

# Commission 45: Stellar Classification

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## 1. Introduction

This report, like its predecessors, focuses on areas which have been especially active since the last General Assembly. Two major developments have been the unification of the T-dwarf standards and the new general catalogue of stellar spectral classifications.

## 2. Working Groups

The following Working Group publishes a biannual newsletter, which may be accessed along with information on its activities from a link on the Web page of Commission 45: <http://www.iap.fr/com45uai/>

Working Group on Standard Stars

chairperson: Chris Corbally

editor of the Newsletter: Richard Gray

Other Working Groups that are related to Division IV and have a specific concern to Commission 45 are also listed at the above Web page.

## 3. Classification of Ultra-Cool Dwarfs

(Sandy K. Leggett)

There has been a major step forward in L and T dwarf spectral classification in the last three years. The two different schemes of Burgasser *et al.* (2002) and Geballe *et al.* (2002) for IR typing of T dwarfs have now been “unified”. The title of the ApJ paper is “A Unified Near Infrared Spectral Classification Scheme for T Dwarfs” by Burgasser, Geballe, Leggett, Kirkpatrick, and Golimoski (2005). As the IR is the only sensible wavelength for typing T dwarfs one can imagine this will be *the* canonical paper on T dwarf classification, at least for a while. The next steps will be understanding metallicity and gravity effects.

## References

- Burgasser *et al.*, 2002ApJ...564..421B  
Burgasser *et al.*, 2005astro.ph.10090B  
Geballe *et al.*, 2002ApJ...564..466G

#### 4. Classification of Extrasolar Planet Stars

(Dante Minniti, Chris Corbally)

More than 150 extra-solar giant planets have been discovered to date (Schneider 2005). But how big, how massive, how dense are they? In other words, how similar to the giant planets of the Solar System are these extra-solar planets? This is difficult to answer until the properties of their parent stars are known. In fact, the uncertainty in the stellar parameters is the most critical limitation to know the properties of these planets. For example, a difference of 1 spectral subclass implies a change of 10% in  $M^*$ , and 10% in  $R^*$  for solar type stars. These errors are propagated to the planetary parameters, making for example the mean planetary density change by 30% all other things being equal.

In this topic we have to make a clear distinction between the nearby stars and the distant stars. The radial velocity searches measure  $M_p \sin i$ , and are targeted to nearby stars that have known parallaxes, and zero reddening (e.g., Fischer *et al.* 2005).

Gray *et al.* (2003) are completing a project, under the aegis of the Nearby Stars (NStars) /Space Interferometry Mission Preparatory Science Program, to obtain medium resolution spectra, spectral types, and, where feasible, basic physical parameters for the 3600 dwarf and giant stars earlier than M0 within 40 pc of the Sun. They give precise, homogeneous spectral types first as a description of the parent star and then as an essential help towards the starting parameters for comparison with synthetic spectra, derived from Kurucz atmospheric models without overshoot. The comparison is refined using a SIMPLEX method. Output are the effective temperature, surface gravity, and overall metallicity [M/H], and also measures of the chromospheric activity of the program stars. Accuracy and precision are extensively discussed, and it is found that the parameters from this study compare very well with the best in the literature derived from detailed spectral analysis.

In contrast, the transit searches measure  $R_p$ , and are pointed towards more distant stars, with uncertain distances and reddenings. The full characterization of the companions (M-type stars, brown dwarfs or exoplanets) requires high-resolution spectroscopy to measure properly masses and radii. With the advent of massive variability surveys over wide fields (e.g., Udalski *et al.* 2004), the large number of possible candidates makes such a full characterization for all of them impractical. Future transit searches from space are expected to discover large numbers of extra-solar planet candidates (e.g., the CoRoT and Kepler missions, Brode *et al.* 2003, Borucki *et al.* 2004).

Gallardo *et al.* (2005) have developed a fast technique to pre-select the most promising candidates using either near-IR photometry or low resolution spectroscopy. This method is based on the well-calibrated surface brightness relation along with the correlation between mass and luminosity for main sequence stars, so that not only can giant stars be excluded but also accurate effective temperatures and radii measured. The main source of uncertainty arises from the unknown dispersion of extinction at a given distance. They applied this technique to observations of a sample of 34 stars extracted from the low-depth transits identified by OGLE during their survey in the Carina fields of the Galactic disc. They infer that at least 78% of the companions of the stars which are well characterized in this sample are not exoplanets.

