

Spectral classification and determination of the star distances using H α emission line

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ABSTRACT

The sky surveys are used to collect in the shortest time possible a great amount of observations in order to make many data available for the users. Obviously, not all the observations have been completely analysed. Most of the objects are catalogued only with some physical characteristics, i.e. the magnitude and the colour. In this study we tried to determine the spectral class and the distance of five objects of the INT/WFC Photometric H α Survey of the Northern Galactic Plane (IPHAS) catalogue.

I. INTRODUCTION

During the days we spent at the Asiago Astrophysical Observatory (Mt. Pennar), we observed and collected data of an appropriately selected group of stars. The stars were selected from the IPHAS catalogue of H α emission-line sources in the northern Galactic plane (Witham et al. 2008). IPHAS contains 4853 point sources that show a photometric evidence of the H α emission line.

The stars in the catalogue represent a variety of stellar types, including early-type emission-line stars, active late type stars, symbiotic binary and compact nebular stars.

We started with a list of 766 sources with very prominent H α emission line and apparent magnitude between 13 and 19.

The aim of our work was to classify the stars by comparing the obtained spectra with the spectra of stars with known spectral class.

We selected 5 stars out of the 766 extracted sources. Since the studied stars are located in the Galactic plane we were forced to tackle the issue of the Galactic extinction.

Once solved the problem and carried out the classification, we were surprised by one of the examined objects. At last, we estimated the distance of the five objects.

II. OBSERVATIONAL DATA

A first selection was carried out choosing sources brighter than mag 16; then we selected 32 sources with apparent magnitude brighter than 14. At the end, we chose among these, 5 stars with $r\text{-H}\alpha > 0.6$.

These stars were observed with the 1.2 m telescope of the Asiago Astrophysical Observatory on February 18th, 2009.

Object name	R.A.	Dec.	Exposure time	U.T.
KW97 27-49	6h 13m 42s	+14° 04'	1200sec	20:50
KW97 20-46	5h 03m 27s	+41° 42' 03"	1200sec	21:37
2MASS J05330904+ 2911030	5h 33m 09s	+29° 11' 03"	1200sec	22:17
2MASS J05390916+ 3544225	5h 39m 9s	+35° 44' 23"	1200sec	22:53
EM VES 880	5h 10m 51s	+43° 21' 30"	1200sec	23:27

Tab.1: The five selected objects with their equatorial coordinates and the exposure time.



Fig.1: 2MASSJ05390916+3544.

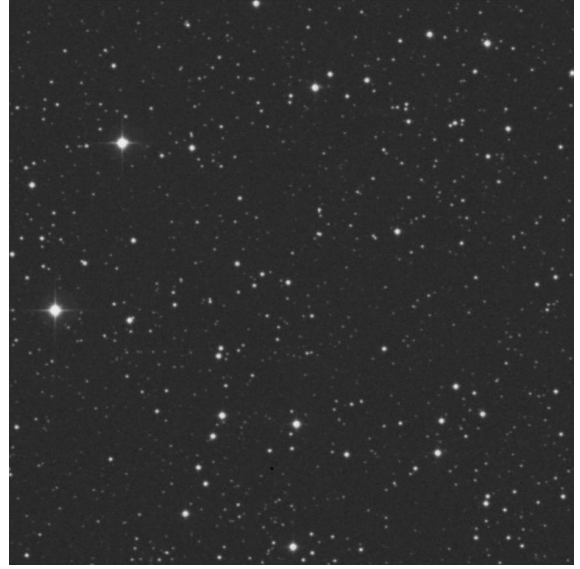


Fig. 4: EM VES 880.



Fig. 2: KW97 20-4.



Fig. 5: KW97 27-46.



Fig.3: 2MASS J05330904+2911030.

III. WORK DESCRIPTION

It was necessary to process the spectra taken during the night, before analyzing them.

First, we corrected the spectra for bias and flat field. Then, for wavelength calibration, we used the emission spectrum of a Hg-Ne-Ar lamp. For the conversion of counts into flux, during the same night, we acquired a spectrum of a spectrophotometric standard star, with known fluxes.

At last, we subtracted from the spectra the sky contribution. After we reduced and calibrated the spectra, we normalized them making the flux=1 at $\lambda=5500\text{\AA}$.

