COSMOLOGY WITH THE SPACE SCHMIDT TELESCOPE- GALAXY COLORS AND COLOR DISTRIBUTIONS

GUSTAVO BRUZUAL A.
Centro de Investigaciones de Astronomía (CIDA),
A.P. 264, Mérida 5101-A, Venezuela.

ABSTRACT

Galaxy spectral evolutionary models are used to compute the following quantities in optical and UV bandpasses: (a) galaxy color, luminosity, two-color diagrams, and surface brightness profiles as functions of redshift; and (b) galaxy counts, and color and redshift distributions as functions of apparent magnitude. These predictions may be used as a guide to prepare and interpret observing runs with the Space Telescope, the Space Schmidt Telescope, and the Starlab Observatory.

INTRODUCTION

In this paper I report some results from a series of investigations carried out by the author (Bruzual 1981, 1983 a, 1983 b, 1983 c). In these papers parametric models for the spectral evolution of galaxies are developed using the evolutionary synthesis technique. The direct result from the synthesis program is the prediction of the evolution in time of a galaxy spectral energy distribution (s.e.d.). The model s.e.d.'s make it possible to predict observational quantities of cosmological interest that will serve as a guide in the preparation for and the interpretation of observing runs with telescopes from space (Space Telescope, Space Schmidt Telescope, Starlab Observatory, etc.). These predictions are subject to the limitations imposed upon the models by the simplifying assumptions underlying these models. Some of these assumptions are the following: (1) Galaxies can be treated as closed systems. (2) Chemical evolution is not important (for our purposes) after the stars in galaxies are formed. The models assume solar composition throughout. (3) The star formation rate (SFR) is a smooth function of time (independent of stellar mass) which

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 527–532.

determines the spectral and luminosity evolution of a galaxy. (4) The initial mass function (IMF) is a simple function of the stellar mass (independent of galaxy age) of the same general form as the IMF observed in the solar vicinity. (5) The effects of gas and dust on galaxy spectra can be neglected on a first approximation. The validity of these assumptions lies in the ability of the models to reproduce the observations.
Under these assumptions at a given galaxy age a model is specified by the SFR and the IMF. To relate time and redshift a cosmological model must be used. For reasons of space no more details about the spectral evolutionary models will be given here. The reader is referred to the papers cited above for further details.

RESULTS

Model predictions have been computed in the UBV photoelectric system, the U^+J^+FN photographic system, and in four gaussian shaped UV bands centered at wavelengths 1400, 1700, 2200 and 2700 A. The magnitudes corresponding to the UV bands will be denoted 14, 17, 22, and 27, respectively. A complete definition of the photometric systems is given in Bruzual (1983 c). A summary of the most relevant predictions follows.

(a) Color Evolution.

Color versus redshift lines have been computed for most of the color combinations in the systems mentioned above. As an example Fig. 1a shows the behaviour of the color 22-27 with redshift. The quantities next to each line refer to the values of the parameters used in the SFR and the IMF. $H_o=50$, $q_o=0$ in this figure.

(b) Two-Color Diagrams as a Function of Redshift.

The loci in the 17-22 versus 22-27 two-color diagram expected to be occupied by galaxies at z=0, 0.2, 0.5, 1.0, 1.5, and 2 are shown in Fig. 1b, for the $H_o=50$, $q_o=0$ cosmology. The hatched area indicate the region of the diagram where stars are expected. This kind of diagram should be helpful in identifying high redshift objects which subsequently can be studied spectroscopically.

(c) Luminosity Evolution.

The dependence on Z of the 27 magnitude is shown in Fig. 1c for the same models and cosmology as in Fig. 1a. The reader is referred to Bruzual (1983 b) for details about