Eight transiting extra-solar planets are known to date: HD209458-b (Charbonneau *et al.* 2000), OGLE-TR-56-b (Konacki *et al.* 2003), OGLE-TR-132-b (Bouchy *et al.* 2004), OGLE-TR-111-b (Pont *et al.* 2004), OGLE-TR113-b (Bouchy *et al.* 2004, Konacki *et al.* 2004), and OGLE-TR-10-b (Konacki *et al.* 2005), TrES-1-b (Alonso *et al.* 2004), and HD 149026-b (Sato *et al.* 2005). The parent stars of these new planets have been accurately measured by these authors, and knowledge of their densities has allowed to develop and test models of planetary formation and evolution.

## References

- Alonso *et al.*, 2004ApJ...613L.153A  
 Brode *et al.*, 2003A&A...405.1137B  
 Borucki F., *et al.*, 2004A&A...421L..13B  
 Bouchy *et al.*, 2004A&A...421L..13B  
 Charbonneau *et al.*, 2000ApJ...529L.45C  
 Gallardo *et al.*, 2005A&A...431..707G  
 Gray *et al.*, 2003AJ....126.2048G  
 Fischer *et al.*, 2005ApJ...620..481F  
 Konacki *et al.*, 2003Natur.421..507K  
 Konacki *et al.*, 2004ApJ...609L..37K  
 Konacki *et al.*, 2005ApJ...624..372K  
 Pont *et al.*, 2004A&A...426L..15P  
 Sato *et al.*, 2005astro.ph.07009S  
 Schneider, J. 2005, The Extrasolar Planet Encyclopedia,  
<http://vo.obspm.fr/exoplanetes/encyclo/encycl.html>  
 Udalski *et al.*, 2004AcA....54..313U

## 5. Catalogues & Atlases

### 5.1. *General Catalogue of Stellar Spectral Classifications*

A new and exciting compilation of spectral classifications is in process by Brian A. Skiff of Lowell Observatory. This general catalog contains spectral classifications for stars collected from the literature and serves as a continuation of the compilations produced by the Jascheks, by Kennedy, and by Buscombe. Its superior value lies in giving citations for every entry, in listing only types derived from spectra (viz. line and band strengths or ratios), in including full types with remarks, and in being as complete as possible. This completeness extends to the large objective-prism surveys done at Case, Crimea, Stockholm/Uppsala, Abastumani, and elsewhere. The classifications include MK types as well as types not strictly on the MK system (white dwarfs, Wolf-Rayet, etc), and in addition simple HD-style temperature types. System-defining primary MK standard stars are included from the last lists by Morgan and Keenan, while Garrison's (1994mpyp.conf...3G) list of MK 'anchor points' is being noted in this regard.

As a 'living catalogue', an attempt is being made to keep up with current literature, and to extend the indexing of citations back in time. The compilation is being made available through the CDS, and access can be gained via its descriptive page at

<http://cdsweb.u-strasbg.fr/viz-bin/Cat?III/233>

### 5.2. *Galactic O-Star Catalogue*

Walborn reports a catalog of 378 Galactic O stars, with accurate spectral classifications, that is complete for  $V < 8$  but includes many fainter stars.

2004ApJS..151..103M Maíz-Apellániz *et al.*

### 5.3. *Far-UV Spectral Atlases*

Walborn also reports the following atlases of far-ultraviolet spectra secured with the FUSE satellite:

2002ApJS..141..443W Walborn *et al.*, far-uv atlas of MC OB stars

2002ApJS..143..159P Pellerin *et al.*, far-uv atlas of Galactic OB stars

2004ApJS..154..651W Willis *et al.*, far-uv atlas of Galactic, LMC, and SMC WR stars

## 6. Spectral Classification

(Brian A. Skiff)

Approximately 20,000 new spectral classifications were published during the triennium. This includes types determined from spectra at wavelengths from the near-UV to the near-IR through the traditional MK process, as well as detailed fitting of line-profiles to model atmospheres, but not from fits to coarse spectral energy distributions, photometric colors, or types inferred from direct determinations of temperature and gravity. The summary below describes material published in mainstream journals between cover dates July 2002 and June 2005. Papers with “many” stars are highlighted in preference to those with only a few.

