GLOBAL EVOLUTIONARY EFFECTS IN THE MAGELLANIC CLOUDS

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ABSTRACT: Following Larson and Tinsley the integrated colours of the MCs from the UV to the red can be used to obtain the ratio of the present rate of star formation to the total amount of stars formed. Other tracers of recent star formation (number of bright stars, of supernova remnants, $H\alpha$ emission, etc...) will be used to determine the present rate of star formation and to obtain some information on the initial mass function. The recent ($t <$ a few 10^7 years) history of star formation in the MCs will then be discussed. Finally, it is found that the ratio present rate/total amount of stars ever formed is of the order of 0.1 Gyr^{-1} for both Clouds, implying a rather uniform average rate of star formation if the Cloud ages are the order of 10^{10} years. The results will be confronted with the metallicity-age relation and the age distribution of stars and clusters.

This review considers mainly each Magellanic Cloud as a whole and uses global properties to try to shed light on its evolution. Such an approach is relatively new and no trace of it can be found in the earlier symposia on the Magellanic Clouds. Not only is this method interesting *per se*, but its application to the Magellanic Clouds for which many data are available allows to assess its use for more distant galaxies in which one can only observe global parameters.

I will first discuss the present initial mass function (IMF) of stars and the present star formation rate (SFR) in the Clouds. Then I will go back in time and address the problem of the short-term history of star formation in the Clouds. Finally I will use their global properties to try to derive the past history of star formation in the Clouds, by comparison with the predictions of models of photometric and chemical evolution ; some comparisons will also be made with the results of detailed population studies.

I. THE PRESENT INITIAL MASS FUNCTION AND STAR FORMATION RATE IN THE MAGELLANIC CLOUDS

The direct determination of the IMF requires the consideration of a complete sample of stars in the Herzprung-Russell (H-R) diagram. Assuming a constant star formation rate (SFR) and using theoretical stellar evolutionary tracks, one adjusts the IMF until a match is achieved between theoretical and observed relative numbers of stars in the various parts of the HR diagram. Unfortunately those star catalogues covering all, or almost all, the face of the MCs are reasonably complete only down to $B \simeq 13$ and 14 for the LMC and the SMC respectively (see e.g. Vangioni-Flam et al., 1980). They contain only the very brightest zero-age main-sequence (ZAMS) stars ; the least massive stars which appear in complete samples have masses of the order of 15 $M_\odot$ (however there are deeper star surveys in some small areas of the Clouds, as we will see later). For the determination of the mass function, the stars have to be binned into mass intervals, thus requiring evolutionary tracks which are still uncertain : in addition, evolution times along the tracks are needed to derive the birthrate. Large uncertainties also arise from the necessary transformation between the M_{bol}, log T_{eff} diagram and the V, B-V diagram.

Dennefeld and Tammann (1980) have first attempted to derive the IMF of the Clouds using this method, for masses $m > 9\ M_\odot$. They found the IMF of the LMC to be $dn(m)/dm \propto m^{-2.0}$, and that of the SMC to be flatter : $dn(m)/dm \propto m^{-1.39}$. The errors on the exponents are unspecified, but they are obviously very large. They also derive the present rate of star formation for those stars and find it to be about the same per unit *total* mass in the LMC and in the solar neighbourhood (SN), and about twice larger in the SMC. Unfortunately these results depend very critically on the evolutionary tracks *after* the main sequence, which themselves depend considerably on the assumed stellar mass loss rates, convection overshooting and internal mixing. Recently, Meylan and Maeder (1982) have made a detailed comparison of the upper HR diagrams of very young *clusters* in the Galaxy, the LMC and the SMC with the predictions of models. They find that the relative frequency of yellow and red supergiants increase with decreasing metallicity, a result which can be understood as the result of a decreasing mass-loss rate and is also visible for field stars (Maeder et al., 1980 ; Maeder, 1981b ; Meylan and Maeder, 1983). While this effect might in principle be taken into account in the derivation of the IMF and SFR if the mass-loss rates were known, another problem turns out to be worse : too many stars are observed outside the theoretical MS band, a discrepancy noted by several authors after Stothers and Chin (1977). Everything occurs as if the MS was extending to effective temperatures as low as log T_{eff} = 4.0 - 3.9, thus including A stars. Whatever the cause of this extension (internal mixing, or opacity of stellar winds as in Wolf-Rayet stars) it is clear that it is still premature to try to derive the IMF from the present star samples. The SFR is perhaps less sensitive to these problems : the similarity between the luminosity functions and also between the complete parts of the HR diagrams of the SN, the LMC and the SMC

