

Galactic Structure

The Luminosity and Mass Functions at the Bottom of the Main Sequence

IIIaF and IVN plates taken in ten fields (covering a total of 270 degrees²) as part of the POSS II and UKSRC surveys and scanned with the COSMOS measuring machine, have been used to construct complete samples of VLM candidates for study in the infrared. Using K-band photometry of these stars subsequently obtained, combined with the I-band colours from the photographic catalogues we estimate a bolometric luminosity function which extends to $M_{bol} = 13.75$.

Combining these data with a purely photographic luminosity function for more luminous stars, we find significant evidence for a luminosity function decreasing towards the bottom of the main sequence. We also find that our data are consistent with the results of studies based on the Nearby Star sample, when those data are presented as a bolometric luminosity function. We convert our observed LF into the form of a mass function, which extends with reasonable statistics to $0.08M_{\odot}$ — the H-burning minimum mass. We find significant evidence for features in the mass function at these masses. Specifically, the mass function ‘turns over’ at $\approx 0.25M_{\odot}$, goes through a local minimum at $\approx 0.15M_{\odot}$, and seems to increase again below $0.1M_{\odot}$ — none of these features are predicted by any of the current theories of star formation. Lastly, the mass density we observe just above the H-burning minimum mass makes it difficult to envisage brown dwarfs contributing significant quantities of missing mass without invoking either a mass function in this region significantly steeper than that seen for main sequence stars, or an extremely low cut-off mass to the mass function.

*C.G. Tinney
ESO, Garching, Germany*

Activity Analysis of dM Stars based on Wide-field Photographs

Our Galaxy is abundant in red dwarf stars and the large majority of these objects seems to be unstable. Conversely more than 60% of the variable stars known in the solar vicinity ($r < 20\text{pc}$) are flare stars and taking into account the number of BY Dra stars too the proportion of red dwarfs amongst local variables is superior to three quarters. Their absolute visual magnitudes range from +6 to +17.5 or even more. During flare events their brightness may reach a maximum corresponding to an enhancement of 1000-10,000 times. The amplitude of a large flare in the U band may be as high as 8-10 magnitudes. These events take place non-periodically in unpredictable moments; no unquestionable periodicity has been found in the time distribution of stellar flares. However the activity level of various flare stars is considerably different. Some of them show observable flare ups with a mean frequency of 1 per hour whilst others produce only one event per annum. For the scarcity of the phenomenon photoelectric photometry of individual stars is not the adequate means to a better understanding of flare stars. The other way: wide-field photographic photometry is definitely more advantageous for the possibility of simultaneous recording of the possible brightness variations of hundreds of objects and for the high limiting magnitude offered by fast Schmidt-cameras in the U spectral band. This latter made the statistical investigation of flare stars and their flare ups in open clusters possible, since their red dwarfs are too faint (especially in the ultraviolet) to be readily measurable by photometers mounted on moderate-sized telescopes. Some of the younger and richer open clusters are perfectly disposed for such a study. Their distance modulus is inferior to 7.5 but their angular diameter fits nicely that of the viewing angle of the photographic telescopes used in the observing campaigns. The quasi-uniformity of these devices and the similarity of the emulsions and other important parameters of

the photographic procedures permitted the combination of the results of many individual runs and the spatial and photometric filtering of the published data led to more reliable and more convincing conclusions concerning the flare activity of dM stars.

G. Szecsenyi-Nagy
Eotvos Lorand University
Department of Astronomy
Budapest, Ludovika ter 2, H-1083, Hungary

Star Counts as Constraints for Galactic Evolution

The Besançon model of population synthesis of the Galaxy has been built as a tool to constrain our knowledge of the Milky Way by allowing us to compare predictions of evolution scenarios with photometric and astrometric observations (Robin and Crézé, 1986; Bienaymé et al., 1987). It uses the age distribution in the HR diagram (Haywood 1993), coming from galactic evolution scenarios, to parametrize the distribution functions (densities, velocities and metallicities). The model is made dynamically selfconsistent through Poisson and Boltzmann equations. It allows us to nicely reproduce the proper motion distributions in the solar neighbourhood (Robin and Oblak, 1987) and at remote distances (Bienaymé et al., 1992; Soubiran, 1992).