Though spectral classification of low-mass stars is the current “growth industry”, the more general emphasis has been on all four corners of the Hertzsprung-Russell diagram: of extremes in mass, age, temperature, and luminosity. Thus the less common surveys of ordinary stars are a welcome respite.

### 6.1. *Young low-mass stars and substellar objects*

With the more complete establishment of classification criteria for low-mass stars and substellar bodies in the far-red and near-infrared, comprehensive searches for these objects in star-forming regions has become a bandwagon topic. In many cases the recent near-IR catalogues (2MASS at JHK and DENIS at IJK) have been used to sort out likely candidates from field stars. The recent catalogues from the ROSAT and Chandra X-ray spacecraft have also been examined for visible or near-IR stellar counterparts. In the first list of citations below, very faint stars in Chamaeleon have been canvassed by groups led by Gómez, Comeron, Luhman, and Lyo.

2002A&A...389..494G Gómez & Persi, near-IR spectra in Cha I  
 2003AJ....125.2134G Gómez & Mardones, near-IR spectra in Cha I  
 2004A&A...417..583C Comeron *et al.*, more stars in Cha I  
 2004ApJ...602..816L Luhman, census of Cha I  
 2004ApJ...616.1033L Luhman *et al.*, epsilon Cha  
 2004MNRAS.355..363L Lyo *et al.*, PMS stars in eta Cha

Other (partly-related) southern star-forming regions have also been searched specifically for low-mass stars:

2005AJ....129.1564K Kim *et al.*, low-mass stars in CG 30/31/38  
 2002ApJ...575..484G Gizis, brown dwarfs in TW Hya assoc  
 2002AJ....124.1670M Mamajek *et al.*, post-T Tau stars Cen/Cru  
 2003A&A...406.1001C Comeron *et al.*, Lupus 3 dark cloud  
 2002AJ....124..404P Preibisch *et al.*, Upper Sco OB assoc  
 2004AJ....127..449M Martin *et al.*, brown dwarfs in Upper Sco from DENIS

The traditional Taurus-Auriga region, including the less well observed westward extension into Aries, has not been ignored either. The Hartigan & Kenyon paper cited below made use of the STIS spectrograph on HST to obtain separate spectra of the components of subarcsecond binaries among many well-known T Tauri stars.

2002AJ....124.2164A Andersson *et al.*, survey of Lynds 1457 (Aries)  
 2003ApJ...583..334H Hartigan & Kenyon, subarcsec binaries in Taurus-Auriga  
 2004ApJ...616..998W White & Hillenbrand, Taurus-Auriga  
 2004ApJ...617.1216L Luhman, brown dwarfs in Taurus

More distant, obscured star-forming regions in Perseus and Cepheus have also been searched for low-mass stars and more ordinary pre-main-sequence objects:

2003ApJ...593.1093L Luhman *et al.*, census of IC 348  
 2005ApJ...618..810L Luhman *et al.*, more stars in IC 348  
 2003AJ....125.1480A Aspin, NGC 1333 S  
 2004AJ....127.1131W Wilking *et al.*, NGC 1333  
 2004AJ....128.1233H Herbig *et al.*, NGC 1579  
 2004AJ....128..805S Sicilia-Aguilar *et al.*, low-mass stars near Cep OB2

The inventories of low-mass stars and substellar objects in Orion has been extended both in the Trapezium region and in areas outside the much-observed Orion Sword, extending as far north as lambda Orionis, inspired by recent deep photometric surveys (viz. Dolan & Mathieu 2002AJ....123..387D).

2003A&A...404..171B Barrado y Navascues *et al.*, sigma Ori substellar population  
 2004A&A...416..677A Alcalá *et al.*, stars in Lynds 1616 (Orion)  
 2004ApJ...610.1045S Slesnick *et al.*, low-mass stars in Orion nebula cluster  
 2004ApJ...610.1064B Barrado y Navascues *et al.*, lambda Ori  
 2005AJ....129..907B Briceño *et al.*, low-mass variables in Ori OB1

### 6.2. Older low-mass nearby stars in the field

Similar work amongst the nearest stars on the faint end of the ‘high-gravity’ main-sequence has been facilitated by 2MASS and DENIS as well as comprehensive proper-motion and photometric catalogues (SDSS, revisions of the Luyten catalogues, etc). “Teegarden’s Star” was added to the short list of named stars having the very largest proper motions. The large set of uniform spectral data by Cushing *et al.* should greatly aid the assessment of spectral variations with temperature, gravity, age, and metallicity down to the lowest-mass objects observed so far.