(Vangioni-Flam et al., 1980) might be taken as an indication that they can be used to infer relative SFRs, as done in Table 1. However these similarities might be due to a compensation of factors, given the probable differences in the stellar mass loss rates (Prévot et al., 1980 ; Hutchings, 1982).

Some indirect tracers which deal with main-sequence stars cause less problems, since the M-S evolution is less sensitive to abundance than the post M-S one. These tracers are :

a) The flux of Lyman continuum photons

These photons are essentially produced by O stars, which are all on the main-sequence, and induce ionization of the interstellar gas ; recombination produces photons in the visible, in particular Hα photons, whose flux is proportional to the flux of ionizing photons. Integral Hα photometry exists only for the SMC (Schmidt, 1972). From an integration of the Hα map, a colour excess E(B-V)= 0.08 and the usual relations, I find assuming a distance of 70 Mpc a flux of Lyman continuum photons absorbed by the gas in the SMC $N_c' = 4.6\ 10^{51}$ ph s^{-1}. In the SN Güsten (1981) and Abbott (1982) estimate independently a flux of ionizing photons emitted by the stars $N_c = 3\ 10^{50}$ ph s^{-1} kpc^{-2}, of which according to Güsten (1981) half are actually used to ionize the gas : hence $N_c' = 1.5\ 10^{50}$ ph s^{-1} kpc^{-2}. This number is combined with that for the SMC to derive the relative SFR in Table 1.

Table 1. Basic data (from Vangioni-Flam et al., 1980) and relative rates of massive star formation from 4 indicators

	Distance	(1) $M_{gas} (M_\odot)$	$M_{tot} (M_\odot)$	(2) L_B/M_{tot}	(3) N_*/M_{gas}	N_c'/M_{gas}	L_{1690}/M_{gas}	N_{SNR}/M_{gas}
				(Solar units)				
Solar neighbourhood	(SN)							
1 kpc^2	-	$6.0\ 10^6$	$9.0\ 10^7$	-	1	1	1	1
LMC	52 kpc	$7.0\ 10^8$	$6.1\ 10^9$	1.5	1.2 - 1.6	-	1.3	1.8
SMC	70 kpc	$6.5\ 10^8$	$1.8\ 10^9$	2.3	0.15 - 0.27	0.28	0.30	0.4 - 0.6

(1) M_{HI} x 1.3 to take helium into account.

(2) These low values may raise problems. They might mean that the total mass is somewhat underestimated.

(3) From Vangioni-Flam et al. (1980).

b) The far-UV fluxes

They are dominated by *main sequence* B stars, thus are not very sensitive to the mass-loss rate. I have re-evaluated the fluxes at 1690 A from Vangioni-Flam et al. (1980) using better extinction corrections, and find $L_{1690} = 3.5\ 10^{39}$ and $7.3\ 10^{38}$ erg $s^{-1}Å^{-1}$ for the LMC and the SMC respectively. These figures are used in Table 1 together with the calculated flux of $2.26\ 10^{37}$ erg $s^{-1}Å^{-1}$ kpc^{-2} in the SN, in order to estimate relative SFRs.

