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COMMENT ON PHOTOMETRIC EVOLUTIONARY CORRECTIONS

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De récentes études de galaxies très bleues montrent que la formation des étoiles a lieu avec une fonction initiale de masse plus riche en étoiles de masse élevée que la fonction de Salpeter.

The initial mass function (IMF) for star formation is a major factor in determining the luminosity evolution of a galaxy. Early attempts at calculating evolutionary corrections (Tinsley 1972a, 1972b) were based exclusively on galaxy models with a Salpeter IMF, the IMF derived for the solar neighborhood (Salpeter 1955). This is approximated by a power-law dependence on mass, $M^{-\alpha}$, with an α of about 2.35. In fact, Searle et al. (1973) found the broad band colors of almost all galaxy types then studied could be fit by model galaxies using only the Salpeter IMF. More recently, analysis of giant elliptical spectral energy distributions led Tinsley and Gunn (1976) to suggest that a flatter IMF, one with a smaller α, better fits the observed spectroscopic characteristics.

In a study of the bluest galaxies – Markarian and Haro galaxies and some Zwicky blue compacts – the writer has also found evidence for star formation with a flatter than Salpeter IMF. In order to model the broad band colors and spectroscopic properties of these galaxies, I have constructed evolutionary galaxy models with power-law IMFs, and a variety of ages and star formation rates as a function of time. Although it is possible to fit the observed colors with a Salpeter IMF and bursts of star formation, it is not possible to fit the observed Hβ emission versus color data with only the Salpeter IMF.

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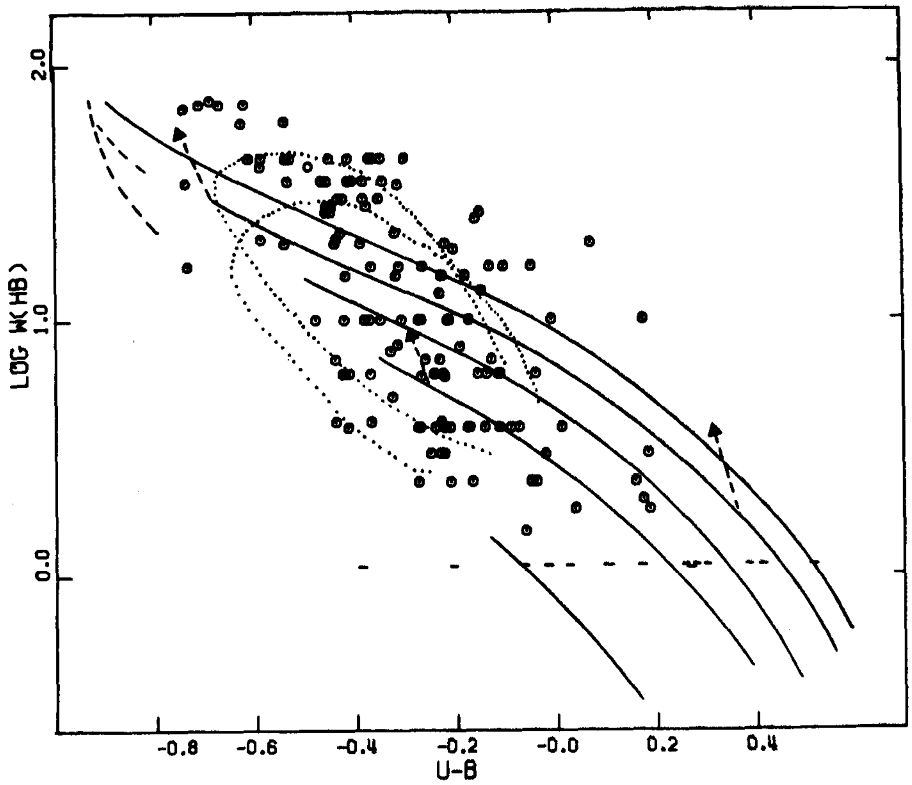

Figure 1. Model predictions for the log of the Hβ equivalent width in emission versus U-B, superposed on the observed values (Huchra 1976).

The model construction is similar to that of Tinsley (1968, 1972a) and Searle et al. (1973), but includes the contribution of emission from gas ionized by hot stars. The solid lines are old galaxy models with constant IMFs and exponentially decreasing star formation rates. The model α's are 3.35, 2.35, 1.85, 1.35 and 0.35 from the bottom up. The dashed lines to the far left are young galaxies with different IMFs and ages less than 10^9 years. The dotted lines represent the evolutionary tracks of composite galaxies — old galaxies plus a burst of star formation. The lower loop model has α = 1.85, and the upper has α = 0.35. The arrows represent the effect of increasing the upper limit of the IMF from 31 to 45 $M_{\odot}$.

Old models will not fit the data unless they have flat IMFs. Young models will not fit the data unless they are highly reddened. However, the available estimates of internal

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absorption do not support significant reddening (Huchra 1976). Composite models can be forced to fit the data with a Salpeter IMF only at the expense of populating regions of this diagram with no observed galaxies.

The formation of super high-mass stars, stars with masses $\geqslant 100\ M_{\odot}$, could eliminate the need for a flat IMF. However, the available evidence on the brightest stars in other galaxies (Sandage and Tammann 1974), does not support this idea.

Thus, the evidence concerning recent star formation at the high mass end of the IMF also suggests that the Salpeter function is not universal.

REFERENCES

Huchra, J. P. 1976, Ph.D. Thesis, California Institute of Technology.

Salpeter, E. 1955, Ap. J., 121, 161.

Sandage, A., and Tammann, 1974, Ap. J., 191, 603.

Searle, L., Sargent, W. L. W., and Bagnuolo, W. 1973, Ap. J., 179, 427.

Tinsley, B. 1968, Ap. J., 151, 547.

———. 1972a, Astr. and Ap., 20, 383.

———. 1972b, Ap. J. (Letters), 173, L97.

Tinsley, B., and Gunn, J. E. 1976, Ap. J., 203, 52.

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