2003AJ....125.1598L Lepine *et al.*, new northern large-motion stars  
 2003AJ....126..353R Rojo & Ruiz, Calan-ESO proper-motion stars  
 2003AJ....126.2421C Cruz *et al.*, “Meeting the cool neighbors. V”, M & L dwarfs  
 2003AJ....126.3007R Reid *et al.*, “Meeting the cool neighbors. VII”, M dwarfs  
 2003ApJ...589L..51T Teegarden *et al.*, new very-large-proper-motion star  
 2003ApJ...594..510B Burgasser *et al.*, T dwarfs in the far-red  
 2004A&A...416L..17K Kendall *et al.*, M and L dwarfs in DENIS  
 2004AJ....127.2856B Burgasser *et al.*, T dwarfs and others in 2MASS  
 2004AJ....127.3553K Knapp *et al.*, near-IR spectra of L and T dwarfs  
 2004AJ....128..463R Reid *et al.*, “Meeting the cool neighbors. VIII”, <20pc  
 2005ApJ...623.1115C Cushing *et al.*, R-to-L-band spectra (0.6-4.1 microns)

### 6.3. Low-mass stars in open clusters

Finally, the pursuit of the bottom of the main sequence in open clusters has likewise benefitted from similar deep photometric surveys in the far-red and near-infrared, sometimes combined with proper-motions and x-ray detections. In approximate order of increasing cluster age:

2002A&A...393..195M Marco & Negueruela, PMS candidates in NGC 1893  
 2005AJ....129..829D Dahm & Simon, T Tauri stars in NGC 2264  
 2002AJ....124.2083B Balog & Kenyon, emission-line stars in NGC 6871  
 2003MNRAS.343.1271J Jeffries *et al.*, low mass stars in NGC 2547  
 2005MNRAS.358...13J Jeffries & Oliveira, more low-mass stars in NGC 2547  
 2004ApJ...614..386B Barrado y Navascues *et al.*, low-mass stars in IC 2391  
 2005A&A...436..853L Lodieu *et al.*, low-mass stars in alpha Per cluster  
 2002AJ....124.1570A Adams *et al.*, M dwarfs in Praesepe

6.4. *Other stars in open clusters*

General spectroscopic surveys in open clusters have been used to help separate cluster members from the field and to find interesting targets for more detailed study. Photometry, types, and proper motions by Villanova *et al.* in the striking high-latitude star-group Collinder 21 show that this is not a physical cluster after all. The dense, obscured cluster Westerlund 1 was worked over several times by Negueruela & Clark, highlighting what a remarkable object it is. The citations below apply to clusters in approximate RA order.

- 2002AJ....124..507W Walborn, absolute magnitudes of O stars in associations  
 2002AJ....124..989G Gray & Corbally, peculiar A stars in twelve open clusters  
 2004A&A...428...67V Villanova *et al.*, Collinder 21 star-group  
 2005AJ....129..393O Oey *et al.*, IC 1795 and the W3/W4 complex  
 2002AJ....124.3289B Bragg & Kenyon, Be stars in h & chi Persei  
 2002ApJ...576..880S Slesnick *et al.*, mostly hot stars h & chi Persei  
 2005ApJ...618L.123K Kalirai *et al.*, white dwarfs in Messier 37  
 2003MNRAS.341..169B Bosch *et al.*, OB stars near Ruprecht 55  
 2003A&A...405..571C Corti *et al.*, OB stars near Bochum 7  
 2005A&A...432..491G Giorgi *et al.*, Pismis 8 and NGC 2866 (Pismis 13)  
 2002A&A...396L..25C Clark & Negueruela, massive stars in Westerlund 1  
 2005A&A...434..949C Clark *et al.*, more stars in Westerlund 1  
 2005A&A...436..541N Negueruela & Clark, still more stars in Westerlund 1  
 2004ApJ...617L..61W Walborn *et al.*, period of Of?p Spectrum Alternator HD 191612  
 2003A&A...406..893B Boeche *et al.*, NGC 6738 star-group  
 2004AJ....128..330D Delgado *et al.*, IC 4954/5 = Roslund 4 nebulous cluster  
 2004A&A...415..145B Boeche *et al.*, NGC 6913  
 2004A&A...419..149V Villanova *et al.*, NGC 6997 (not NGC 6996)  
 2002AJ....124.1585C Contreras *et al.*, intermediate-mass stars in Trumpler 37  
 2003AJ....126.1415C Caron *et al.*, blue stars in NGC 7419