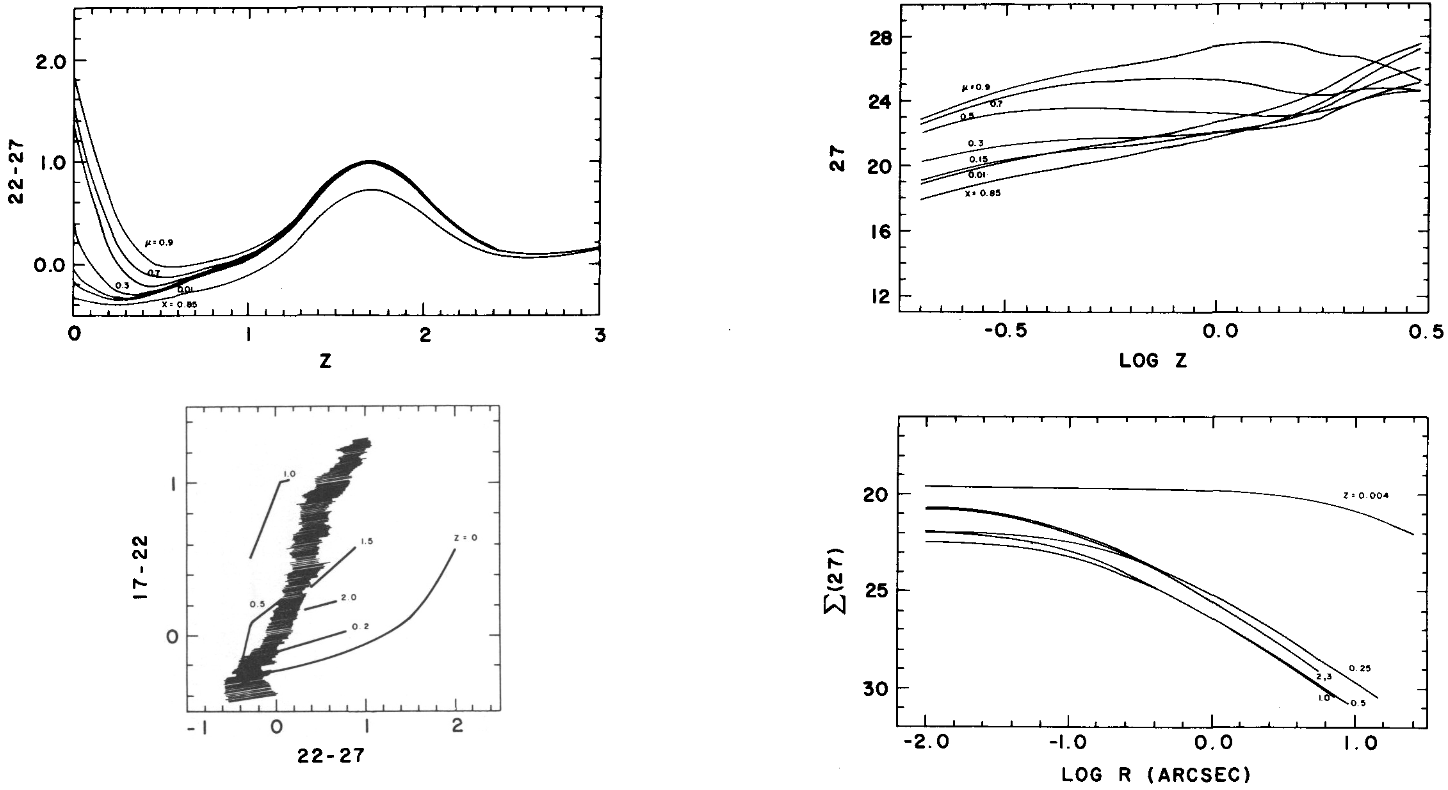

Figure 1.- (a) Behaviour of the color 22-27 versus redshift for several representative models described in Bruzual (1983 c). (b) Loci in the 17-22 versus 22-27 two-color diagram expected to be occupied by galaxies at Z=0, 0.2, 0.5, 1.0, 1.5 and 2. The hatched area indicate the region of the diagram where stars are expected. (c) Dependence on Z of the 27 magnitude. (d) Surface brightness profiles in the 27 magnitude for a $\mu = 0.7$ model at the redshifts indicated next to the curves. For the four figures it was assumed that $H_O=50$, $q_O=0$, and galaxy age = 16 Gyr.

the absolute magnitude assigned to each galaxy s.e.d.

(d) Surface Brightness Profiles.

Figure 1d shows the surface brightness profile in the 27 magnitude for a mildly evolving s.e.d. ($\mu = 0.7$). The shape of the profile is preserved at any Z. The vertical displacement for a given Z is determined by the luminosity evolution of the given model in the specific emitted wavelength. In the case shown the galaxy is brighter for Z=2 and 3, than at z=1. For bluer galaxies ($\mu = 0.01$) the same effect takes place irrespective of evolution (just due to the K correction term).

(e) Galaxy Counts and Galaxy Colors and Redshift Distributions.

With the information presented so far it is possible to predict galaxy number counts as a function of apparent magnitude in any desired bandpass (Fig. 2a). The derived color and redshift distributions can also be computed as a function of apparent magnitude. Figure 2b shows the 22-27 color distribution as a function of apparent magnitude. Figure 2b shows the 22-27 color distribution as a function of apparent B magnitude. Figure 2c shows the distribution of log Z for the same models. The reader is referred to Bruzual (1983b) for further detail.