We describe here how photometric star counts at $10 < V < 18$ towards the galactic pole and the anticenter at low latitude, and one sample at bright magnitudes from the Hipparcos Input Catalogue allow the constraining of the history of disc star formation in the ($d < 2kpc$) solar neighbourhood. The comparison with the data is made on an extensive range of models and provide new constraints in the time variation of the SFR, together with a new consistent description of the solar neighbourhood.

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M. Haywood, A.C. Robin and O. Bienaymé
Observatoire de Besançon
BP 1615, F-25010 Besançon Cedex, France

M. Crézé
Observatoire Astronomique de Strasbourg
11 rue de l'Université, 67000, Strasbourg
France

Wide-field Observations of Variable Stars in the Region of NGC 7129

During our programme for investigation of nonstable and flare stars in the regions of star formation more than 250 UBV photographic plates in the field of the bright nebula NGC 7129 were obtained. The observations were made with the 50/70/172 cm Schmidt telescope and 2m RCC telescope of the Rozhen Astronomical Observatory of the Bulgarian Academy of Sciences during the period September 1984 - April 1993.

For V 350 Cep known as a T Tauri star we have obtained that in this period the star brightness gradually increases. The results of the photometric observations of newly discovered variable stars probably of T Tauri type and CCD spectral observations are presented.

Evgeni H. Semkov
Institute of Astronomy, Bulgarian Academy of
Sciences
Tsarigradsko Shose 72, 1784 Sofia, Bulgaria

CCD Imaging of Nearby Evolved Planetary Nebulae

We present results from narrow band CCD images in $H\alpha$ + $[\text{NII}]$, and $[\text{OIII}]$ of 9 very faint, nearby (less than 0.5 Kpc) planetary nebulae, of large angular extent.

The images were taken using the 30cm Schmidt-Cassegrain telescope equipped with a CCD camera which operates at Mount Skinakas on the island of Crete. A brief outline of the existing instrumentation as well as the reduction procedure followed for such wide field images is presented here.

The PN images we present are calibrated using a spectrophotometric standard star. The faintest structures revealed in our images are as faint as 10^{-17} ergs $\text{sec}^{-1}\text{cm}^{-2}$ arcsec^{-2} . New structures are revealed at large distances from the central part of those nebulosities which are hard to reconcile in the current frame-work of well established evolutionary models. The individual peculiarities of each object merit further study by deriving kinematic data. Finally features reminiscent of the interaction of the former Red Giant Envelope with the ambient Interstellar Medium are evident from our images. The observations presented here are part of an ongoing program to study a large sample of extended and evolved PNs.

J. Papamastorakis, K.M. Xilouris and E.V. Paleologou
Physics Department, University of Crete
71409 Heraklion, Crete, Greece

Wide-field Imaging Photometry and Spectrophotometry of Orion Population Stars

Wide-field imaging detectors can assist us in answering problems in the study of Orion population stars, in particular T-Tauri stars. Highly sensitive modern digital detectors make the study of faint stars accessible to small telescopes. Compact groups of stars, field stars and noise levels can be observed simultaneously.

On the television complex of the Crimean Astrophysical Observatory MTM-500 (0.5m meniscus telescope + purpose-built instrument

+ high sensitive detector) there is provided the capability of complex monitoring of Orion population stars. Several objects from the Herbig-Bell catalog of Orion population emission-line stars were observed during June 1990 to June 1992. Accurate increases in brightness were registered using simultaneous observation of the target star(s), noise level and a comparison star (or stars) in one of the U, B, V or R colour systems. With the help of the original system, quasi-simultaneous photometry of objects in the BVR colour system could be undertaken. On the purpose-built slitless spectrograph, low dispersion data can be obtained for the evaluation of the distribution of energy in the spectra and of integrated magnitudes of stars. All spectra are obtained on the slit spectrograph with a spectral extent of 4000 to 7000 Å, with a resolution of 5 Å and time resolution of 15 mins.