Other tracers of SFR have been discussed by Lequeux (1979). The most reliable one appears to be the number of supernova remnants (SNR), since at least the supernovae of type II result from the evolution of the core of massive stars : this evolution is almost unaffected by mass loss, according to Maeder (1981a). The catalogue of Mathewson et al. (1983) contains 17 SNRs with diameter less than 32 pc in the LMC, and 3 to 5 in the SMC while there are 0.08 such SNRs per kpc^{-2} close to the Sun according to Clark and Caswell (1976). Ignoring the difficulty in distinguishing between remnants of SN of type I and type II, and assuming the evolution of SNRs to be similar in the Galaxy and in the Clouds, this yields the SFRs given in Table 1.

The determination of the relative SFRs given in the 4 last columns of Table 1 are in rather good agreement with each other considering the large uncertainties in the parameters. The good agreement between the ratios N_c'/M_{gas} and L_{1690}/M_{gas} for the SMC is interesting since it gives an indication that the IMF for massive stars should not differ much between the SMC and the SN. We see that the SFR *per unit mass of gas* is about 1.5 times larger in the LMC than in the solar neighbourhood, and 0.3 times in the SMC. Per *unit total mass*, these relative SFRs become 2.7 and 1.6 respectively for the LMC and the SMC. It is to be remembered that the gas masses in the Clouds are probably *underestimates* because of the unknown saturation of the 21-cm line which is used to derived HI masses, and because of the presence of molecular hydrogen in unknown quantities. As to the total masses, they are probably uncertain by a factor 2 at least, especially for the SMC.

Finally, one should remember that these SFRs refer to massive stars, more massive than about 4 $M_{\odot}$, and that we know nothing of the present global SFR for less massive stars. However Butcher (1977) and Stryker and Butcher (1982) have built the MS luminosity function in two small fields of the LMC down to $M_V \simeq 5$ and find that it is close to that of the solar neighbourhood between $0 \lesssim M_V \lesssim 3$ or 4 suggesting a similar IMF down to masses slightly larger than 1 $M_{\odot}$. They interpret the break at $M_V \simeq 3$-4 as an age effect ; I will come back to this point later.

II. THE RECENT STAR FORMATION IN THE MAGELLANIC CLOUDS ($<$ a few 10^7 years)

The recent history of star formation can be considered from two complementary points of views : a) global variations of the SFR ; b) spatial variations and propagation of star formation.

The first type of study involves unbiased statistics of stars or star clusters of different ages. An early attempt has been made by Hodge (1973) who considered the 509 clusters of the LMC in which the brightest star is brighter than V = 15.5. He considered these stars as giving the approximate turning point of the main sequence turn-off for each cluster, hence obtaining a rough estimate of the age. As acknowledged by the author himself, this method is very crude. Statistics on the ages yield a roughly constant rate of production of clusters from 14 to 4 10^6 years ago of about 4 10^{-5} per year. There is a lack of clusters younger than 4 10^6 years, but it is probably only apparent given the large difficulty in dating very young clusters. No such study exists for the SMC. A similar attempt has been made by Ardeberg (1976) using supergiant stars, that he places between theoretical isochrones on the HR diagram. However the stars are observed only on limited portions of the evolutionary tracks which correspond in practice to post main-sequence evolution, and one must take into account the lifetime of the stars over each of these portions. These lifetimes are extremely model-dependent (we encounter here the same difficulty as when we wanted to know the IMF and SFR for massive stars). For this reason, I do not think that his result - that the bulk of recent massive star formation took place about 7.5 10^6 years ago - can be taken too seriously. The question must still be considered as unsettled.

However the relatively good agreement between the SFRs of Table 1, which refer to stars of different mass ranges hence of different mean ages, suggests a relatively constant SFR in both Clouds, together with an upper IMF not too different from the galactic one - unless there is by chance some compensation between these two factors - There has been also an argument, based on the well-known apparent absence of carbon stars with $M_{bol} \lesssim -6.5$ in the Clouds, that little star formation has occurred during the last 2.5 10^8 years : this time is the lifetime of a star of 3 $M_\odot$, a mass which is supposed to be the lower limit of the mass of the progenitors of the "missing" bright carbon stars ; however younger stars certainly exist in vast quantities, e.g. young Cepheids noticed by Becker (1982), in the fields where carbon stars have been investigated.