For the analysis and the measurements, we used the IRAF program. To compare the spectra, we used the Topcat program. In the following pictures, we show the calibrated and normalized spectra.

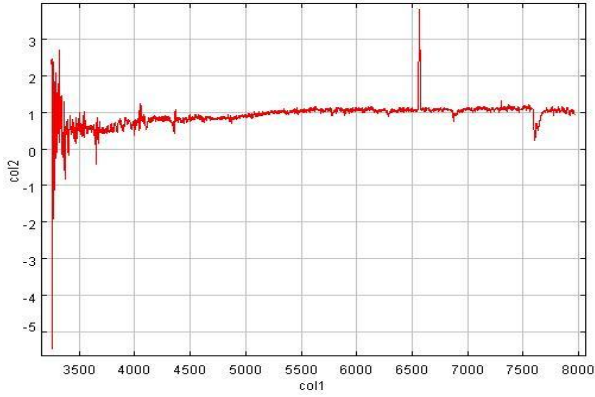


Fig. 6: KW97 27-49.

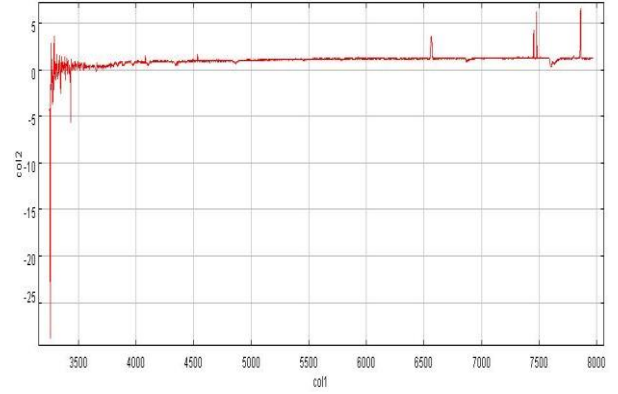


Fig.. 9: 2MASS J05390916+3544225.

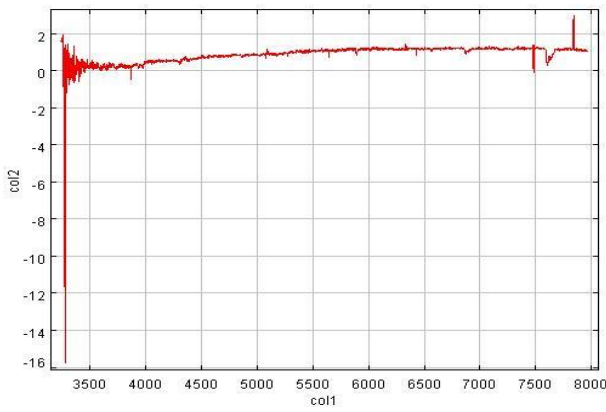


Fig. 7: KW97 20-46.

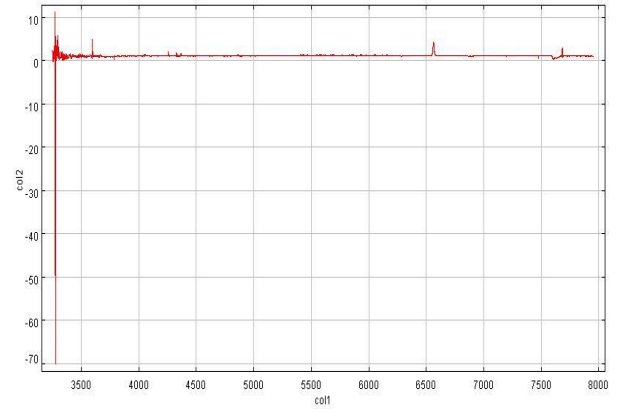


Fig. 10: EM VES 880.

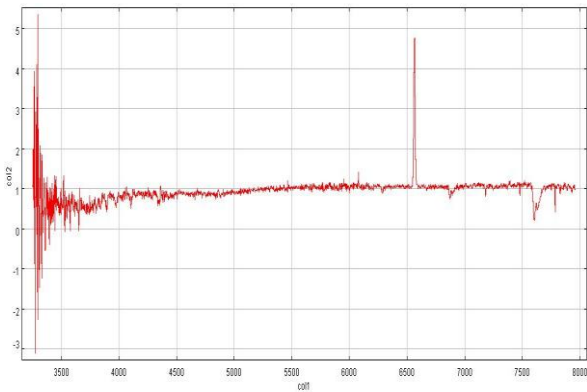


Fig. 8: 2MASS J05330904+2911030.

