SEARCH FOR VARIABLE EXTRAGALACTIC OBJECTS

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ABSTRACT. Preliminary results of a study of automatically detected variable objects are presented.
The sample is divided into stellar and diffuse objects and the corresponding integrated counts as a function of magnitude are evaluated and compared with results in the literature.

1. INTRODUCTION

Selection of QSO according to different criteria as radio properties (1), ultra - violet excess(2), objective prism spectra(3) and x-ray emission(4), leads to samples with steep integral counts (IC) as a function of magnitude.
Steep IC are generally assumed as an indicator of strong evolution.
The faint part (B>20) of the IC is especially important for different reasons, among which:
- a linear extrapolation of the bright part of the IC to faint magnitudes, together with a simple assumption about the ratio between X-ray and optical luminosity, would result in an excessive contribution to the X-ray background (5)
- a decrease of the IC slope at faint magnitudes would constrain the population evolution models enabling a better understanding of density and/or luminosity evolution effects (6)
- the low luminosity part of the IC contains both bright high redshift QSO and faint nearby AGN, enabling the study of early evolutionary stages as well as of the relation between QSOs and active galaxies.
Evidence for IC slope change from about 2(B/2.5) in the bright part, to about 1.1(B/2.5) in the faint one has been found by D.Koo and R.Kron (7;8), on color selected samples of stellar objects. Results from Hawkins (9), based on a sample selected by a variability criterion on a UK Shmidt plates set, but without discrimination between stellar and diffuse objects, give a slope of 1.9(B/2.5) in the range 19<B<21. The

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present analysis, based on a sample selected by variability on J plates taken at the KPNO 4m telescope, shows that the role played by the object shape in the selection of the sample, may be significant.

2. OBSERVATIONAL MATERIAL AND DATA REDUCTION

The present analysis is based on a subset of 4 KPNO 4m plates belonging to a set of 23 plates, centered at alpha(1950)=13h06m, delta(1950)=29°45', in SA57 with UJFN colors, dating from 1974 to 1985, most of which were taken by D.Koo and R.Kron (see (8) and refs. therein). The plates are: MPF (1053,3313,3919 and 3977) dating 3/74, 5/80, 4/84 and 4/85 respectively, all taken with IIIaJ + GG385 filter. The telescope scale is 18.7 arcsec/mm. and plate scanning was performed using a 20X20μm aperture with a 15μm step, corresponding to 0.28 arcsec, in both x and y directions. The area was covered by a 8000x8000 pixel transparency image, corresponding to a total area of 0.36 sq deg. The automatic reduction procedure, described in (10), was carried out on a VAX 11/780 at the Astronomical Institute of the Rome University. A catalog containing parameters for each object in all plates was derived. Object magnitudes, computed into fixed aperture diaphragms of 2.2 arcsec of radius, have been equalized to the magnitude of the plate MPF1053, evaluating the mean magnitude difference among plates as a function of magnitude. These equalized values have been recalibrated respect to a photometric sequence as described in (10). The difference between the magnitude computed in two different apertures, for each object, were used as a parameter to separate star-like objects from diffuse object, as shown in fig 1.

3. SELECTION OF VARIABLE OBJECTS SAMPLE

For each object, the magnitude value averaged over the 4 plates:

$$\langle m_i \rangle = \Sigma^4{}_{j=1}\ 1/4\ m_{ji}$$

and the RMS deviation from the mean:

$$\Delta i = (1/4\ \Sigma^4{}_{j=1} (m_{ji} - \langle m_i \rangle)^2)^{1/2}$$

have been computed.The Δ distribution as a function of magnitude gives an indication of the intrinsic error of the photometry, shown in fig.2, in the interval $20<J<21$; a peak is seen at $\Delta \approx 0.09$ slighly less than in the Hawkins work (9). However, in the present preliminar study, this figure refers to global analysis of the field without any attempt to improve the accuracy by a position dependent photometry equalization as in Hawkins work.

We choose as variable the objects having $\Delta i > 0.3$ mag, which is a value equal to the magnitude difference adopted in (9) to define long period variations. No attempt was made in the present work to eliminate short-period galactic variables, which however should represent no more than a few percent of the objects, according to (9), up to $B<21$ and even less at fainter magnitudes. As shown in Hawkins analysis, the majority of variable objects should be considered genuine extragalactic ones.