The study of spatial variations in star formation has given more convincing results. A pioneer in the field was C. Payne-Gaposhkin (1972) who published maps of the distribution in the LMC of Cepheids of different periods, hence of different mean ages (see also Schmidt-Kaler, 1977). She showed that the sites of star formation have moved considerably within the last 10^8 years. In particular, the Bar has been the site of an active formation of massive stars about 5 10^7 years ago, while it has not been particularly active for the last 3 10^7 years ; this is confirmed by the study by van den Bergh (1981) of the space distribution of young clusters (for which one should rather use the age calibration of Hodge, 1983). Similar studies spanning a shorter past have been made on LMC clusters by Hodge (1973) and on LMC supergiants by Ardeberg (1976) and more recently by Isserstedt (1983) and Prévot and Vigroux (1983). Although details differ somewhat, probably because it is rather difficult to assign absolute ages to clusters and individual stars due to uncertainties in their evolution, all these studies agree in that massive star formation occurs in important local bursts of size ≃ 1 to 2 kpc. This agrees with the idea of stochastic star formation (Feitzinger et al., 1981). However it is not obvious that star formation is generally contagious unless it propagates at extremely large velocities, of the order of 100 km/s ; these velocities seem too large to be physically meaningful.

The SMC has been much less studied in this respect. Brück (1975) has noticed that young clusters of various (very uncertain) ages are not distributed in the same way ; the study by van den Bergh (1981) yields a more detailed picture. While old clusters are scattered everywhere, young clusters (22 - 200 10^6 years according to the calibration by Hodge, 1983) are found preferentially in the Bar, while the present (< 30 10^6 years) cluster formation takes place mainly in the NE tip of the Bar and in the wing. This is also apparent in the Hα surface photometry of Schmidt (1972) which yields indirectly the distribution of O stars ; the distribution of Hα also reveals some very recent star formation in the SW part of the Bar. Brück (1981) considers that the SMC central bar is the seat of a rather continuous star formation while the surrounding "arm" regions rather proceed by bursts ; this difference does not seem very obvious to me in view of the studies mentioned above.

Another way of looking at the recent star formation is to compare the distribution of young stars with that of the gas from which they form. In the LMC massive star formation seems to take place mainly on the edge of HI complexes or between them, yielding an overall poor correlation between the distributions of gas and young stars (Martin et al., 1976); in some cases like the Shapley III superassociation it might be that the gas has been pushed out by newly-born stars. In the SMC, there is apparently a better correlation between gas and young stars (Sanduleak, 1969 ; Schmidt, 1972 ; Azzopardi and Vigneau, 1977). However this correlation is only apparent. When stars and gas in the same range of radial velocities are compared, it becomes as poor as for the LMC (Martin et al., this Symposium), although the SMC stars have a lesser efficiency to disturb the gas (Table 1 and Tarrab, 1983).

III. THE PAST HISTORY OF STAR FORMATION IN THE CLOUDS

The past history of star formation in a galaxy is reflected in its colours and in some parameters like the chemical composition of gas and stars and the mass fraction in interstellar matter. Many papers have been written about this problem and I will review here only those dealing specifically with the Magellanic Clouds. For the moment, I will ignore the structure of the Clouds and their obvious complexity and inhomogeneity and consider them as single entities.