The observed stars were compared with stars of known spectral types in order to look for the similarities between them.

We observed a decrease of the signal in the blue region. This was the effect of the Galactic extinction because the Galactic plane dust absorbs the light of the observed objects mainly in the blue spectral range.

We applied different values for the extinction to the spectra till they became more similar to the reference stars. In order to have a further confirmation of our identification of the spectral classes, we checked the presence of those characteristic lines that identify the spectral classes.

We report the corrected spectra of the stars compared with the spectra of the reference stars which seemed to better correspond.

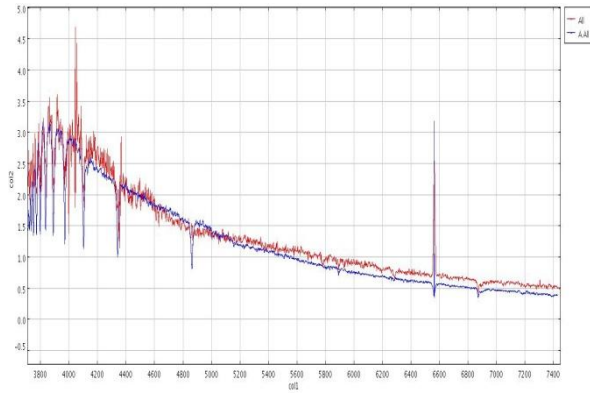


Fig.11: KW 97 27-49(in red) compared with a B6 star (in blue).

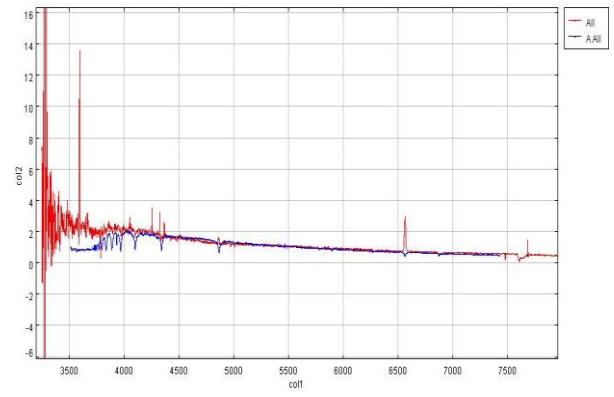


Fig. 14: EM VES880 (in red) compared with an A5 star (in blue).

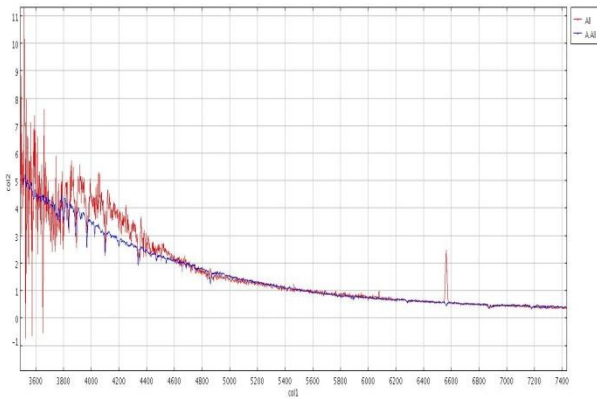


Fig. 12: 2MASS J05330904+2911030(in red) compared with an O7 star (in blue).

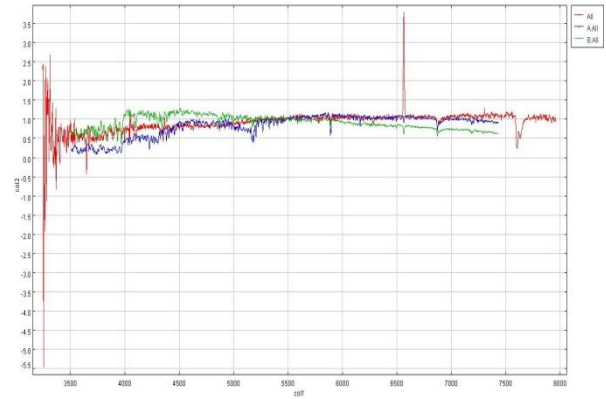


Fig. 15: KW97 20-46 comparison between the observed spectrum and a K4 spectrum (in blue) and a G0 spectrum (in green).