6.5. *Ordinary stars in the field*

In this category falls spectral classification of non-pathological stars in the general field — though many have been the subjects of “bandwagon” topics in the past, and perhaps again in the future! The Ginestet & Carquillat paper is the most recent of a series leading to accurate spectral types for binaries with composite spectra. The papers by Abt, by Gray *et al.*, and by Negueruela and colleagues provide detailed MK types “done right” for substantial numbers of stars between roughly mag 6 and 10. At the other extreme, Pirzkal *et al.* give types for stars 20 magnitudes fainter that appear in the Hubble ‘Ultra Deep Field’.

Classifications for hot degenerate stars, mainly from SDSS spectra, are grouped separately. It has been found that automated classifiers are not yet adequate, and the largest survey here (about 3000 stars by Kleinman *et al.* 2004) reverts to visual inspection of the digital spectra.

- 2002Ap.....45..322G Gigoyan *et al.*, late-type field stars  
 2002ApJS.143..513G Ginestet & Carquillat, composite spectra resolved  
 2003A&A...402..963M Maheswar *et al.*, Stephenson H-alpha stars  
 2003A&A...406..119N Negueruela & Marco, northern OB stars  
 2003AJ....126.1362B Brown *et al.*, earlier-type stars toward NGP  
 2003AJ....126.2048G Gray *et al.*, northern Hipparcos stars earlier than M0  
 2003ApJ...599.1139F Figer *et al.*, cool giants near the Galactic Center  
 2004AN....325..749N Negueruela *et al.*, northern OB stars

- 2004ApJS..155..175A Abt, stars in Yale BSC Suppl  
 2005ApJ...622..319P Pirzkal *et al.*, extremely faint stars in the Hubble UDF  
 2005IBVS.5633....1R Roslund *et al.*, Miras in Scorpius  
 2003A&A...400..939E Edelmann *et al.*, Hamburg quasar survey  
 2003AJ....125.2621R Raymond *et al.*, white-dwarf/M-dwarf pairs in SDSS  
 2003AJ....126.1023H Harris *et al.*, white dwarfs in SDSS  
 2003ApJ...595.1101S Schmidt *et al.*, magnetic white dwarfs in SDSS  
 2004ApJ...607..426K Kleinman *et al.*, white dwarfs in SDSS1  
 2005A&A...430..223L Lisker *et al.*, hot subdwarfs from SN Ia progenitor survey

### 6.6. Carbon stars

A third edition of the Stephenson carbon-star catalogue was prepared by Andrejs Alksnis and collaborators in 2001 (2001BaltA..10....1A). It very quickly had updates and amendments resulting from searches at high galactic latitude in SDSS spectra, and from additional spectral surveys of the traditional sort. MacConnell & Osborn recovered Westerlund's 1100 southern carbon stars using unpublished charts. More ingeniously they found the Smith & Smith late-type stars first published in 1956, completely lacking coordinates, but identified only on a chart of very small scale.

- 2002AJ....124.1651M Margon *et al.*, high-latitude carbon stars in SSDS  
 2003AJ....125.2215C Chen & Chen, candidate carbon stars  
 2003PASP..115..351M MacConnell, southern carbon stars  
 2004A&A...418...77M Maunon *et al.*, high-latitude carbon stars in 2MASS  
 2004AJ....127.2838D Downes *et al.*, more SDSS carbon stars  
 2005A&A...438..867M Maunon *et al.*, high-latitude carbon stars in 2MASS  
 2005BaltA..14..144M MacConnell & Osborn, Westerlund carbon stars recovered  
 2005BaltA..14..148O Osborn *et al.*, Smith & Smith C- and S-type stars recovered  
 2005BaltA..14..167D Dzervitis & Egliotis, properties of carbon stars in 2MASS

### 6.7. Massive Stars in the Magellanic Clouds

Classification work in the Magellanic Clouds continues to concentrate on the most massive single and binary stars to explore the upper mass limits of stars. A striking result for O2 stars was the large variations in their N/O ratios, leading to the definition of the ON2~III(f\*) category. Most notable in this section is the comprehensive survey of over 4000 early-type stars in the SMC made using the 2dF multi-fiber instrument on the 3.9-m Anglo-Australian Telescope.

