3-D Structure of the Galaxy from Star Counts

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Modeling the Galaxy

A systematic analysis of the stellar content of the Galaxy has been undertaken to:

- study the Galactic structure;
- study the stellar extinction along the line of sight;
- obtain information about the age of the various galactic components (halo, bulge and disc);
- derive the past history of star formation;
- simulate the sky (magnitudes, colours, star counts, proper motions and radial velocities) in preparation to the GAIA Mission declared ESA Cornerstone, which will give information about magnitudes, positions, metal content, radial velocities for 10^9 stars in the Milky Way.

We model the Galaxy star counts at varying SFR, enrichment law, scale heights, scale lengths using the model described by Bertelli et al (1995) and Vallenari et al (2000, 2001).

The data sets

The available data consist of several sets:

- ESO Danish 1.5m tel : 260< l < 305, -5 < b < 1.5 Sag-Carina Spiral Arm (with Schmidtobreick- ESO, Carraro - Padova)
- ESO WFI 2.2m : 20 fields in the direction of the Bar 14<l<349 , -8< b <8 in low reddening regions (with Lub, Omont, Schultheis)
- HST fields in the direction of the BW8, NGC 6553 (with Ortolani)
- GSPC2 data (in collaboration with Lattanzi, Spagna, Bucciarelli-Oss. Torino)

The adopted populations

Thin disk : age	3 components from 11 to 0.001Gyr Z=0.08 to 0.03 double exponential mass distribution exp(-r/h)*sech2(z/hz)
Thick Disk age:	10-12 Gyr Z=0.001 to Z=0.004
Spiral Arm age mass distribution	0.001-0.1 Gyr Logarithmic spiral

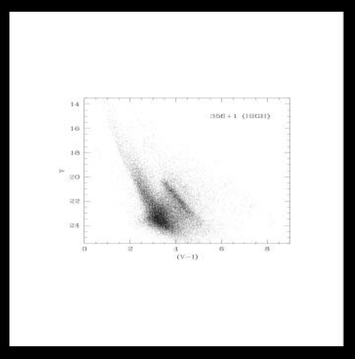


Fig1
Sample of the ESO 2.2m WFI data

The bulge component

The mass model

We stress the importance of taking into account the mass distribution of the bulge (see the following). The bulge has no spherical symmetry. Several models are proposed:

- Power law, as a deprojection of the de Vaucouler law. The flattening of the spheroid perpendicularly to the plane is a free parameter
- COBE-DIRBE oblate spheroid (Dwek et al 1995 G0). It is a Gaussian function with axial ratios 1:1:.56
- COBE-DIRBE triaxial model (Kent 1991, Dwek et al G2) with axial ratios 1:0.22:0.16
- Bissantz et al (1997) triaxial model based on COBE data with axial ratios 1:0.6:0.4 (B2)
- Bissantz et al (2002) model with ratios 1:0.3:0.3
- Exponential triaxial function (Dwek et al G2) with axial ratios 1:0.18:0.39, again based on COBE data
- The position angle of the bar is going from 25 (B2) , 20 (G2) and 36 (E2)

The field population in the direction of NGC 6553 (l=5, b=-3) (Vallenari & Ortolani 2001)

Feltzing & Gilmore (2000) and Beaulieu et al (2001) discuss the nature of the "red flare", the field population towards the bulge cluster NGC 6553. The turn-off of the red flare is visible at V=20.5 in Fig. 2.

These papers suggest the following hypotheses:

a) Metal poor bulge

b) Sagittarius turnoff

We make use of the data from Zoccali et al (2001) to separate cluster and field stars on the basis of the proper motions. Fig.2 represents the CMD of cluster and field stars.

The effect of the mass distribution in the direction of NGC 6553

We point out that the effect of the mass distribution on the colour-magnitude diagram is to produce a large spread at the turnoff and subgiant branch level. The expected distribution of the stars along the line of sight due to the effect of different mass distribution in the bulge is shown in Fig.3.

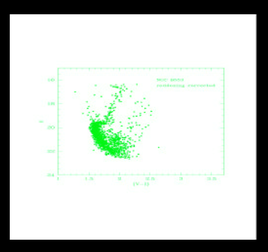
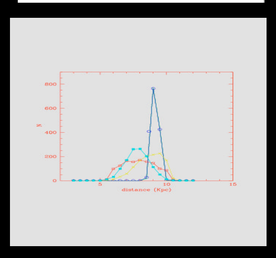


Fig.2



pink: Bissantz et al
light blue: G0
dark blue :E2
yellow :G2

Fig.3

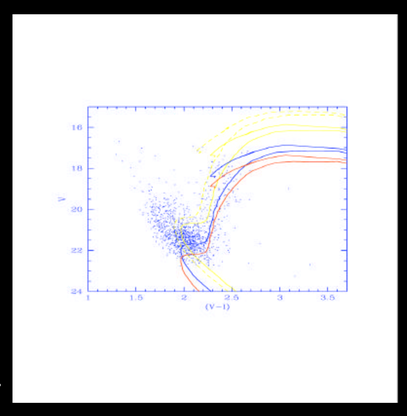


Fig.4

Isochrones of Z=0.019 and age 12 Gyr, distance 5,8,12 Kpc (solid line) and Z=0.008, distance 5 Kpc (dotted line) on the data of the field population where the cluster has been removed