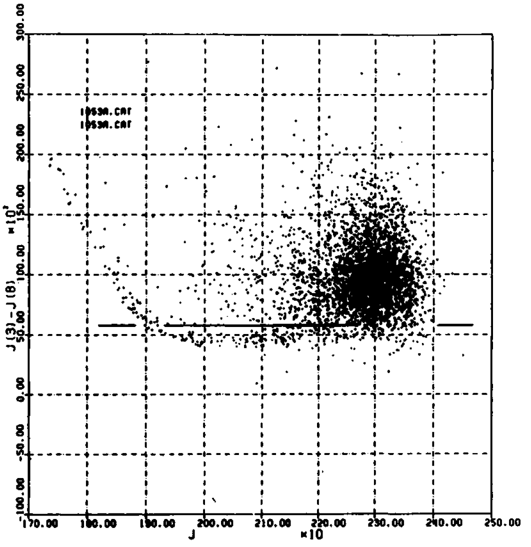

Fig.1. Object classification: difference between magnitudes at 3 and 8 pixels radius aperture, versus magnitude. Stellar objects, which have the same intensity profile, lie on a Δm=const locus, from which bright stellar objects deviate due to saturation effect. The solid line represents the threshold adopted for point - like / diffuse object classification.

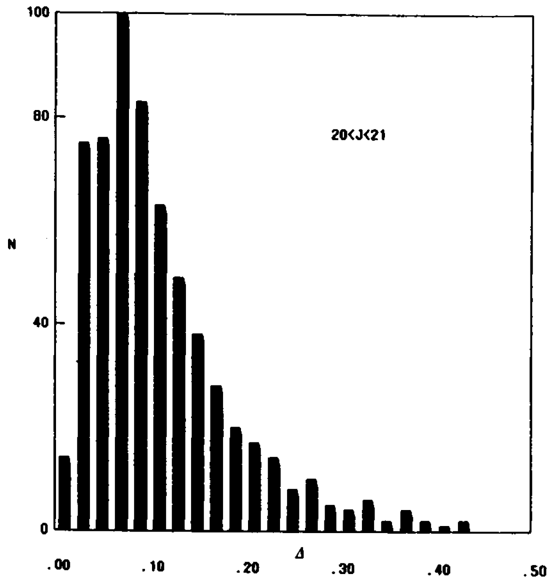

Fig. 2. Histogram of the RMS magnitude variation.

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4. RESULTS AND CONCLUSIONS

Fig.3 shows the IC for the entire sample of variables and for the subsample of star-like objects respectively.
At faint magnitudes, the diffuse variable objects overnumber the star-like ones and the slope of the IC of the entire sample is about 2(B/2.5), which is a value similar to the one found by Hawkins and also similar to the slope of the bright QSO IC. Star-like variable objects show instead a slope of about 1.3(B/2.5), which is a value only slightly higher than the one found by D.Koo and R.Kron (7,8) at the same magnitude for the color selected stellar objects.
The IC of diffuse objects could be interpreted purely in terms of the increase with magnitude of the photometric noise, in conbination with the slope of the galaxy IC. The different slope for the stellar objects could also be interpreted in a similar way, taking into account the decrease of stellar differential apparent luminosity distribution at faint magnitudes.
Nevertheless it is surprising that the resulting slopes numerically agree with the IC of bright and faint QSOs respectively. Possible incompleteness of QSO samples due to the exclusion of extended images, has been already discussed in several papers (11,12,13,14). If the results of the present analysis are due to real properties of extragalactic objects, the role played by extended objects should be reconsidered possibly including them in the analysis of the population evolution as suggested by Hawkins (9). If further analysis will show that these results are a consequence of a special combination of noise variation and apparent luminosity distribution of galaxies, we must explain also why the IC slope is about the same as the one found by Hawkins (9) on different photographic material. In this case we have found a systematic effect which must be taken into account in the evaluation of the IC slope of all the samples selected by variability.

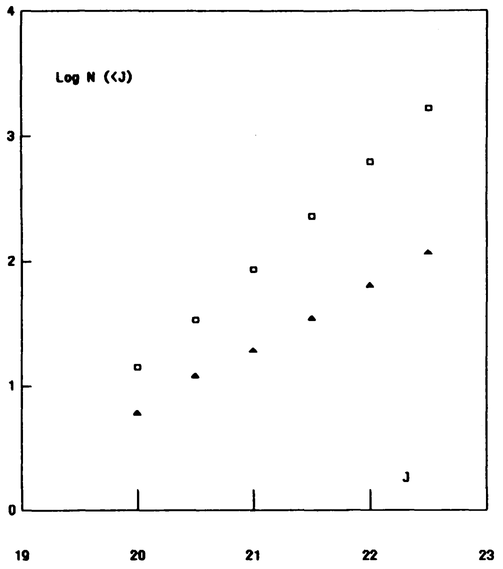

Fig. 3. Integrated counts (IC) for the entire sample (squares) and for stellar objects (triangles).

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