Aleksei A. Shlyapnikov
Astronomical Observatory of Nikolaev State
Pedagogical Institute
Roza Luxemburg 24, Nikolaev, 327000 Ukraine

High-velocity Clouds: Estimation of Gas/Dust Ratio based on All-Sky Survey Data

We have developed a method of gas/dust ratio estimation for high-velocity clouds (HVC) based on all-sky survey data in the microwave spectral range. The data from the 'Relikt-1' experiment and HVC catalogue were used to obtain this estimation. The Relikt data were compared with the all-sky distribution of HI column density in HVC. Three criteria of comparison (the difference between measurements near north and south elliptical poles, RMS on maps, quadruple component values) were applied. The evaluated gas/dust ratio is approximately 3 – 7 (for $T_{\text{dust}} = 5 - 10$ K accordingly) times higher than the ratio in interstellar medium (where gas/dust = 100). If dust in HVC is heated by radiation of the Galaxy, the estimated average distance to clouds is equal to 150 kps.

I.A. Trifalencov and A.A. Brukchanov
Space Research Institute, Moscow, Russia

First Observations with the Bonn Wide-field Photometer and Polarimeter — Surface Polarimetry of the Crab Nebula

The Crab Nebula was observed on 17.2.93 at the 1.82m telescope of the 'Osservatorio Astronomico di Padova' at Asiago using the Bonn Wide Field Photometer and Polarimeter (WWFPP).

This focal reducer system was designed for simultaneous observations of four directions of polarization using a twin wollaston prism in the collimated beam in combination with a masking technique in the telescope focal plane. This method is independent of fluctuations of atmospheric transparency and variation of the seeing during exposure time.

The field of view at this telescope was 14 x 14 arcmin with 0.42 arcsec/pixel and 2048 x 2048 pixels, ideally suited for observations of extended objects with low surface brightness.

Th. Leiber
Sternwarte, Universität Bonn, Germany

K. Reif
Radioastronomisches Institut, Universität Bonn

Objective Prism Surveys of the Galaxy

The main results of the low dispersion objective prism surveys of the Milky Way undertaken in the last thirty years for the study of the distribution of late type stars, namely M and C stars, are discussed.

Among them are two surveys made at Abastumani. One is a yellow-red (IIIa-F, IIIa-J) spectral survey (about 2000 A/mm at 5100 A) of the region from $l = 30^\circ$ to $l = 165^\circ$ and $-5^\circ < b < 5^\circ$ and another is a near-infrared (IV-N+RG8) spectral survey (about 7000 A/mm at A band) of the region $50^\circ < l < 115^\circ$, $-5^\circ < b < 5^\circ$. The limiting magnitudes of the surveys are $V = 16.0$ and $I = 15 - 15.5$ mag. As a result more than thirteen hundred new Carbon Stars were revealed in both surveys.

The study of the latitude and longitude

distribution of all detected C stars shows that the former is uniform while the latter is nonuniform. The mean surface density of C stars in the yellow-red survey is one per sq. degree, while in the near-infrared — three per sq. degree.

Using the nearest neighbour method it is shown that statistically significant numbers of C star pairs and members of the open star clusters are not observed. The connection of C stars with dark clouds was also studied.

The C/M5 ratio has been determined for different regions of the Milky Way.

Further prospects related to objective prism surveys for late type stars are discussed.

O. Kurtanidze and M. Nikolashvili
Abastumani Astrophysical Observatory
Georgia

Space Distribution of Stars in the Milky Way Selected Region

The main goal of this research is to investigate the structure of the nearby part of the Local Spiral Arm of the Galaxy in the direction of Kapteyn Selected Area No. 64 with $(l, b) = (67.5^\circ, -0.2^\circ)$ on the basis of photometric and spectral data for the relatively bright stars.

