SIMULATIONS OF THE BRIGHTEST STARS IN GALAXIES AS DISTANCE INDICATORS

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The brightest stars in galaxies have been often considered useful as distance indicators. However, one may expect that the absolute magnitude of the brightest stars in galaxies should depend on the IMF and on the present SFR, and that statistical effects may be important, although different in different photometric bands, due to the different numbers of objects effectively sampled.

To investigate on this problem I have performed a number of numerical simulations of the absolute magnitude of the brightest objects in a population of stars more massive than 15 $M_{\odot}$, in four different bands: two UV bands, centered at 1400 Å and 1750 Å, the B and the V bands. Each synthetic population is constructed by performing a number N of random extractions of pairs (mass,age), according to a given IMF and a constant SFR. The location in the theoretical HR Diagram for each pair is found by linear interpolation on the evolutionary tracks with moderate mass loss computed by Maeder (1981a, 1981b, 1983), while the magnitudes are determined by using model atmospheres avaliable in the literature. Different values of N are explored, namely N= 50,100,200,500,1000,2000,4000,8000, while the corresponding number of simulations are 1200,800,600,500,400,300,250 and 100. In each run, only the three brightest stars were retained. Two different slopes of the IMF, namely 2.5 and 3, and two different values of the upper mass cut off (150 and 200 $M_{\odot}$) were tested.

The main results are the following:
i) the UV bands always sample the MS stars and are therefore most effective for selecting the brightest stars in galaxies with ongoing star formation. The statistical effects are found to be very important for the less luminous galaxies, as the theoretical distributions can be as wide as 2 mag. As the total number of objects sampled increases, the probability of sampling the upper end of the mass distribution increases and, correspondingly, the magnitude of the brightest stars decreases and

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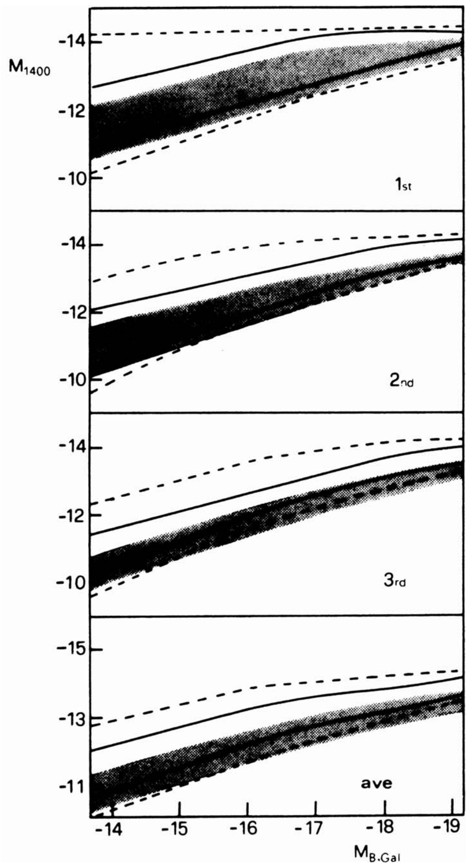

Fig. 1 : HMFW of the distributions (solid line) and 99% probability level for the brightest UV stars as function of the B magnitude of the parent galaxy. Shaded area: HMFW for s=3.

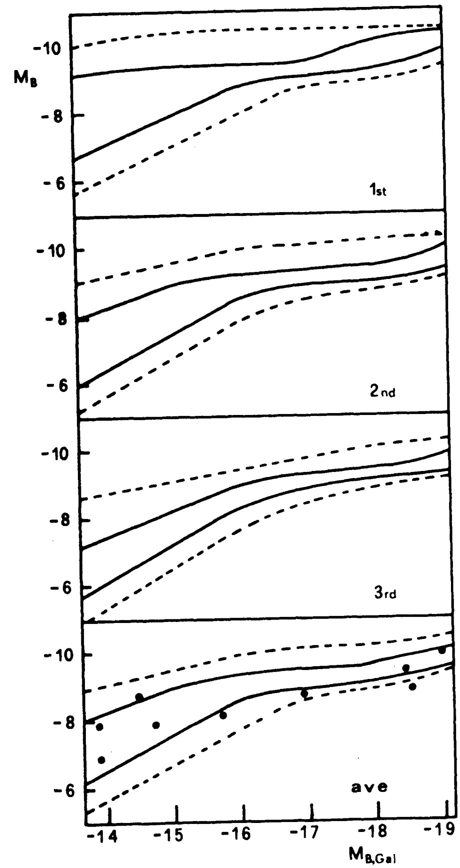

Fig. 2 : The same as Fig. 1 for the B magnitude. The dots are the observations reported by Sandage (1984).

the distributions get narrower (see Fig. 1). Therefore, for the most luminous galaxies, the brightest UV stars can be used to derive distances, although their magnitudes are dependent on the IMF. Infact, it is found that when the IMF slope s varies from 2.5 to 3, the magnitudes of the brightest stars get get larger by ~0.3—0.5 mag, while when the upper mass cut off varies from 200 to 150 $M_\odot$, they vary by 0.5—0.7 mag, for the most luminous galaxies.

ii) Contrary to the UV bands, the optical bands are more likely to sample stars in advanced evolutionary stages. However, for the less luminous galaxies, the brightest stars turned out to be MS objects in ~45% of the

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cases, due to the fact that the evolutionary lifetime of the core H-burning phase is much longer than that of the core He-burning stage, and consequently, for low N's the number of evolved stars is very small. Since the B magnitude of MS stars is appreciably lower than that of the A supergiants, the distributions turn out to be very wide. The same result was found by Schild and Maeder (1983). As the total number of objects increases, the fraction of A supergiants among the brightest stars increases rapidly: the low luminosity tail of the distribution disappears and the HMFW gets as narrow as ~ 0.4 mag. For the brightest galaxies, however, the upper end of the mass distribution becomes well populated and the fraction of MS stars among the brightest objects increases. Correspondingly, the distributions tend to get wider again (see Fig. 2).

In all the explored bands, the distributions for the magnitude of the 3rd brightest stars, or for the average magnitude of the three brightest stars are the narrowest and then, they can be used with more confidence for the estimate of the distance modulus of the parent galaxy. As a general conclusion, one may suggest the use of observations in different photometric bands of the brightest stars in large samples of galaxies, all at the same redshift. This should minimize the statistical effects and allow a good estimate of the most probable value of the absolute magnitude of the brightest stars.

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