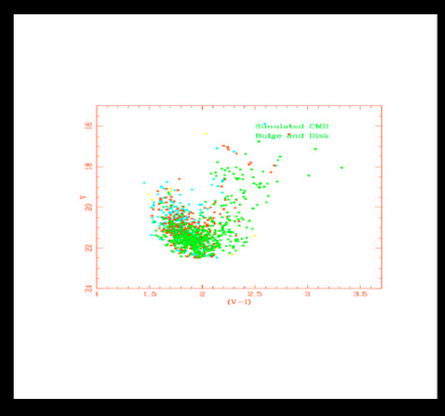


Fig.5

Simulation of the CMD including bulge and disk stars. The red flare is a natural consequence of the distribution of the stars along the line of sight. Due to the poor statistics, all the models but E2 are in agreement with the data

The bulge in the Bw8

We make use of Hst archive data on Bw8 (see Fig.5).

We derive a reddening of Av=1.4.

We simulate the disk population following Vallenari et al (2000).

Concerning the bulge simulation we make use of three populations, namely a) an old metal poor one of age 13-14 Gyr having Z ranging from 0.001 to Z=0.05, b) an old metal rich one with age 13-14 Gyr and Z=0.005-0.03, and finally c) a young metal rich of age ranging from 10 to 12 Gyr and Z from 0.008 to 0.05.

We find a dependence of the turnoff magnitude on the spatial distribution of the stars. The termination point of the main sequence changes of 0.3-0.4 mag because of this effect. The best fit is obtained with model c) and a mass distribution G2 (?? probability 0.97) and reddening Av=1.45. Model a) and b) give a fit only for the mass distribution B2 and a too high value of the reddening, Av=1.6 and Av=1.7 respectively (? probability 0.90) ,

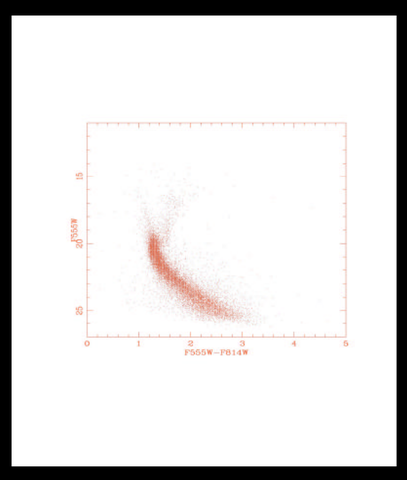


Fig.6

• The Luminosity function in BW8 is well reproduced by a flat IMF slope x=1.35 (Salpeter x=2.35). Fig.6 represents the luminosity function of the data (dots) taken at various colour ranges, in comparison with the model (solid line) obtained with population c) and a flat IMF.

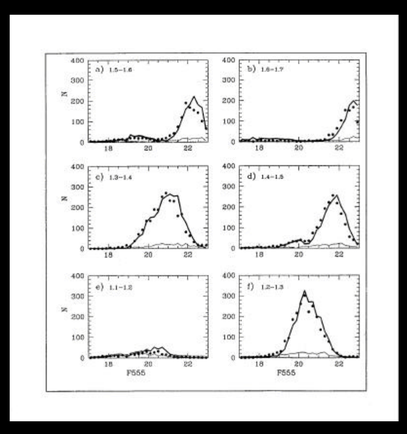


Fig.7

The Galactic plane in the direction of Sag-Carina Arm (Vallenari et al 2002)

Several fields in the direction of the Sag-Car arm are analyzed:

• 5 fields (Bochum 9, 10, 11, NGC 3114, Coll 228) between l=283-288, | b| <2 .

• 4 fields having (l=265,276,290,305,| b| <5)

Fig.8 shows the directions of some of the fields superposed on the logarithmic spiral model by Vallée (2002)

The main results can be summarized:

The data are in agreement with a logarithmic four-arm spiral model.

We derive a pitch angle of 12.7 in agreement with Vallée (2002). Adopting a gaussian distribution of the stars inside the arm we find a sigma_h=0.07 Kpc.

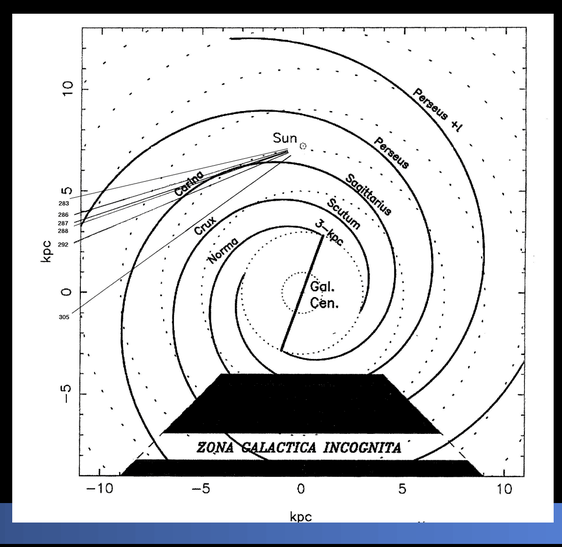


Fig.8

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