Photographic UBV photometry to a limiting magnitude of $V = 12.5$ is reported for about 1000 stars for which MK spectral classification was recently carried out at the Abastumani Astrophysical Observatory using the 70cm meniscus-type telescope equipped with an 8 degree objective prism.

On the basis of the catalog data the spatial distribution of stars and the stellar density for various spectral types have been determined. The spatial variation of interstellar absorption is also studied.

T. Kvernadze
Abastumani Astrophysical Observatory
Georgia

Photometry from Schmidt Plates Digitized with the MAMA Microdensitometer

A survey of proper motions and B, V photometry from Schmidt plates digitized with the MAMA microdensitometer is under realization. The aim is to obtain a large data set representative of the stellar populations probing the Galaxy to a few kpc in several directions. Computational, statistical, photometric and astrometric skills have already been tested on a 7 square degree field. Thanks to the high precision of the MAMA machine, the large number of plates, the long time baseline and the optimised methods of reduction, the accuracy of differential proper motions was estimated to be better than 2 mas/yr. The absolute reference frame was provided by carefully selected extragalactic sources. The photometric and astrometric data were combined to derive kinematics of 2500 stars. The deconvolution of the velocity distributions of the old disk, thick disk and halo has provided a reliable determination of their kinematical parameters. Radial velocities and metallicities are now being measured for a part of this preliminary sample.

*Caroline Soubiran
Centre d'Analyse de Images/MAMA
Observatoire de Paris
61 Avenue de l'Observatoire, 75014 Paris
France*

Galactic Dynamic and Kinematics from a Deep Proper Motion Survey

Strasbourg and Besançon observatories (France), CAI (Paris Observatory) and UP State Observatory (India) are conducting a sample survey in UBV photometry and proper motions as part of an investigation of galactic structure and evolution supported by Indo-French centre for the Promotion of Advanced Research. The project is based on Schmidt plates (from Tautenburg, Palomar, ESO and OCA telescopes) digitized with the MAMA machine. The high astrometric quality of the MAMA gives access to micronic accuracy

leading to a few mas per year accuracy using plates spread over a 30 year baseline. Medium photometric accuracy and high proper motion accuracy for complete faint star probes in large fields will give access to the properties of star samples out of the solar neighbourhood. The Schmidt sample survey is complemented by deep CCD photometry in some fields in order to get a wider magnitude range and to give access to faint or remote populations. To interpret this multidimensional data set we have developed a synthetic approach of galaxy modelling. Model simulations compared to observed stellar distributions in space (V, B-V, U-B, m_1 , m_2) will lead to suitable tests for galactic structure, dynamic and evolution.

*O. Bienaymé and A. Robin
Observatoire de Besançon, France*

*M. Crézé
Observatoire de Strasbourg, France*

*V. Mohan
UPSO, Nainital, India*

A Complete, Multicolour Survey of Absolute Proper Motions in the Anticentre Direction at Intermediate Latitude

As part of an investigation of galactic structure and evolution, we present the observational results of UBV photometry and absolute proper motions in the anticentre direction at intermediate latitude ($l = 170^\circ$, $b = 45^\circ$) for a 8.6 square degrees. The sample is complete down to $V = 17$, and the accuracy of the proper motions is better than 0".25 per century for stars brighter than $V = 16$. We discuss the implications of present data on stellar kinematics and the structure of our Galaxy.