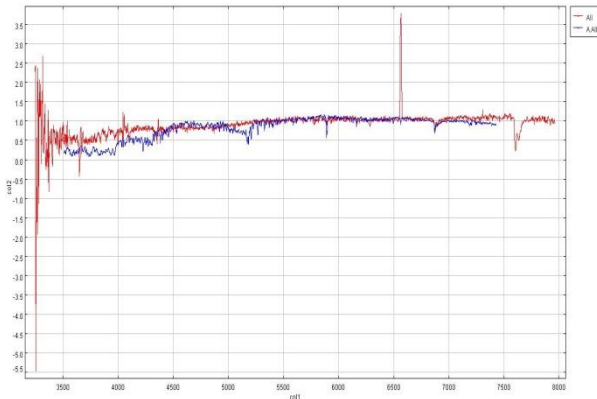


Fig. 13: KW97 20-46 (in red) compared with a K4 star (in blue).

After obtaining the spectral class and the extinction, we could estimate the absolute magnitude of the stars through HR diagram. For apparent magnitudes, we referred to IPHAS, which provided us with the apparent magnitude in r band and $r - i$ colour. We used these data to calculate the apparent magnitude in UBVRI bands.

STAR	r	r-i
KW97 27-49	13.83	0.0010
KW97 20-46	13.59	0.0010
2MASS J0533904+2911030	13.79	0.0020
2MASS J05390916+3544225	13.77	0.0010
EM VES 880	13.57	0.0010

Tab.3: Magnitudes (r) and colors (r-i) of the stars.

STAR	M	A(V)
KW97 27-49	-0.5	+3.0
KW97 20-46	+7.5	0.0
2MASS J0533904+2911030	-4.6	+3.5
2MASS J05390916+3544225	0.0	+3.0
EM VES 880	+2.0	+0.5

Tab. 4: Characteristic absolute magnitude M and extinction A(V) for each star.

We calculated the apparent magnitude with the following relation (Jordi et al. 2006):

$$m = r - 0.153 (r - i) - 0.117$$

Therefore, we estimated the distance of the objects in pc with the distance modulus formula:

$$M - m = 5 - 5 \log(d) - A$$

From which it follows:

$$d = 10^{\frac{m+5-M-A}{5}}$$

IV. RESULTS

STAR	CLASS	A(V)
KW97 27-49	B6	+3.0
KW97 20-46	K4	0.0
2MASS J0533904+2911030	O8	+3.5
2MASS J05390916+3544225	B8	+3.0
EM VES 880	A5	+0.5

Tab. 5: Spectral classification and Galactic extinction values used to compare the spectra.

As we can see, in four cases our objects are stars of high Main Sequence. This necessarily brought about, especially in three cases, a significant extinction correction. On the contrary, the spectrum of KW9720-46 was better reproduced by the spectrum of a K star. These stars are relatively cold and emit a small fraction of their light in the blue region of the spectrum. In fact, we did not need to correct anything in this case. However, this object was in some way different from the others. We could not find a good correspondence between the reference spectrum and the observed one. We tried to overlap both a K4 and a K5 star without finding a satisfactory result. At the end, we realised that the mentioned object is actually a binary source composed of a K5 type star and a solar type star.

The integration of the two spectra forms a curve that is not a Planck curve. On the contrary, it is the sum of two spectra at different temperatures that give an excess trend both in blue and in red.

STAR	m	d (pc)
KW97 27-49	13.71	174
KW97 20-46	13.47	156
2MASS J0533904+2911030	13.67	9010
2MASS J05390916+3544225	13.65	1348
EM VES 880	13.46	1553

Tab.6: Apparent magnitudes (m) and distances (d) of the five stars.

Considering that the stars had an apparent magnitude $13.4 < m < 13.8$, the spectral class was the factor that conditioned the distances in a decisive way. The output confirms it and shows that the star at a lower temperature is definitely the nearest and that the estimated star of type O8 is by far the farthest. The fact that we do not have unreliable distances, i.e. an object out of the Milky Way, allow us to consider correct the obtained analysis.

V. BIBLIOGRAPHY

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