Even a casual inspection of the global properties of the Clouds reveals differences in their past evolution. The SMC contains a higher mass fraction of gas than the LMC, presently forms 5 times less stars per unit mass of gas (Table 1) and contains 4 times less heavy elements : the SMC is clearly a less evolved galaxy than the LMC. As to the LMC, it is more similar to the SN although there remain important differences as we will see later. The first attempt to study quantitatively the evolution of the MCs is due to Olson and Peña (1976) who treated simultaneously the evolution of the SN and of the MCs. They built a computer code yielding as a function of time for a given IMF the gas fraction, the gas chemical composition and the UBV colours of the system. A law of star formation as a function of the mass (or density) of the gas had to be assumed as well as a rate of infall of external gas, which was supposed to be primordial, without heavy elements. Olson and Peña note correctly that the blue B-V colours of the Clouds imply a higher proportion of massive stars than in the SN, hence a SFR decreasing less rapidly with time and perhaps even nearly constant. This in turn implies that if the SFR is assumed to vary as a power K of the mass of gas, K must be smaller than 1. This conclusion might at first sight seem at variance with the finding by various authors (e.g. Sanduleak, 1969 ; Hamajima and Tosa, 1975 ; Martin et al., 1976 ; Azzopardi and Vigneau, 1977 ; Brück, 1981) of a positive correlation of the surface density of young, massive stars or of HII regions with that of neutral hydrogen (Schmidt's law) : however Olson and Peña remark that this concerns the *spatial* behaviour of star formation at the present epoch and has nothing to do with the *global* SFR as a function of time. Moreover we have already seen that there are local *anticorrelations* between young stars and gas in the LMC, e.g. in the region of Sh III : Martin et al., 1976 ; there are similar phenomena in the SMC : Martin et al., this Symposium. Once the slope of the IMF and a rate of infall are chosen, the chemical composition and gas mass/total mass ratio can be used to set the lower mass limit of the IMF. One problem that Olson and Peña encountered is that their models are still not blue enough, especially for the SMC ; they had to invoke a recent enhancement in star formation in order to produce bluer colours.

After this paper, Larson and Tinsley (1978) made a general study of the colour evolution in galaxies. They showed that for a given IMF, (assumed to be constant in time) the position of a galaxy on the common line in the U-B, B-V diagram is "almost uniquely determined by the SFR per unit (total) mass averaged over the past 10^8 years". To be more precise, this position depends only on the ratio $R(t_o)$ of the "present" SFR (averaged over a few times 10^7 years) over the integrated past SFR

$$R(t_o) = SFR(t_o) / \int_o^{t_o} SFR(t)\, dt.$$

Rocca-Volmerange et al. (1981) have extended this property to *any* combination of two colours, using their models of photometric evolution. They also showed that the colours, and in particular B-V, are sensitive to metallicity. This effect was not taken into account by Olson and Peña, and is apparently sufficient to explain why they found a too red B-V for the SMC. Rocca-Volmerange et al. used their model to try to reproduce the full spectrum of the Clouds from 1690 Å to the red. They succeeded by chosing $R(t_o) = 0.10$ to 0.14 Gyr^{-1} for the LMC and 0.045 to 0.11 Gyr^{-1} for the SMC. These values are dependent on the choice of the IMF (which is also assumed to stay constant in time). The heavy element abundances can give constraints to the IMF. It excludes an IMF as flat as Salpeter's IMF ($dn(M)/d\ell n M \propto M^{-x}$ with $x = 1.35$) which produces too much heavy elements ; a slope $x \simeq 2$ appears more appropriate. However this conclusion will not hold if there is a very large rate of infall, since a large heavy-element production could then be partly or almost entirely balanced by dilution with the accreted gas. Ignoring this problem for the moment, the quoted range of values of $R(t_o)$ corresponds to extreme possible IMFs in the case of no infall. The Salpeter's IMF (with large infall) would yield a smaller $R(t_o)$. It is possible to try to go farther and to reproduce simultaneously the colours, the integrated luminosity, the mass of gas and the total mass. For the LMC, Rocca-Volmerange et al. (1981) find that a good fit is obtained with a uniform SFR, hence an age of $R(t_o)^{-1} \simeq 7$ to 10 Gyr. For the LMC, a slightly decreasing SFR $\propto \exp - 0.15(t/10^9\ \mathrm{yr})$ seems more appropriate, the age being of the same order. However this assumes no infall, and on the other hand the total masses of the Clouds are so uncertain that these conclusions cannot be taken without care. The previous study is presently extended to the infrared (Rocca-Volmerange, in preparation), but the results will be *a priori* less secure due to uncertainties in the evolution of the red giants which dominate the IR emission, due to our poor knowledge of their mass losses.

