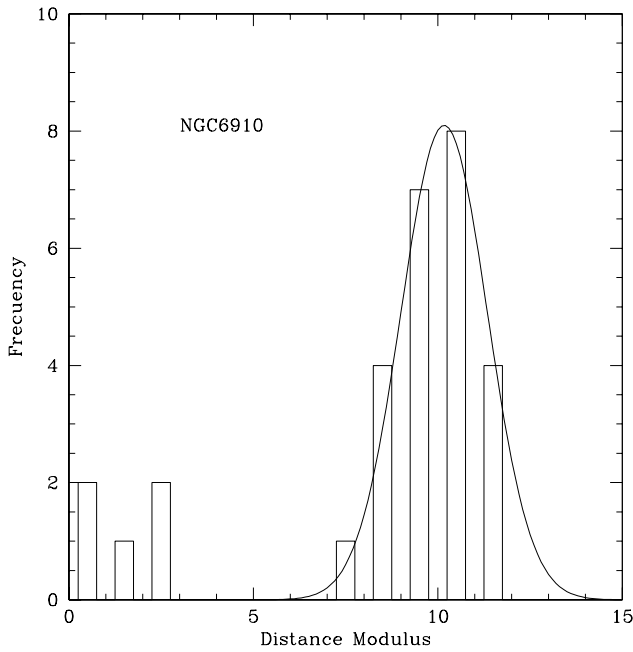


Figure 2: Distances modulus at  $10.02 \pm 1.17$  of *NGC 6910*.

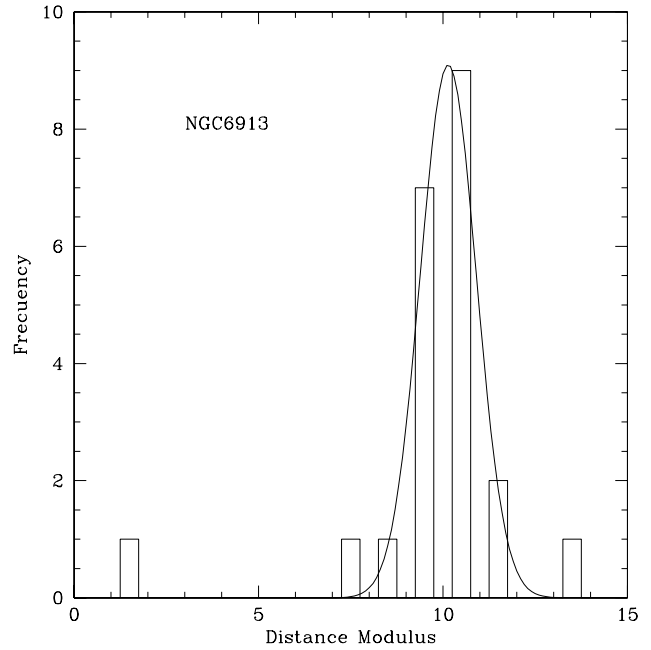


Figure 4: Distances modulus at  $10.14 \pm 0.76$  of *NGC 6913*.

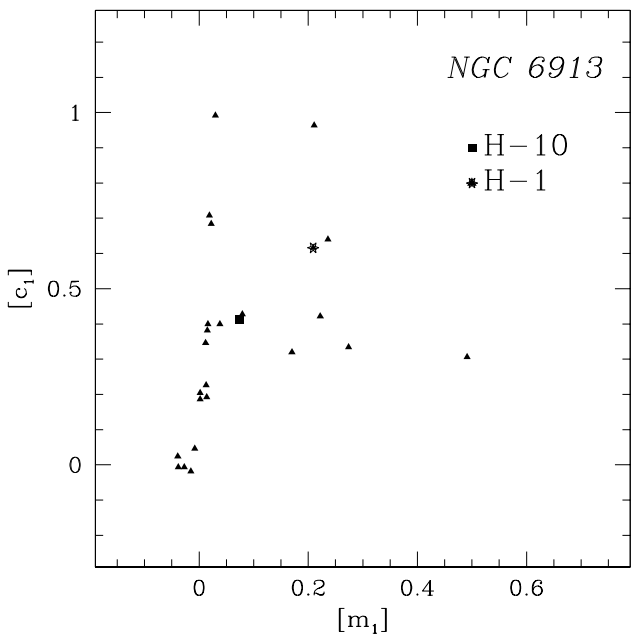


Figure 3: Diagram  $[m_1]$  vs  $[c_1]$ .