CONCLUSIONS

Under the assumptions named in the introduction, it would seem safe to conclude that in a first approximation no unexpected results are anticipated. Faint galaxy counts are predicted to increase as expected from an extrapolation of ground-based observations. Color distributions as a function of apparent magnitude would seem to be have as hinted from data already available (Bruzual and Kron 1980, Koo 1981). Stars and galaxies can be differentiated, in principle, by their position in the UV two-color diagrams. As expected, galaxies with widely different UV luminosities at the present epoch may come from systems that looked equally bright in the past. The surface brightness profiles will, in general, behave as expected with galaxy redshift, even though for distant enough galaxies the spectral evolution (or just the K correction) in some bands may dominate the redshift term.

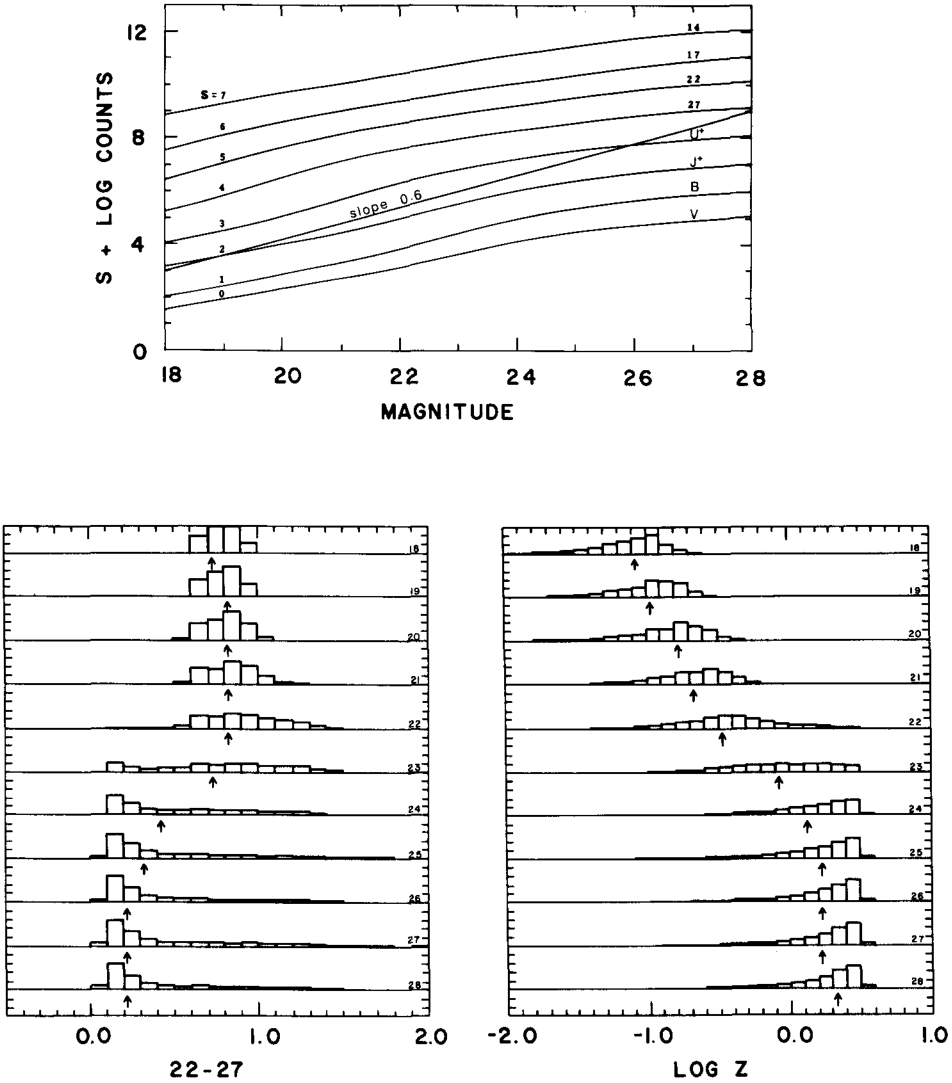

Figure 2.- (a) Galaxy number counts as a function of apparent magnitude. (b) 22-27 color distribution as a function of apparent B magnitude for B in the range from 18 to 28 magnitude. The arrows point to the median color of the distribution. (c) Distribution of log Z as a function of apparent magnitude. The arrows point to the median value of log Z. In all cases $H_o=50, q_o=0$, and galaxy age = 16 Gyr.

REFERENCES

Bruzual A., G. 1981, Ph.D. thesis, University of California, Berkeley.

Bruzual A., G. 1983 a, Ap. J., 273 (in press).

Bruzual A., G. 1983 b, Ap. J. Suppl., 53 (in press).

Bruzual A., G. 1983 c, Rev. Mexicana Astr. Ap., 8. pp.63-81.

Bruzual A., G., and Kron R.G. 1980, Ap. J., 241, p. 25.

Koo, D.C. 1981, Ph.D. thesis, University of California, Berkeley.