One interest of the previous studies is to show that there is no need of invoking a recent burst of star formation to account for the global properties of the Magellanic Clouds. They give no evidence that the Clouds may have a small age, a complex past history, etc. This evidence has to be searched for by other means, and I will come back to this point. However the above studies already raise a big problem which is perhaps clearer in the case of the LMC : how could the SFR have been roughly uniform in the past while the amount of gas available to form stars has decreased by more than a factor 10 ? As discussed by Rocca-Volmerange et al. (1981) there are at least two ways out of this difficulty. One is to suppose that a large rate of accretion compensates for the SFR, keeping the mass of gas roughly constant. Another one is that the present SFR (integrated over the IMF) has been overestimated :

if we impose a low-mass cut-off of say 1-2 $M_\odot$ to the IMF, the *present* lifetime of the gas against star formation is raised from 1 to 4 Gyr. In this case, the low-mass stars which are certainly present and contribute much to the luminosity must have been formed mainly at an early epoch. Although speculative such a bimodal star formation is not excluded by theory (see e.g. Silk, 1980). The presence in the LMC of a halo and of a bar mainly made of low-mass stars might be taken as a possible evidence for this speculation (remember however that there has been relatively recent star formation in the haloes : see later).

It is of interest, before ending this section, to make a short review of the other information on the past SFR in the Clouds.

First of all, it appears that some globular clusters of the Clouds are very old. From the main-sequence turn-off points, the ages of NGC 121 and Linsay 1 in the SMC are estimated as 13 ± 5 and 9 10^9 yr respectively, and that of NGC 2257 in the LMC as about 14 ± 2 10^9 years (see Hodge, 1983). There is however a remote possibility that the latter object is a galactic globular cluster captured by the LMC (Stryker, 1983), in which case star formation could have started later. From the ages and metallicities of globular clusters and individual stars it is possible to infer the chemical evolutionary history for the Clouds. Searle, Wilkinson and Bagnuolo (1980) first noticed that age and chemical composition of LMC clusters are highly correlated. Cohen (1982), Cowley and Hartwick (1982) and Butler et al.(1982) further studied this correlation (the latter also included individual stars). They agree that in both Clouds the heavy element enrichment has been relatively slow, a result already foreseen by van den Bergh (1975). This progressive evolution differs markedly from that of the Galaxy, where a phase of fast enrichment was followed by little or no enrichment at all. The observed correlations for both Clouds are not inconsistent with the predictions of a closed model with a uniform SFR and constant IMF (see Cohen, 1982); however errors in the ages and metallicities of clusters are very critical in this kind of comparison, and are still too large to be able to trace the evolution in more detail.

Some "anomalous" heavy element abundances may indirectly give a hint on the past SFR. According to Dufour et al.(1982) the C/O ratio is noticeably smaller in HII regions of the Clouds than in the Galaxy, by a factor as high as about 5 in the SMC. The weakness or absence of the 2200 A feature in the extinction laws of the Clouds is another evidence for this deficiency in carbon, since this feature is supposed to be due to graphite. Carbon can be produced in rather low-mass stars in the red-giant phase, and a smaller C/O ratio can be interpreted as the consequence of a relatively smaller integrated death -rate of such stars, compared to the Galaxy. This is another possible indication of a relatively smaller SFR in the past. However Foy (1981, 83) finds that iron-peak elements in SMC stars are less deficient than oxygen, when compared to the Galaxy. Since these elements, like carbon, are often considered as being produced by smaller-mass stars than oxygen (see e.g. Tinsley, 1979), this result seems in contradiction with the strong underabundance of carbon; I cannot offer an explanation for this discrepancy.