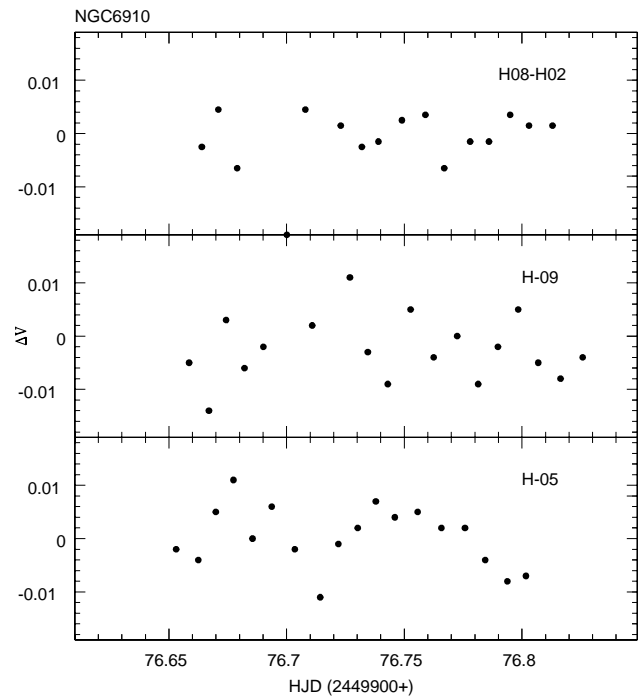


Figure 5: Light Curves of variable stars in *NGC 6910*.

pilation of the cluster can be found in Wang & Hu (2000). In summary: it is considered to be a very young cluster. Its estimated age vary between 0.3 to 1.75 *Myr*. Since it is so young, it should have stars in the pre-main-sequence phase; a mean distance modulus

of  $10.17 \pm 0.14$  mag (dist = 1.08 *kpc*) is determined; extinction in the cluster center is relatively homogeneous, but very large; out of 100 spectroscopically classified stars they found: 2 *O* type stars, 4 *O B* type stars, 33 *A* type stars, 15 *F*, 6 *G*, and 4 *K*.

### 3.1 Absolute photometry

We carried out *uvby* -  $\beta$  absolute photometry at the San Pedro Mártir Observatory, México, in two seasons: October 1989 and June 2000 with 40 stars, 21 in common with Crawford et al. (1977) and 6 more observed only by them, constituting a whole sample of 46 stars. Their  $[m_1] - [c_1]$  diagram shown in Fig. 3.

### 3.2 Differential photometry

The stars were observed in September 1995 at the 84cm telescope. Five stars within the instability strip limits were chosen: (Hoag number 01, 07, 09, 10 and 11; Sanders number 135, 174, 146, 182, and 178, respectively) Two were constants (07 and 09) whereas two, (01 and 10) were found to be variables.

In a parallel run in the V filter in 1995, five stars (Hoag's number: 02, 04, 05, 08 and 09) were monitored for variability. Of these two had constant behaviour (02 and 08), two are clearly variables (05 and 09) and one (04) marginally variable. The corresponding light curves are shown in the Figure 5.

From the  $[m_1] - [c_1]$  diagram, (Fig. 1), it is evident that both variable stars belong to early stars class A and from their distances they belong to the cluster.

The star (11) most likely is variable, but its light curve is too noisy to unambiguously establish the variability. Of the two short period variables, one, H01 does not belong to the cluster and might be a  $\delta$  Scuti star. The other star, H10, is a B type star and it belongs to the cluster.

## 4. Conclusions.

Although this study is preliminary, at this stage we can conclude the following: From the photometric analysis carried out on the *uvby* -  $\beta$  data, both clusters, NGC 6910 and NGC 6913 show well-defined peaks that clearly define the accumulation of stars (Figures 2 and 4). Differential photoelectric photometry of five stars in each cluster was carried out and in each cluster, at least two short period variables were found in the direction of each of the clusters. For NGC 6910, two variable stars H05 and H09 that belong to the cluster were found; for NGC 6913, of the two short period variables one, H01, does not belong to the cluster and it might be a  $\delta$  Scuti star. The other one, H10 is a B type star and it belongs to the cluster.

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