*D.K. Ojha, O. Bienaymé and A.C. Robin
Observatoire de Besançon
Av. de l'Observatoire
BP-1615, 25010 Besançon Cedex, France*

Wide-field Stellar Statistics from Tautenburg Schmidt Plates

The combination of Tautenburg plates and automatic measuring machines provides a powerful means to obtain accurate proper motions of a great number of stars for statistical investigations of the kinematics of our Galaxy. With two plate pairs and a 20 years base line a proper motion accuracy better than 5 mas/year can be achieved for stars over a wide range of magnitudes. Outside the galactic plane proper motions are obtained with respect to an extragalactic reference frame defined by hundreds of background galaxies. More than 70 fields with at least 4 Tautenburg plates taken before 1970 provide an important observational basis for different proper motion programmes.

We present current results of statistical investigations in the main galactic meridian as well as of a kinematical study of open and globular clusters which has been carried out in Potsdam using Tautenburg plates.

*E. Schilbach, R.-D. Scholz and S. Hirte
WIP-Projekt Astrometrie bei der Uni. Potsdam
An der Sternwarte 16
O-1590 Potsdam-Babelsberg, Germany*

Stellar Kinematics in the Galaxy North Pole Region on the Basis of Tautenburg Schmidt Telescope Plates

The spatial velocity components and their dispersions in the galactocentric (X) and rotation (Y) directions, eccentricities of galactic orbits, parameters of spatial distribution and the change of all these characteristics with Z-distance from the Galaxy plane are investigated. These results have been determined on the basis of the absolute proper motions and stellar B, V magnitudes in two sky regions near the North Galactic Pole (NGP) by means of the plate set of the Tautenburg Schmidt Telescope.

Four subsystems distinguished in the direction of the NGP on the basis of the relation between the velocity V_Y with respect

to the Local Standard Rest and velocity dispersion have spatial boundaries between them $Z = 0.3, 1, 4.5$ kpc and age boundaries 10, 90, 95% of the Galaxy age. The relation of velocity dispersion ellipsoid axes $\sigma_X : \sigma_Y$ for these subsystems changes from 1 : 0.7 to 1 : 0.9. The semithicknesses of the subsystems are equal to 0.15, 0.3, 0.65, 1.5 - 2.5 kpc and the bulk of the Galaxy stellar populations is contained in the disk with semithickness 5 kpc and radius of 20 kpc.

*N.V. Kharchenko, E. Schilbach and R.-D. Scholz
Main Astronomical Observatory
Goloseevo, 252127 Kiev, Ukraine*

Galactic Orbits of Globular Clusters from Schmidt-Plate Astrometry

Plates from the Tautenburg Schmidt telescope have for the first time opened the opportunity to determine absolute proper motions of galactic globular clusters with direct reference to a large number of background galaxies. Combining plates with epoch differences of 20 to 27 years, absolute proper motions of the two clusters M3 and M92 could be measured with an accuracy of about $0.06''/100a$. Together with known values for distance and radial velocity these give a complete description of the clusters kinematics and allow the determination of their galactic orbits. We present results of orbit integrations based on a three component mass model for the Galaxy and discuss the behaviour of important orbital parameters during an interval of 10^{10} years backwards in time. The types of motion found for M3 and M92 are shown to be quite different.

*M. Odenkirchen
Sternwarte der Universität Bonn, Germany*

*R.D. Scholz
WIP-Projekt Astrometrie bei der Universität
Potsdam, Germany*

*M.J. Irwin
Royal Greenwich Observatory
Cambridge, UK*

New Proper Motions in Open Clusters: I. Milli-arcsecond Proper Motions in Pleiades

As a first step of our open cluster programme a preliminary catalogue of proper motions and photographic B, V, R magnitudes for stars up to 18 mag within a region centred near Alcyone is presented. The catalogue is based on MAMA measurements of plates taken with Tautenburg and OCA (CERGA) Schmidt telescopes. The photometric survey includes ca. 65,000 stars and covers a total field of about 25 square degrees. Proper motions have been obtained for ca. 20,000 stars within a central 9 square degree region of this field. For the majority of stars in the survey an accuracy of 0.15 mag and 2 mas/year has been estimated for photometric data and proper motions, respectively. The results of the determination of the Pleiades membership up to magnitude 18 are presented.