Direct information on the past SFR could be derived if statistics of stellar ages could be obtained. This is unfortunately a most delicate topic. Butcher (1977) and Stryker and Butcher (1982) find in two fields of the LMC a deficiency in stars less bright than $M_V \sim$ 3-4 with respect to the solar neighbourhood. They suggest that the bulk of star formation started in the LMC only 3-5 10^9 years ago. However the lack of low-luminosity, hence low-mass stars, might also be a property of the IMF : see above the discussion of a possible bimodal star formation. In this model, stars with $M \gtrsim 1\ M_\odot$ formed early in the evolution would have evolved from the MS (this would not be inconsistent with the HR diagram presented in Fig. 3 of Butcher, 1977). But independent evidence for a large amount of star formation 3-5 10^9 years ago in the LMC has been presented. Mould and Aaronson (1982) suggest a peak in the age distribution of LMC globular clusters at $\sim$ 4 10^9 years, but a decreasing distribution from 12 10^9 years ago to now for the SMC ; however their age scale does not agree with that of Hodge (1983), and moreover Mould and Aaronson consider that their age distribution might be biased by luminosity evolution of the clusters and is not inconsistent after all with a constant SFR. The age distribution of SMC clusters looks different from that of the LMC and may imply a SFR decreasing with time ; these results agree with the suggestions of Rocca-Volmerange et al.(1981). It should be emphasized however that a strong increase of SFR in the LMC 3-5 10^9 years ago would not necessarily be in contradiction with the global properties of this galaxy.

In the previous discussion, the Clouds have been considered as homogeneous objects. It is well known however that both show structure : the Bar, a disk, and a halo with different properties in the LMC, and a main body, a Wing and a halo in the SMC. Surprisingly, star formation seems to have occurred fairly recently in some parts of the halos: around NGC 2257 in the LMC (Stryker, 1982), and in the region of Kron 3 in the SMC (Hawkins and Brück, 1982). In the latter region, star formation has taken place about 3 ± 1 10^9 years ago : the presence of older stars is also suggested. Clearly the history of the various components of the Clouds has been different ; another intriguing related problem is the apparently different kinematic behaviour of the old ($\gtrsim$ 1-2 10^9 years) and young (< 10^9 years) globular clusters of the LMC : Cowley and Hartwick, 1982 ; Freeman et al., 1983.

IV. CONCLUSIONS

Although an enormous observational and intellectual investment has been put into the problem of the evolution of the Magellanic Clouds, we are still far from having obtained a definite picture. A simple-minded model consistent with most observations is that of a relatively smooth evolution at a nearly constant rate since about 10 billion years. However some observations (luminosity function for relatively faint stars) do not seem to fit, and it is clear that at small scales in time and in space the evolution is not smooth. It may be that the Ockam's razor does not work for the Magellanic Clouds after all, and that their evolution has indeed been complex. This is not unexpected, since the Clouds are likely to form an interacting system with our Galaxy ; each encounter might produce a big effect on their evolution, with mass exchange etc.. The problem is certainly quite interesting but extremely complex. The possible lines of approach are multiple, and several of them are followed at the present time. I hope that their results will allow to draw a more convincing picture of the Magellanic Cloud evolution at the next specialized symposium.

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DISCUSSION

Danziger: If it was known that the slope of the IMF was a continuing function of the metallicity would this affect your conclusions concerning the differential evolution of the SMC and the LMC?
Lequeux: Most of the conclusions will be affected by changes in the IMF, as I was careful to state in my review. However the fact that the SMC is less evolved than the LMC is purely observational (from metallicity and M(gas)/M(tot). There are indeed several lines of evidence showing that either the IMF slope flattens or the upper mass cut-off increases when metallicity decreases (Serra, Puget, etc.).
Danziger: Nevertheless Melnick and Terlevich have presented some evidence recently for this dependence of slope of IMF on metallicity!