- 2002AJ....124.1601W Walborn *et al.*, O stars in 30 Doradus  
 2003A&A...400..923H Heydari-Malayeri *et al.*, clusters R127 and R128  
 2003AJ....126.2867M Massey & Olsen, red supergiants in the LMC & SMC  
 2004A&A...420.1087M Martins *et al.*, SMC N81  
 2004ApJ...608.1001M Massey *et al.*, early-O stars in the LMC & SMC  
 2004ApJ...608.1028W Walborn *et al.*, CNO dichotomy in O2 stars in the LMC & SMC and the ON2~III(f\*) category  
 2004MNRAS.353..601E Evans *et al.*, 2dF survey of the SMC  
 2005A&A...436..117M Meynadier *et al.*, OB stars in N214c  
 2005MNRAS.357..304H Hilditch *et al.*, OB eclipsing binaries in the SMC  
 2005PASP..117..699M Morrell *et al.*, N IV and O IV features in O2-O5 spectra

### 6.8. *Other Local Group galaxies*

The main classification activity here was of Wolf-Rayet stars in M33 and the starburst galaxy IC 10. The more difficult B-supergiants were studied for chemical abundances by Trundle *et al.*

2002A&A...395..519T Trundle *et al.*, B-type supergiants in four M31 OB assoc

2003A&A...404..483C Crowther *et al.*, WR stars in IC 10

2004A&A...414L..45C Clark & Crowther, one more WR star in IC 10

2004MNRAS.350..552A Abbott *et al.*, WR stars in M33

### 6.9. *Other*

In this category falls a variety of classes of objects. Two groups are looking for new Herbig Ae/Be stars throughout the Milky Way. It has become evident that knowing the masses of the cool companions to dwarf novae helps constrain models of the binary and disk. Two examples of classifications of these stars from far-red spectra are cited.

Three unique objects may be singled out during the triennium. First, Ruiz-Lapuente *et al.* claim to have identified the original companion of a more massive cataclysm, Tycho's 1572 supernova in Cassiopeia. Next, after nearly a hundred years of suggestions, Comeron & Pasquali seem to have found a likely candidate for the ionizing star of the prominent North America and Pelican Nebulae near Deneb, an overlooked mag 13 late-O star. Third, also long sought, with many candidates not passing muster in the last 50 years, are stars with 'escape velocity', i.e., on hyperbolic galactic orbits. The first of these was identified by Brown *et al.*, who suggest its motion is consistent with having been ejected from the Galactic Center.

2003AJ....126.2971V Vieira *et al.*, Herbig Ae/Be candidates

2004AJ....127.1682H Hernandez *et al.*, more Herbig Ae/Be stars

2005AJ....129..856H Hernandez *et al.*, Herbig Ae/Be stars in OB assoc

2003MNRAS.342..151P Putte *et al.*, cool companions of dwarf novae

2004PASP..116..300T Thorstensen *et al.*, cool companions of dwarf novae

2004A&A...427..231G Gorny *et al.*, Wolf-Rayet nuclei of PNe

2004Natur.431.1069R Ruiz-Lapuente *et al.*, Tycho SN progenitor companion?

2005A&A...430..541C Comeron & Pasquali, ionizing star of North America/Pelican

2005ApJ...622L..33B Brown *et al.*, unbound hypervelocity star

## 7. Photometric Classification

(Vytautas Straižys)

### 7.1. *General Investigations*

General investigations related to the determination of stellar parameters by multicolor photometry.

2003A&A...398..705M Melendez & Ramirez, IRFM  $T_{eff}$  calibrations for the Vilnius, Geneva, RJ(C) and DDO photometric systems

2004A&A...417..301R Ramirez & Melendez, IRFM  $T_{eff}$  calibrations for cluster and field giants in the Vilnius, Geneva, RJ(C) and DDO photometric systems

2005ApJ...626..465R Ramirez & Melendez,  $T_{eff}$  scale of FGK stars

### 7.2. *Medium-band Systems*

*Strömvil and Vilnius Systems* Many papers with classifications via the Strömvil and



Vilnius systems are covered in section 1 of the report of Commission 25, Stellar Photometry and Polarimetry. Also reported there is the selection of the two “Gaia” systems for classification and parametrization of stars by this orbiting observatory (see <http://www.rssd.esa.int/index.php?project=Gaia> ).