The extension of the proper motion survey to a field of 18 square degrees is in progress.

E. Schilbach, J. Guibert, S. Hirte and J. Souchay
WIP-Projekt Astrometrie bei der Uni. Potsdam
An der Sternwarte 16
O-1590 Potsdam-Babelsberg, Germany

Absolute Proper and Space Motion of the Globular Cluster M2

M2 is a globular cluster, which is supposed to have a large velocity component of about 280 km/s in the direction perpendicular to the galactic plane (Cudworth, *AJ*, **105**, 168). It is the fourth globular cluster on our programme for the determination of its absolute proper motion. We use measurements of plates on the double refractor of Sternwarte Bonn (now at Observatorium Hoher List), of glass copies of Palomar, and of recent deep Schmidt plates.

Eleven refractor plates with an epoch difference of up to 85 years have been used to derive relative proper motions with an accuracy of the order of 0"1/100a for all stars up to $V=15.5m$ in a field of 1.5 x 1.5 square degrees. The membership of the stars in the region of M2 has been determined. A first

result of the absolute proper motion and space motion of the cluster M2 based on measurements of 30 extragalactic objects is given.

M. Geffert and C. Forner
Sternwarte der Universität Bonn

M. Hiesgen
Astronomisches Institut der Universität
Münster

Membership and Internal Motions of Faint Stars in the Globular Cluster M3

A proper motion study from Tautenburg Schmidt plates is presented for the globular cluster M3 and its vicinity. The plates were scanned with the Automated Photographic Measuring (APM) system in Cambridge (UK). With a limiting magnitude of about $B = 21$ proper motions with an accuracy from 2 to 3 mas/yr have been obtained for stars with $B < 19$. The proper motions were determined applying a stepwise regression method with 3rd order polynomials in the plate-to-plate solutions with about 2000 reference galaxies. We used the results for the determination of membership probabilities and looked for internal motions of M3.

R.-D. Scholz
WIP-Projekt Astrometrie bei der Universität
Potsdam, Germany

N. Kharchenko
Main Astronomical Observatory of the
Ukrainian Academy of Sciences, Kiev

Photographic UVB Photometry of the Globular Clusters M3, M15 and NGC6712

Photographic intermediate band uvb observations of RGB and some AGB stars in fields centred on the globular clusters M3, M15 and NGC6712 are presented. The photometry confirms the existence of the gaps in the giant branch of M15. For NGC6712 the

Stromgren colours point at a bimodal carbon abundance for the bright giants in the central part. 42 stars from the central part of M3 which have not yet been photometrically and astrometrically investigated, are found to be photometrical members of the cluster. The possibilities of the uvby system for a classification of RGB and AGB stars are briefly discussed. Good dependence exists between the average value $\langle v-b \rangle$ of the RGB stars of each cluster and the values of $\%Fe/H!$.

N.T. Kaltcheva

Dept. of Astronomy, Sofia University

James Bouchier Ave. 5, Sofia 1126, Bulgaria

NGC 4833 and NGC 4590: First Results of a New International Project of Photographic and CCD Photometry in Globular Clusters

Co-operation has been established between the Isaac Newton Institute (Santiago, Chile), Institute for Astronomy of the Russian Academy of Science and Sternberg Astronomical Institute (Moscow). The photographic plates of globular clusters, taken in Chile by Gonzalo Alcaíno and collaborators, are being measured with the Sternberg Institute automatic densitometer. We also reduce Chilean CCD observations of globular clusters. The poster will present, as the first results, the photographic $V - (B - V)$ diagram for the globular cluster NGC 4833 and the most complete CCD $I - (R - I)$ diagram for the globular cluster NGC 4590. Some technical details of the measurements and reductions, as well as some properties of the clusters' colour-magnitude diagrams, will be discussed.

N.N. Samus

Institute for Astronomy of Russian Academy of Science

and

Moscow Research Branch of the Isaac Newton Institute