MAGELLANIC CLOUD CEPHEIDS: INTRINSIC AND EXTRINSIC PROPERTIES AS INFERRED FROM NUMERICAL SIMULATIONS OF TWO-COLOUR PHOTOMETRY

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Controversy is raging over the question which of the relations linking periods, luminosities and colours of classical cepheids should be used to the greater advantage of cosmologists in desperate need of a reliable primary distance indicator. Adopting a cepheid evolutionary scenario of utmost simplicity, Sandage and Tammann (1969) (=ST) have introduced the concept of an universal period-luminosity-colour (PLC) relation which is expected to minimize the Malmquist bias by virtue of its small intrinsic spread; the PLC relation constitutes the only primary pillar of their controversial distance scale. More recently, Stift (1982) and Clube and Dawe (1983) have shown that there are good reasons to consider a more realistic and hence more complex picture of cepheid evolution and photometric behaviour. The PLC based distance scale advocated by ST will be seriously affected by a number of non-canonical effects such as mass loss, abundance differences and varying relative crossing times. Cepheids no longer obey a single universal PLC relation as in canonical theory but a different PLC relation with a period-dependent colour coefficient applies for every crossing, mass loss rate and chemical composition (see also van Genderen 1983b). It is possible to model cepheid photometric behaviour in a way similar to that proposed by Stift (1982) and to analyze existing LMC and SMC cepheid surveys in order to put constraints on intrinsic and extrinsic properties. The <B> and <V> magnitudes are given by

$$(\langle B\rangle-\langle V\rangle)_0 = a\ \log P_0 + b + SBV\cdot U\{-0.5,+0.5\} \qquad \text{canonical} \qquad (1)$$

$$(\langle B\rangle-\langle V\rangle)_0 = a\ \log P_0 + b + G\{SBV,CBV\} \qquad \text{iconoclastic} \qquad (2)$$

$$\langle V\rangle_0 = \alpha \log P + \beta(\langle B\rangle-\langle V\rangle)_0 + \gamma \qquad (3)$$

where

$$\log P = \log P_0 + CR \qquad \text{crossing difference} \qquad (4)$$

$$\log P = \log P_0\cdot(1 + SML\cdot U\{0,1\}) \qquad \text{differential mass loss} \qquad (5)$$

$$\log P = \log P_0 + G\{SAB,CAB\} \qquad \text{abundance differences} \qquad (6)$$

and finally

$$E(B-V) = T\{\nu,\lambda\} \qquad (7)$$

$$\langle V\rangle = \langle V\rangle_0 + G\{SV,CV\} + R\cdot E(B-V) \qquad (8)$$

$$\langle B\rangle = \langle V\rangle_0 + (\langle B\rangle-\langle V\rangle)_0 + G\{SV,CV\} + (R+1)\cdot E(B-V) \qquad (9)$$

$U\{m,n\}$ stands for a deviate from an uniform distribution between m and n; $G\{\sigma,c\}$ for a deviate from a Gaussian distribution with standard deviation σ and cutoff at $c\cdot\sigma$. $T\{\nu,\lambda\}$ for a deviate from a reddening distribution resulting from absorption in a mean of ν clouds, $1/\lambda$ being the mean amount of absorption per cloud – ν follows a Poisson distribution, $1/\lambda$

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an exponential distribution (Tscharnuter and Stift 1983) (=TS). R denotes the ratio of total visual to selective absorption, SBV the strip width in B-V at constant period and SV the standard error of an observation. SML is taken to be ≃0.02-0.03, CR≃0.10 and SAB≃0.02. Cutoffs range between 2σ and 3σ. Comparison of the predicted with the observed scatter about the mean PL, PC and Wesenheit relations - TS give the numerical values for the 5 surveys used in this investigation - leads to the following conclusions (see also Stift 1982):

(1) If the canonical view holds true both photoelectric and photographic LMC cepheid photometry must be credited with much higher accuracy than the corresponding SMC photometry. Given the small differential distance modulus of $\Delta\mu<0\overset{m}{.}4$ and given the fact that the surveys have been carried out with comparable or even identical equipment this conclusion appears paradoxical.

(2) The paradox can be resolved by assuming that up to 10-15% of the SMC cepheids are observed in the 1st, 4th and 5th crossings, as compared to only a few percent of the LMC cepheids. Some support for this explanation comes from theory which suggests a correlation between enhanced relative importance of 1st crossings and lower metallicity (Becker et al. 1977).

(3) Another way of resolving the paradox consists in the adoption for the SMC of a value of R substantially in excess of R=3.2. It can be shown that Isserstedt's (1980) claim for R=2 has to be rejected; on the other hand my estimate of 3<R<5 is well in line with Harris' (1981) findings.

(4) A reliable estimate of total LMC and SMC extinction turns out to be impossible. It appears however that to a very high degree of probability, SMC and LMC suffer reddening of a comparable order of magnitude, viz. $E(B-V)\simeq0\overset{m}{.}11-0\overset{m}{.}14$ (van Genderen 1983a); the extremely low values of $E(B-V)<0\overset{m}{.}04$ sometimes found in the literature can safely be excluded. Reddening estimates are somewhat higher on the average in the canonical case than in the iconoclastic case.

(5) By no means is the zero-point of the PLC relation insensitive to chance selection effects especially in view of an empirical determination of this relation. The uncertainty may attain a few $0\overset{m}{.}1$ in the canonical case and is aggravated by a period-dependence of the colour-coefficient as well as by the above-mentioned non-canonical effects. Minimization of chance selection effects can best be achieved by the use of mean magnitudes at standard period following de Vaucouleurs (1978).

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