Additional papers in the Vilnius system

2005BaltA..14..104Z Zdanavičius, optimum passbands for photometric classification

2004Ap&SS.294..225B Bartašiute & Tautvaišiene, open cluster NGC 7789

2003BaltA..12..547L Lazauskaite *et al.*, metal-deficient dwarfs

*Strömgren System* Investigations in the uvby $\beta$  system include

2002AJ....123.2715T Twarog *et al.*, metallicities of G dwarfs

2002A&A...392.1031A Adelman al, Teff and log g of B and A stars

2002ApJ...577L..45M Martello & Laughlin, metallicity calibration of metal-rich stars

2002RMxAA..38..141M Moreno-Corral *et al.*, open cluster Haffner 19

2002A&A...394..479C Capilla & Fabregat, open cluster h+chi Per

2002RMxAA..39..171S Schuster *et al.*, open cluster NGC 823

2003A&A...403..937P Paunzen *et al.*, open clusters NGC 6192 & NGC 6451

2003AJ....125.1383T Twarog *et al.*, open cluster NGC 6253 (uvby $\beta$  + Ca)

2004AJ....127.1000A Anthony-Twarog & Twarog, open cluster NGC 3680 (uvby $\beta$  + Ca)

2004AAS...205.2207A Anthony-Twarog *et al.*, open clusters NGC 2420 and NGC 6791 (uvby $\beta$  + Ca)

2004AJ....127.1227C Clem *et al.*, color-temperature relation

2004A&A...418..989N Nordström *et al.*, ages and metallicities of Solar vicinity F-G dwarfs

2004A&A...422..527S Schuster *et al.*, stars with very low metallicities: classifications, red-denings, ages,...

2004A&A...426..827B Balaguer-Nunez *et al.*, open clusters NGC 1817 and NGC 1807

2005AJ....129.1642F Fitzpatrick & Massa, calibration of the systems UBV, uvby $\beta$ , Geneva, RIJHK, 2MASS with Kurucz model atmospheres, B and A stars

2005AJ....129..872A Anthony-Twarog *et al.*, open cluster NGC 2243 (uvby $\beta$  + Ca)

2005MNRAS.358...66F Fabregat & Capilla, open cluster NGC 663

2005RMxAA..41..69M Moreno-Corral *et al.*, open cluster Haffner 18

2005A&A...437..457B Balaguer-Nunez *et al.*, open cluster NGC 2548

2005MNRAS.360.1345K Karatas *et al.*, ages and metallicities of Solar vicinity F-G stars

*DDO System* Investigations in the DDO photometric system include:

2003A&A...399..543C Claria *et al.*, open cluster IC 2488

2005BaltA..14..301C Claria *et al.*, open cluster NGC 2447

*BATC System* Investigations in the BATC 15 color photometric system include:

2003A&A...397..361Z Zhou *et al.*, Landolt SA 95 standard star field

2004AJ....128.2265D Du *et al.*, metallicity of F-G dwarfs

2005PASP..117...32W Wu *et al.*, open cluster M48

### 7.3. Wide-band Systems

Investigations in the UBVRI system are reported in section 1 of the report of Commission 25, Stellar Photometry and Polarimetry. It should be noted that only the Vilnius system (and partly uvby $\beta$ , DDO and BATC) were used for two- or three-dimensional classification of stars.

*Washington System* Investigations in the Washington photometric system include:

- 2002MNRAS.329..556P Piatti *et al.*, LMC clusters NGC 2155 and SL 896
- 2003A&A...399..543C Claria *et al.*, open cluster IC 2488
- 2003MNRAS.340.1249P Piatti *et al.*, open cluster NGC 2194
- 2003MNRAS.341..771G Geisler *et al.*, 8 open clusters in LMC
- 2003MNRAS.343..851P Piatti *et al.*, star clusters in LMC
- 2003MNRAS.344..965P Piatti *et al.*, star clusters in LMC
- 2003MNRAS.346..390P Piatti *et al.*, open cluster NGC 2627
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## 8. Surveys

### 8.1. Digitization and Auto-Classification of the Michigan Objective-Prism Plates

(Sang-Gak Lee)

The main goals of the project are first, to digitize all deep Michigan objective-prism plates, second, to auto-classify them. The deep (20 min exposure) plates of about 1000 excellent plates, covering the southern whole sky lower than the declination of +3.5 degree, were shipped to the Astronomy Department of Seoul National University for a long-term loan from Dr. Nancy Houk at Michigan University in Oct 2003.

