

ate their nature and evolution. Our results give support to the gravitational contraction theory of star formation. We present spectra and discuss properties of the individual stars.

### A PHOTOMETRIC SEARCH FOR EARLY TYPE STARS IN THE HALO OF THE MILKY WAY

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We are conducting a three color (Kron-Cousins  $B$ ,  $V$ , and  $I$ ) direct imaging survey in 12 selected areas at high galactic latitude ( $b \geq 30^\circ$ ) in search for early type stars. Every selected area covers a  $23 \times 3$  arcmin<sup>2</sup> field and the limiting magnitudes for the  $B$ ,  $V$ , and  $I$  bands are 23.5, 21.5 and 22.5 mag, respectively. An automatic classification algorithm has been applied to separate non-stellar objects. The generated data base is allowing us to construct accurate color-magnitude and color-color diagrams that enable the selection of suitable candidates.

### $uvby-\beta$ PHOTOMETRY OF HIGH-VELOCITY AND METAL-POOR STARS: AGES OF HALO AND DISK STARS

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ages have been determined for the stars from our second  $uvby-\beta$  catalogue using the isochrones of Vandenberg (1985, ApJS, 58, 711), Vandenberg & Bell (1985, ApJS, 58, 561), and Bergbusch & Vandenberg (1992, ApJS, 81, 163). Two methods have been used: polynomial fittings to the isochrones in the  $0 - (b - y)_0$  plane, and graphical interpolations in the  $\delta M_V$ ,  $\log T_{eff}$  plane. The interstellar color excesses,  $E(b - y)$ , and metallicities,  $[Fe/H]$ , have been determined using our previous photometric calibrations. Membership of the stars in the different stellar populations has been determined using  $V_{(rot) - [Fe/H]}$  diagram.

Combining with previous work, ages have been obtained for 95 halo stars and for 332 "high-velocity disk stars". Cleaning our samples of the more obvious binary-star contamination, 71 halo stars and 307 high-velocity disk stars remain.

Our previous conclusions are mostly confirmed: that there is good evidence for a cosmic age scatter of about  $\pm 2.5$  Gyr within the halo field stars, and that there is considerable overlap between the ages of the halo stars and the older disk stars. However, the previously found metallicity-age correlation for the halo field stars has mostly disappeared. Evidence is found that the inner part of the halo is older than the outer part. The significance of these results for models of galactic formation and evolution are discussed.

### EFFECTIVE TEMPERATURES FOR SUPERGIANT STARS FROM 13-C PHOTOMETRY

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Observations on the 13-color (13-C) photometric system are reported for 71 A0-K0 supergiant stars brighter than  $V = 6.0$ . In order to de-redden the photometry of the F0-G3 stars, the calibration by Arellano Ferro & Parrao (1990, A&A, 239, 205) is used. A confrontation of observed intrinsic colors with synthetic colors from atmospheric models, leads to our determination of  $T_{eff}$ . A comparison of observed flux distributions with theoretical flux distributions from Kurucz (1979, ApJS, 40, 1) shows that these models are not able to reproduce the observations of supergiant stars. We have obtained a  $T_{eff}$ -13-C calibrations valid for F0-G3 supergiants. Temperatures were gathered from the literature for 18 calibrator stars, and were correlated with nine colors properly de-reddened in the 13-C photometric system.

Application of the above calibrations allowed us to estimate effective temperatures for 30 yellow supergiants.

### ROSAT OBSERVATIONS OF CLASSICAL CEPHEIDS: $\zeta$ GEM

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Classical Cepheids are supergiants and bright giants of spectral classes F-K and they resemble non-

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variable stars in the same location of the H-R diagram in many respects. Among the features Cepheids do not seem to share with their non-variable counterparts is coronal activity. Ten years ago the X-ray flux limits set by the *Einstein* Observatory for three Cepheids did not settle the question, because the upper limits were at the same level as X-ray fluxes observed in non-variable supergiants.

We report new deep pointed observations of  $\zeta$  Gem ( $P = 10$  days, F7-G3 Ib) with *ROSAT*. The Cepheid was observed on two separate dates in September and October 1992. No X-ray flux was detected. The upper limits are approximately 5 times lower than previously observed. This means that the soft X-ray luminosity of  $\zeta$  Gem is below  $1 \times 10^{29}$  erg s $^{-1}$ . In terms of X-ray to bolometric luminosity, this means that this Cepheid is more than 50 times weaker than our Sun, and more than 15 times less luminous than Canopus (F0 Ib) and 11 Pup (F8 II) in X-rays.

These new results seem to indicate that classical Cepheids do not have any hot plasma in their upper atmospheres. This puts severe constraints on the sources of coronal heating in luminous cool stars. These sources seem to be inhibited by the global envelope pulsation, unlike the sources of chromospheric heating which are not affected.

#### *uvby- $\beta$* PHOTOELECTRIC PHOTOMETRY OF CEPHEIDS

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Simultaneous *uvby- $\beta$*  photoelectric photometry of several Cepheids stars is presented.  $M_V$  values have been determined.

Cox (1974, Rep. Prog. Phys., 37, 563) mentioned that most of the pulsating stars lying in a clearly defined oval region in the H-R diagram (RR Lyrae variables, Classical Cepheids, W Virginis variables, Dwarf Cepheids and Delta Scuti variables) are thought to owe their instability to a common physical mechanism. According to Cox, this oval region is loosely referred to as the "instability strip" and he emphasizes that the classification of pulsating stars into different types seems to be valid.

Jacoby et al. (1992, PASP, 104, 599), has stated that "with only two colors it is not possible to estimate the reddening for individual stars and hence the most common expedient has been to adopt a global reddening correction". Since this latter difficulty can be overcome by the simultaneous photometry attainable at the Observatorio Astronómico Nacional in México, a program was developed with the aim of

acquiring *uvby- $\beta$*  photometric data of the aforementioned variable stars that could become important and that could serve to test the derived period-color relationships and the derivation of their physical parameters.

The absolute magnitudes reported here have been determined following the carefully developed calibrations of Eggen (1985, AJ, 90, 1260) for a much larger sample of stars than that presented here. The determination of  $M_V$  for the nineteen Cepheid stars is a significant contribution to the knowledge of this important type of stars.

#### PERIOD CHANGES AND EVOLUTION IN THE LOWER PART OF THE INSTABILITY STRIP

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Period changes in pulsating variable stars are expected from stellar evolutionary tracks inside the Lower Instability Strip. Hence, evolutionary period changes must be present in individual stars and must be observable, at least over long time scales. This fact can be used as a test of the evolutionary status of these stars by comparing the observational and theoretical period change rates. This comparison is carried out for the  $\delta$  Sct and SX Phe stars using the latest published grids of stellar evolutionary models by Schaller et al. (1992, A&AS, 96, 269) computed for metallicities  $Z=0.020$  and  $Z=0.001$  including the new opacities by Rogers & Iglesias (1992, ApJS, 79, 507) and by Kurucz (1991, in Stellar Atmospheres Beyond Classical Models, NATO ASI Series C, Vol 341).

#### $\delta$ SCT STARS REVISED

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An extensive and up-to-date list of  $\delta$  Sct stars is presented. This catalogue is intended to be a comprehensive review of observational characteristics of the  $\delta$  Sct stars known until now, including stars contained in earlier catalogues together with other newly discovered variables, covering information published until August 1993. The corresponding diagrams are also shown.