Michigan objective-prism plates were taken with the Michigan Curtis Schmidt (36/24 inch) telescope at Cerro Tololo Inter-American Observatory. The 4° + 6° prisms yield a dispersion of 108 Å/mm at H and the resolution is about 2Å. The spectra were taken on IIa-O plates and widened to 0.8 mm and exposed 20 min. Each plate covers 5° × 5° field of view (19.5 cm × 19.5 cm) and contains good spectra of most HD stars in each field. HD stars were reclassified visually on the objective-prism plates by Houk and catalogued in five volumes of the Michigan Spectral Catalogue.

Unfortunately the budget request for the renovation of the originally proposed microdensitometer PDS 2020 GMS at the Seoul National University for the PC-based data acquisition system was rejected in 2004, and the positioning accuracy of the microdensitometer PDS 1010 GMS at the Korea Astronomy Observatory is so poor that one has to do it manually.

Therefore a commercial scanner, Microtek ScanMaker i900 and a dedicated PC have been purchased for this project. The ScanMaker i900 is a 48-bit, high-speed color (16-bit grey scale) scanner featuring a dual interface (FireWire and Hi-Speed USB), 6400 × 3200-dpi optical resolution, and two scanning beds: an upper bed for scanning reflective materials and a lower bed for scanning transparent materials such as glass plates. Tests have shown that the spatial resolution of 8 μ/pixel by the scanning resolution of 3200 dpi is appropriate for the 108 Å/mm dispersion objective-prism plates with 2Å resolution. With 3200 dpi scanning resolution, the scanning time and the file size for a 19.5 cm × 19.5 cm plate are about 30 min and 1.2Gb. It is expected to complete scanning for 1000 plates by the end of this year.

The future plan is to make a spectrum file for each HD star on all of the Michigan objective-prism plates. This will include a one-dimensional wavelength calibrated spectrum, which will be available publicly and will be used for auto-classification.

## 8.2. The COROT Mission

(Werner W. Weiss)

COROT (COnvection ROTation and Transits of planets) is a French led European space mission designed for ultra-precise photometry and is scheduled for launch in summer 2006. The scientific goals are twofold: asteroseismology of stars brighter than 9th magnitude, and detection of planet transits for stars in the magnitude range from 11th to 16th V-magnitude. For the latter, CoRoT will continuously measure the fluxes of up to 12 000 stars selected in a field of view of about 3.4 square degrees. Two fields in opposite directions in the sky and close to the galactic and celestial equator will be observed continuously during 150 days providing a total of 60 000 light curves. In addition, two other fields will be observed during a shorter period of about 20 days, adding another 60 000 light curves, but with a shorter time coverage.

The knowledge of fundamental astrophysical parameters for each of the candidate targets is required not only for a selection of the best targets within each exoplanet target field, but also for assigning the optimum photometric window for the CCD detector. Due to a direct vision prism in front of the CCDs of the exoplanet channel, the point spread function depends on the spectral type and magnitude of a target star. A large program of broad-band photometry with the INT/La Palma has been performed and cross-correlated with near-IR 2Mass data to obtain this information. However, this photometric classification suffers from large uncertainties, the main being unknown reddening which can result in a wrong identification of the luminosity class. In addition, photometry does not provide a good estimate for metallicity nor for binarity. Test observations have been obtained and a full proposal has been submitted for using the GIRAFFE/VLT large field multi-fiber facility at ESO to characterize the bright dwarf population in the CoRoT exoplanet fields. The immediate objective of this programme is to derive fundamental stellar parameters for a large sample of about 24 500 dwarfs, selected among target stars brighter in R than 15 mag. The planned classification survey aims at building a complete database of stellar properties needed for investigating the properties of extra-solar systems and the mechanism of formation of the planets which will be found by CoRoT.

## 9. Conferences

Five members of Commission 45's OC initiated a proposal for a Joint Discussion, "*Exploiting large surveys for Galactic astronomy*". They were joined by members from five other Commissions, and all were delighted to have the proposal accepted as JD13 during the XXVIth IAU-GA in Prague.

## Acknowledgements

I am very grateful to all those colleagues whose names appear at the head of the sections they contributed to this report. I also wish to thank the OC members for their support and in particular the members of the JD13 SOC for their patient and considerable work.

Christopher J. Corbally, S.J.  
*President of the Commission*